

SEVENTY-TWO PROJECTS, \$600 MILLION, AND 15 YEARS - NOW WHAT?

Roger Coffey¹, Sue Marino²

¹Primary Author: HDR Engineering; M. ASCE; Sewer Separation Team Lead; Professional Engineer; 8404 Indian Hills Drive, Omaha, Nebraska 68114; Phone: (402) 926-7182; FAX (402) 399-4918; e-mail: Roger.Coffey@hdrinc.com

²Affiliate Author: City of Omaha Public Works Department; Sewer Separation Design Lead; Professional Engineer; Omaha/Douglas Civic Center, 1819 Farnam, Suite 600, Omaha, Nebraska 68183; Phone (402) 444-3393; e-mail: smarino@ci.omaha.ne.us

ABSTRACT

The City of Omaha entered into a Consent Decree with the State of Nebraska Department of Environmental Quality (NDEQ) to reduce the volume of combined sewer overflows (CSOs) from their combined sewer system (CSS) to receiving streams by October 1, 2024. In response to the Consent Decree, the City of Omaha, in conjunction with the Program Management Team (PMT) comprised of CH2M Hill, HDR Engineering, and Lamp Rynearson Associates, developed the City of Omaha CSO Program Long Term Control Plan (LTCP). The purpose of the CSO Program is to reduce CSOs from the CSS. Sewer Separation is one component included in the CSO Program.

This paper will provide an understanding of the City of Omaha CSO Program, including an overview of the \$1.66 Billion Program that includes 72 sewer separation projects, and 15 Major Projects consisting of lift stations, force mains, wastewater treatment plant improvements, high rate treatment plants, system storage, and conveyance tunnels that are to be completed over a 15 year timetable.

The specifics of the paper will focus on the sewer separation planning aspects of the Program in order to provide design consistency and project delivery. These planning efforts included the development of protocols, procedures, guidance, and standards documents. These documents provide guidance and direction to Project Teams in completing sewer separation design activities.

INTRODUCTION

The City of Omaha is located on the eastern border of Nebraska, with the Missouri River serving as both the eastern boundary of the City and the division between Nebraska and Iowa. The population of the Omaha metropolitan area is approximately 800,000, with the population of Omaha's sewer service area being approximately 600,000 (United States Census Bureau 2000).

The sewers in the older, eastern part of the sewer service area are combined rather than separate. The City's CSS covers an area of approximately 43 square miles and consists of 510 miles of combined sewers and 345 miles of sanitary sewers that discharge into combined sewers. The City's total wastewater service area is approximately 275 square miles in both Douglas and Sarpy counties. As of 2009, there are 29 CSO outfalls identified and permitted to discharge during wet weather in the City's CSS: 19 overflow to the Missouri River and 10 overflow to tributaries of Papillion Creek (See Figure 1).

