XP Software

Creating a Comprehensive Stormwater Model in a Challenging Environment

Written by Matthew Luth, Civil Engineer, Burns & McDonnell

Introduction

The City of Jefferson, Missouri is a town of nearly 40,000 people, situated in the heart of the Missouri River valley. The area's rocky terrain and steep hillsides have created a unique, albeit troublesome drainage environment.

The City's current drainage system is composed of a mixture of enclosed system, overland drainage swales, and concrete and natural channels. Most of the system is structurally in good shape, but not without its problems. Until now, drainage problems were always fixed only at the point where the problem occurred, without much thought given to how these "spot fixes" would affect other locations throughout the watershed.

City staff wanted to replace the "shifting the burden" philosophy for a more comprehensive "whole watershed" approach to stormwater management issues.

Additionally, City staff wanted to develop a better system to inventory and map its conveyance system. A growing city and National Discharge Elimination System (NPDES) Phase II requirements created a sense of urgency. The end result? The City decided now it was time to develop a comprehensive stormwater model and inventory to provide them a user-friendly, dynamic stormwater management system that could grow and change to keep up the City's needs now and in the future.

Data Collection

When the project began, Jefferson City didn't have any digital information on their stormwater structures. Their entire stormwater inventory was contained on hard-copy atlas sheets and CAD drawings from more than a decade ago.

The engineering team decided to perform a citywide inventory of all the stormwater structures, to get a better understanding of the scale of the system. Survey crews from both the city and a local consulting firm scoured the City and located more than 10,000 stormwater structures to add to the inventory.

Data including location coordinates, crown elevation, and invert depths were collected for each structure, and information such as structure dimension and composition were collected for each pipe using Global Positioning System (GPS) technology. As soon as the inventory was finished, it was converted into database format that could then be imported into the stormwater models.

Hydrology and Hydraulics

Project engineers and City staff decided to utilize XP-SWMM software to perform both hydrologic and hydraulic calculations. Following local hydrologic protocol, the project team utilized the approach outlined in the Soil Conservation Service (SCS) Technical Release 55 – "Urban Hydrology for Small Watersheds" in the determination of storm runoff volume, peak rates of discharge, and determination of storage volumes required for detention facilities.

Engineers employed existing city planimetric data in the determination of hydrologic characteristics. Existing topographic data was used to delineate watersheds and determine times of concentration. Additionally, existing soil type and land use information was utilized to determine representative curve numbers for drainage areas. The hydraulics block of XP-SWMM was used to route the flows through both the open channel and enclosed conveyance systems.

The entire model was created from the database developed during the inventory using the import/export database tool that accompanies the GIS Link for XP-SWMM. After the stormwater model was created, the project team used the model for design storm events, checking it against previous studies and calibrating it to historical flooding records.

Project Solutions

After the stormwater models were developed and calibrated, City engineers wanted to start evaluating potential improvements to determine their impacts on stormwater drainage both locally and throughout the watershed. Several scenarios including detention basins, enclosed system enlargements, and channel modifications were modeled to help the City determine which capital improvement projects would yield the greatest overall benefit to the storm drainage system.

A total of over $40 million in recommended capital improvement were presented to the City. The City plans to add a timeline and funding schedule to the database to achieve their capital improvement goals, and to keep track of funds already spent. Furthermore, City staff plans to expand existing database templates created during the project, to expand the stormwater models for system improvements and future development, and eventually add water quality analysis to help satisfy NPDES Phase II requirements.

With the completion of the project, Jefferson City now knew what structures composed their current system, how the existing system handled stormwater runoff loads, and what improvements need to be completed to alleviate stormwater flooding throughout the City.

Conclusions

Overall, Jefferson City has elevated the traditionally static process of preparing a stormwater management inventory and model into a dynamic method of keeping up-to-date with the City's ever-changing stormwater needs. Plans are already underway to add the inventory and create stormwater models for the surrounding rural areas, so that if proposed annexation becomes a reality, City staff will be prepared. A stormwater management concept is now in place that allows

For further information

For additional information on XP-SWMM, please contact your local sales office:