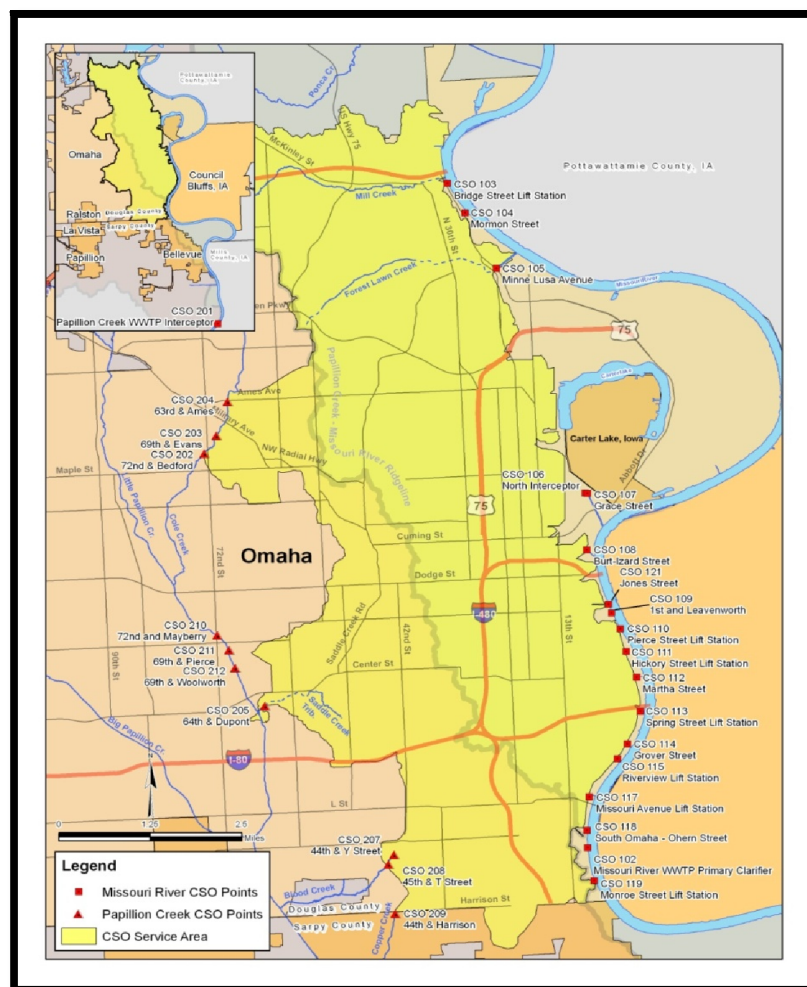


Figure 1 – Permitted CSO Overflow Locations

The City has been separating portions of its CSS since the 1970s. In the late 1980s, a program to separate sewers was formalized to reduce the number of wet weather sewer backups into basements of businesses and residences. The City has spent more than \$100 million on sewer separation projects to date. Although the Sewer Separation (RNC) Program's primary goal has been to reduce sewer backups, efforts have been made to design and construct projects that also reduce the effects of CSOs on the receiving streams. The City has spent more than \$20 million of the \$100 million on projects that directly reduce the number or magnitude of CSOs or improve their water quality. A large portion of the projects constructed under the RNC program involved local area separation, generally in the form of parallel relief storm sewers that eventually tie back into the CSS downstream of the sewer backup problem area. The improvements from the previous projects were incorporated into the controls of the LTCP, thus the money already spent by the City has helped reduce the overall cost of the LTCP.

LTCP STUDY PHASE

For the purposes of the LTCP development, the known CSS service area, along with approximately 20 square miles adjacent to this area, was divided into 10 study basins (See Figure 2). Six of the study basins drain to the Missouri River and four drain into Papillion Creek or one of its tributaries. The 10 study basins were further categorized as either "Complex" or "Less Complex". The Less Complex Basins have lower CSO volumes than the Complex Basins and consist of a high percentage of residential properties. Due to the lower complexity of the Less Complex Basins and the knowledge City staff had of these areas, it was presumed likely at the beginning of LTCP development that sewer separation would be the preferred approach for controlling these CSOs, subject to confirmation. The Complex Basins have higher CSO volumes, significantly higher flow rates, and consist of a higher percentage of urbanized land than in the Less Complex Basins. Due to the greater system complexity of the Complex Basins, it could not be presumed that sewer separation alone would be the preferred CSO control; therefore, numerous CSO control alternatives were evaluated.

LTCP REFINEMENT PHASE

Following submission of the Substantively Complete LTCP (SCLTCP) in October 2007, the City and Basin Consultants conducted 26 Program-Level Refinement Tasks and nine Basin-Level Refinement Tasks to further develop and refine the CSO controls. The Refinement Tasks that were of highest significance to this paper include:

- **Green Solutions (Stormwater Best Management Practices).** Evaluated possible locations for Green Solutions and incorporated into the LTCP the development of a program to further evaluate them during the study and design phases.
- **Refinement of Sewer Separation Projects.** Additional sewer separation projects were identified that are cost effective and have the dual benefit of reducing CSO

volume and minimizing basement backups of sewage in residential areas during wet weather.

- **Refinement of Sewer Separation Design Approach and Project Costs.** Refined costs for and ensured consistency among sewer separation projects and developed a revised Sewer Separation Guidance Document. The Cost Tool data was updated based on ground-truthing of component costs with actual bid results received by the City on similar sewer separation projects and adjusted to a common Engineering News Record Construction Cost Index cost level.

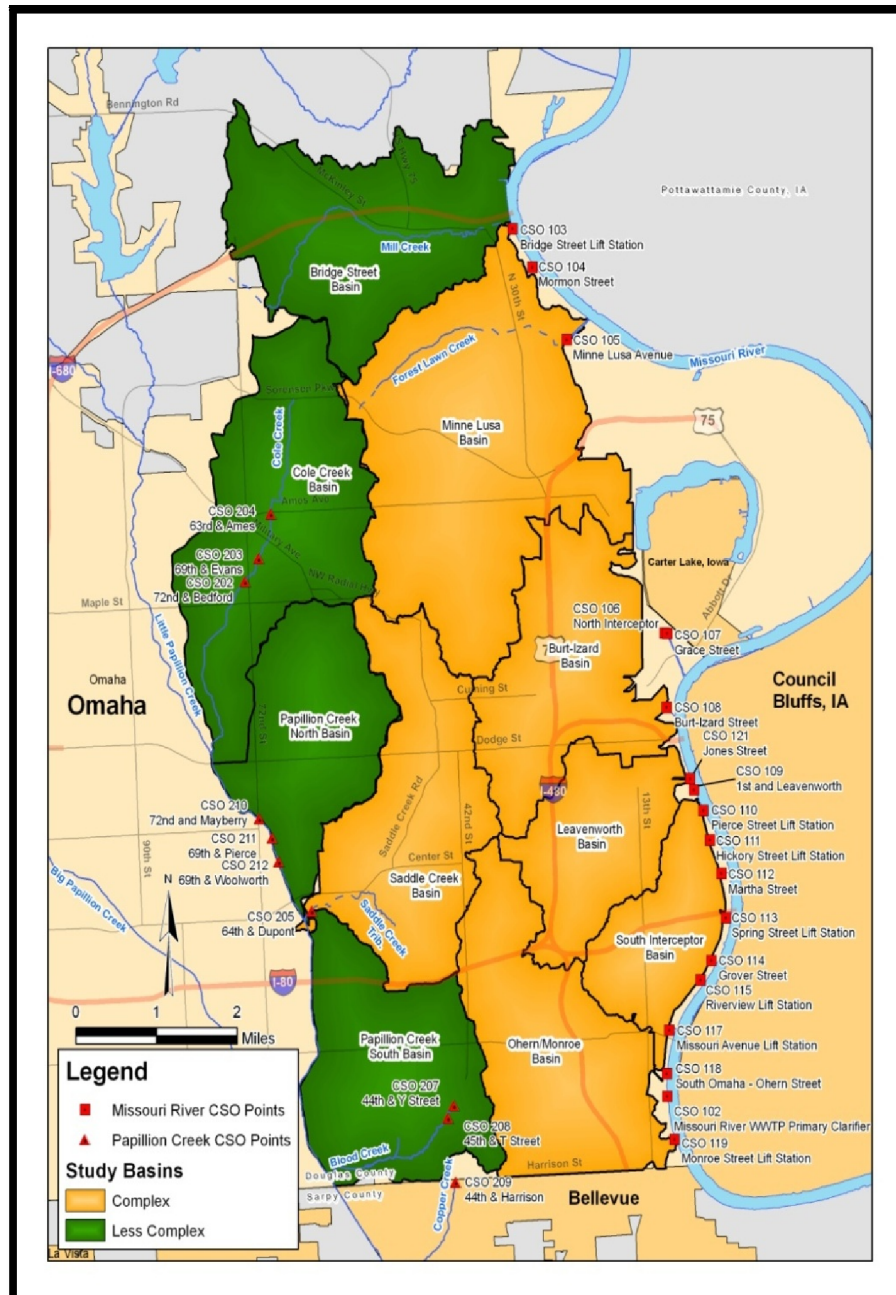


Figure 2– CSO Study Basins

FINAL LTCP

Sewer separation is the construction of new sanitary and/or storm sewers within a combined sewer area to separate storm water from the sanitary sewer flows. The existing combined sewers subsequently serve as either sanitary or storm sewers or may be abandoned. Sources of storm water such as catch basins, roof leaders, and area drains are directed to the separate storm sewers. Sanitary sewers collect domestic wastewater and commercial and industrial discharges only.

As part of the evaluation of CSO controls, the City evaluated sewer separation of varying degrees. In some of the Less Complex Basins, separation of the system was needed only in small areas to complete the separation of the basin. In other areas, separation was performed to a level that generally meets one of the following parameters:

- Eliminates CSOs during all conditions, allowing for deactivation of the CSO outfall.
- Reduces CSOs, with no CSOs occurring during an average year (based on the InfoWorks Model results). It is anticipated that under larger storm events, CSOs could still occur from these locations.
- Reduces the number of CSOs to four or fewer during an average year (based on the InfoWorks Model results).

In the latter two instances, complete separation does not occur and the CSO outfalls would not be deactivated.

The City assembled the results of the Refinement Tasks and developed final CSO controls, an Implementation Plan, an Operations Plan, and a Post-Construction Monitoring Plan. The total program cost is estimated to be approximately \$1.66 Billion (April 2009 dollars; ENRCCI of 8528). The Final LTCP was submitted in September 2009 and approved by the NDEQ in February 2010.

The final LTCP included the following major categories of projects:

- Wastewater Treatment Plant (WWTP) improvements to maximize treatment of wet weather flows.
- Segregation of industrial meat-packing plant flows for separate treatment at the WWTP, including an Industrial Lift Station, Force Main, and Gravity Sewer.
- Deep Tunnel and associated lift station to convey combined sewage to an RTB on the WWTP site.
- RTB at the Saddle Creek CSO 205 outfall.
- Replacement/Upgrades of five existing Lift Stations.
- Stormwater collector sewer to convey stormwater from portions of the Minne Lusa Study Basin directly to the Missouri River.
- Storage facilities at the Minne Lusa Outfall - CSO 105 and at the Cole Creek CSO 204 outfall.
- Sewer separation projects. It is currently estimated that 72 individual projects will add approximately 317,000 feet of new storm sewer and 107,000 feet of new

sanitary sewer to the system. Rehabilitation of portions of the sewer system is also anticipated in the Program. The sewer separation projects will result in about 5,735 acres being separated.

After selection of the CSO Controls, the City reviewed each project to determine its impact on water quality, priority in construction sequence, and cost. The City identified projects that will provide the greatest water quality benefits and sought to schedule them early in the implementation period. While water quality improvement is the primary driver in the development of the implementation schedule, it is also necessary to ensure that the projects are constructed in a logical sequence and that time is allowed for gathering information crucial to design. Because of the significant costs associated with the CSO Program, it will be necessary for the City to increase sewer rates to pay for implementation of the LTCP. The City is also facing major upgrades (outside of the CSO Program) to its wastewater treatment plants and collection system, that will affect the City's ability to pay for the CSO controls. The timeframe under which the City can raise funds is an important factor in the development of the schedule. After water quality and sequencing were considered, the need to maintain a relatively steady cash flow was taken into account.

Based on the ranking of the projects and the steps discussed above, the City developed an estimate of the time needed to complete the key phases of the projects. The projects were sequenced and ranked according to water quality impacts, and the project interrelationships/priorities were established. The City then developed a preliminary LTCP program implementation schedule. This schedule was then adjusted to conform to the City's financing capability.

Ultimately, the schedule of the projects was incorporated by the NDEQ into the NPDES permit and the Program must track and report the progress of the individual projects throughout the implementation period.

RNC SEWER SEPARATION PROGRAM

In addition to the CSO Program, the City is also providing for the continuation and expansion of the City's RNC sewer separation Program to address areas of sewer back-ups not included in the CSO Program. The current RNC Program consists of an additional 29 sewer separation projects with a total program cost of approximately \$200 Million over the same 15 year period.

LTCP IMPLEMENTATION

The City and PMT was faced with the task of completing the design and construction of over 100 sewer separation projects from the combined CSO and RNC Programs valued at \$800 Million in the 15 year period. This amounts to an average of 7 projects (\$50 Million) per year for the 15 year period. However, due to the funding capability of the City and the funding for the other Major Projects as part of the Program, the schedule for the sewer separation projects is not uniform throughout the LTCP schedule. For example in 2014 there may be as many as 17 sewer separation projects being design at the same time. In 2012 there may only be 12, and in 2020 there may

only be 7. Historically, the City averaged 1 to 2 projects (approximately \$6 Million of construction) per year. The majority of the design work was completed in-house by City personnel.

It was recognized early in the development of the LTCP that there would be a significant ramping up of the design and construction effort for the sewer separation portion of the LTCP. Consultants that have never been involved in sewer separation in Omaha would need to be contracted by the City to help in meeting the schedule. Of utmost importance to the City and the PMT was determining how to effectively manage the acquisition of field data, consistency of design and meet the aggressive project delivery schedule.

The City had many years of experience in the design and construction of sewer separation projects within their system. However, procedures and design specifics were not well documented. The plans, protocols, procedures, guidance and standards documents were developed to document the City's procedures and expand upon them to provide for consistency in the design and documentation for the Program. These documents provide guidance and direction to Consultants in completing sewer separation design activities and allow for efficient review of the deliverables. The plans, protocols, procedures, guidance, and standards documents consist of the following:

Quality Management Plan - The purpose of the Quality Management Plan (QMP) is to provide guidelines for quality assurance (QA) and quality control (QC) activities to achieve the highest quality project on schedule and on budget. The QMP will be provided to the project teams for implementation on all project deliverables performed under the umbrella of the CSO program. The program's QMP uses the basic concepts of standard procedures, continuous QA and QC, and teamwork.

Risk Management Plan – The purpose of the Risk Management Plan was the development of a Program Risk Register to identify and quantify costs and schedule risks associated with implementing the Long-Term Control Plan. The Risk Register is composed of a list of elements that if they occurred would impact either the cost or schedule of an individual project with the possibility of affecting the overall Program cost or schedule. The individual risks were assigned an identification number and quantified to give them a dollar value per project at the 50th percentile. This is considered the event risk or risk that an individual event occurs on a given project. The risk assigned to each individual project does not consider the risk of completing an entire program. A Monte Carlo simulation was used to estimate the risk at the 70th percentile for the Program which was then applied to each project type.

Environmental Protocol - This protocol outlines the policies, procedures and guidelines for the City, Program Management Team (PMT), and Project Teams to use to address environmental concerns and permit requirements. Specifically, this protocol addresses the following:

- Responsibilities of the parties involved in addressing environmental issues and permitting of the various projects, from planning to operations;

- Policies, procedures, and guidelines for implementing environmental and permitting services; and
- Communication Policies.
- Reference information provided as part of the Environmental Protocol includes an Environmental Data Resources (EDR) map of the CSO Program area for Project Team reference.

Sewer Separation Protocol - Sewer Separation Projects will be designed by a number of Project Teams over the 15-year implementation period of the Program. As such, an approach that provides continuity and consistency is needed to achieve Program goals and meet Program standards. The purpose of the Sewer Separation Protocol is to summarize systematic procedures to be followed by Project Teams for the study, preliminary and final design phases of sewer separation projects. This Protocol is comprised of the following elements as they pertain to the study, preliminary and final design process: Project management procedures including field services, project design, monitoring and oversight procedures, design development guidance and procedures, geotechnical considerations, cost estimating, drawing and technical specification guidelines, and public/community relations.

Field Services Procedures – Consistency of data interpretation and measurement is a significant function of the data inventory and condition assessment process since many subsequent engineering and management decisions will be influenced by the integrity of the collected data. Field Serve Procedures consist of the following:

- **Pipeline Inspection Using CCTV Procedure** – Pipeline inspection using Closed Circuit Television (CCTV) is the process of placing a video camera into a sewer pipe to collect data on a pipeline, noting the construction features, maintenance and structural conditions. The purpose of this CCTV Procedure is to clarify the work requirements and identify procedures to be implemented. All CCTV inspections performed for the City of Omaha (City) shall be performed by trained operators that have taken and successfully completed the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP). All CCTV work shall be completed using established PACP coding and observations.
- **Manhole and Lamping Inspection Procedure** - Manhole structures are the primary access points into sewer systems to allow for proper maintenance and operation. Inspections of these structures are critical to evaluate potential sources of inflow and infiltration, structural integrity, and potential public safety issues. The purpose of the Procedure is to provide an understanding of the procedures surrounding various levels and types of manhole inspections performed within the City of Omaha programs and guidance for a uniform approach to field data collection. The scope of work for specific projects will identify the levels and types of inspections required. The field data collected will be used to aid in the design of sewer improvements including sewer separation and sewer rehabilitation projects. Consistency of data measurement and interpretation is a significant function of the data inventory and condition assessment process since

many subsequent engineering and management decisions will be influenced by the integrity of the collected field data.

- **Smoke and Dye Testing Procedure** - Smoke Testing and Dye Testing are common sewer assessment procedures used to help identify infrastructure connectivity and locate defects that have the potential to become extraneous sources of primarily inflow and to some extent infiltration resulting from rainfall. The purpose of this document is to provide an understanding of the procedure and guidance for a uniform approach for data collection. The field data collected will be used to aid in the design of sewer separation projects and sewer rehabilitation projects.

Design Phase Procedure - In order to promote consistency in design of the Program projects, design phase standards and procedures are identified for use by the project teams. Checklists have been developed to facilitate the preparation of design documents and for review of the projects. This procedure summarizes a number of Standards documents, identifies the submittal requirements for the 30%, 60%, 95% and final submittals, and identifies the form and number of sets for the deliverables. This document identifies a number of City criteria and requirements including street removal and replacement, intersection radii evaluations, handicap ramp replacement criteria, I/I reduction measures, and construction phasing.

CSO and RNC Public Information Procedure - Public involvement and community acceptance are major components of the CSO Program LTCP implementation. The public involvement element is closely aligned with the Program's communications strategies as well as Community Enhancements activities. To ensure consistent communications this Procedure document is intended to assist Project Teams with the implementation of Public Involvement responsibilities which are part of each project within the CSO and RNC Programs. This document outlines the responsibilities of the key public involvement entities, provides more information about specific public project meetings, and has meeting guidelines and procedures, plus additional communication approaches. The primary goal for these procedures is to insure that information presented to the public for each of the projects within the Program is consistent in the content, detail, form, branding, and delivery.

ROW Management and Property Acquisition Procedure - The purpose of this procedure is to identify the process for effectively managing right-of-way and property acquisition required for sewer separation projects. This document is intended to provide general guidance to the Project Teams, PMT staff, and City staff and identify important elements that need to be considered in the coordination with the City of Omaha ROW Department to meet the schedule of the individual projects.

Geotechnical Investigation Procedure - The purpose of this document is to identify the procedures for geotechnical investigations associated with the sewer separation projects. This will provide for consistency of the geotechnical investigations and reporting of results of these investigations which include street coring and sub-base testing and evaluation.

Utility Coordination Procedure - The purpose of this document is to describe the procedures for obtaining and identifying existing and planned utility information for LTCP projects. Utility data collection shall be in general accordance with current subsurface utility engineering (SUE) quality standards as described in ASCE's "Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data". The procedures are in conformance with the Mayor's Road Construction Task Force Report and include a current listing of contact information for all known utilities in the Program area. The Metropolitan Utilities District provides water and gas service in the CSO Program area and has implemented a program to upgrade the Utility's water and gas systems to meet new Federal requirements and replace aging infrastructure in conjunction with the City's CSO sewer separation program.

Sewer Separation CAD Standards - This CAD Standard provides guidance and information for use by the City of Omaha (City), Program Management Team (PMT), Consultants, and all other staff involved with the preliminary and final design of City of Omaha sewer separation projects. This document is intended to expedite drawing production, improve drawing consistency, and ensure drawing uniformity among all personnel involved in the design of these projects.

Public Works Department Design Division Survey Standards - It is the intent of this Standard to identify all survey requirements and establish an acceptable guideline for the appropriate task performances. The goal is to assure that all necessary work is carried out in a reasonable and timely manner, thereby minimizing the potential for costly and untimely follow-up survey, task repetition or additional field operations. This should provide the Surveyor and the City a greater opportunity for the development of a clear understanding of the City's survey needs on a specific Project by Project basis.

InfoWorks Modeling Standard - The City has developed a hydraulic model of its combined and sanitary sewer system using InfoWorks to support development of the LTCP. The InfoWorks Model (Model) is available to Project Teams to provide information and potentially serve as a tool to help in the design of sewer system projects. This Standard provides information for Project Teams using the Model during Implementation of the LTCP. Model use will primarily be associated with sewer separation projects that involve sanitary pipe design.

Cost Estimate Guidance - The purpose of this document is to describe the guidelines for developing the "Engineers Estimate" (Opinion of Probable Construction Cost) for the projects. This document is intended to guide estimators developing the cost estimates and cover the requirements for the typical deliverables or submittals for the 30%, 60%, 95% and Final design phases. This document is intended to provide general guidance and identify important elements that need to be considered.

Green Solutions in Sewer Separation Guidance - 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 intended to provide general guidance and point out important elements that need to be considered. The integration of Green Solutions into the design of sewer separation

projects has the potential to offer benefits to the City of Omaha. Reducing runoff directly reduces the potential for overflows. 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.

Private Property Investigation Guidance - The purpose of this document is to provide guidance for the City's sewer separation project investigations on private properties to investigate sources of inflow/infiltration to the sewer system. Coordination of the investigations with the property owner/resident is required and the safety of the Project Team field personnel is of great importance.

Sanitary Sewer Design Basis and Methodology Guidance - The purpose of this document is to provide guidance for the design and sizing of sanitary sewers for sewer separation projects. This includes the design and sizing of new sanitary sewers and the design of combined sewers converted to sanitary sewers.

Storm Sewer Design Basis and Methodology Guidance - The purpose of this document is to provide guidance for the design and sizing of storm sewers for sewer separation projects. This includes the design and sizing of new storm sewers and the use of combined sewers converted to storm sewers.

Sustainability Guidance - A Sustainability Guidance Document has been developed that includes a Vision Statement and Program Goals relative to sustainability. From this Guidance Document a Sustainability Benefits Table has been developed which includes specific program-wide benefits and performance metrics. This table also includes example project sustainability strategies. This document provides guidance to project teams in the implementation of the Program sustainability strategies.

Urban Design Review Board Guidance - The Urban Design Review Board (UDRB) was created by the City of Omaha City Council to review design aspects of plans for private developments and public above-ground structures, as referred to it under the Omaha Municipal Code. The term "Right-of-way improvement" is defined as a visible structure, physical element, or design element, which is attached to the ground within the public right-of-way, or which is identified in the Omaha Streetscape handbook. The UDRB has adopted Rules of Procedure that include the description of the types of projects that fall under the review of the UDRB including any right-of-way improvement along a "Green Street" as identified in the Green Streets for Omaha Plan or along proposed or established bike routes. The Project Teams will need to prepare submittal packages for review by the UDRB.

Other Reference Documents – A number of other reference documents and materials are provided to the Project Teams for their use in the design process. These include:

- Bid Summaries from previous sewer separation projects
- Historical Streetcar Routes to identify potential locations of buried rails

- Omaha Regional Storm Water Design Manual
- Omaha Lead Remediation Area Map, and
- City of Omaha Design Guidelines References

PROJECT CONTRACTING

All design consultants and construction contractors are contracted to the City of Omaha. The PMT is assisting the City in the preparation and scheduling of the Requests for Proposals (RFPs), drafting of the Consultant Contracts and Scopes of Services, and the coordination of the schedule for bidding of projects for construction services. The City is attempting to include multiple projects in each RFP to minimize impact to City contracting and also lessen costs to Project Teams for proposals and interviews. A City Project Manager and a Program Management Team (PMT) Coordinator are both assigned to each project to monitor the project and assist the Project Team in accomplishing the project per the plans, protocols, procedures, guidance and standards documents.

DISCUSSION

Implementation of the LTCP was initiated in 2009 with the start of design of a number of projects. At the end of 2010, after one year into the 15-year Program schedule:

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| - Number of projects completed thru construction | - 4 |
| - Number of additional projects bid | - 3 |
| - Number of projects in the final design phase | - 7 |
| - Number of projects in the preliminary design phase | - 8 |

With 20 projects currently under contract to the City in some phase of design or construction there are 14 different prime Consultants and a total of 47 different engineering, architectural, geotechnical, and field services firms working on the Program as part of Project Teams. Each Request for Proposal has resulted in anywhere from 5 to 10 proposals from Project Teams.

CONCLUSIONS

The transition from a sewer separation program primarily designed by in-house City engineering staff, to an expanded program designed by outside consultants has not been without a learning curve for both City staff and Consultant staff. The Project Teams are learning what it takes to complete a sewer separation project for the City of Omaha. Each City is different with different utility coordination issues, local design practices, geotechnical variations, construction contracting requirements, construction materials, local historical features that affect design and construction, etc. And the City and PMT staff is learning to what level of guidance is required to achieve the desired consistency of design in order to expedite the projects. In some instances the Project Teams also introduce sewer separation expertise developed from programs in other CSO cities.

Based on the collaboration between the Project Teams, the PMT and the City, the plans, protocols, procedures, and guidance documents will evolve as the Program progresses. While the information provided in the plans, protocols, procedures and guidance documents is necessary, how this information is packaged and presented will evolve based on the lessons learned from the early projects. An adaptive management strategy was envisioned from the start of this Program and continues to be an integral part of the Program.

The level of consistency of the design documents from project to project is improving and all projects are currently on or ahead of schedule to meet the Program schedule. And the overall sewer separation cost remains within the anticipated budget established as part of the LTCP. The pro-active strategy of developing these plans, protocols, procedures, guidance, and standards documents has provided the basis for consistency in design and the ability to meet project schedules. This basis will be beneficial as the Program moves into the coming years where the number of sewer separation projects being managed dramatically increases.

ACKNOWLEDGMENTS

The development of the LTCP, plans, protocols, procedures, guidance and standards documents for the City of Omaha was a team effort that involved City staff and the PMT firms of CH2M HILL, HDR and Lamp, Rynearson & Associates.

REFERENCES

CITY OF OMAHA (October 1, 2009) *Long Term Control Plan for the Omaha Combined Sewer Overflow Control Program*

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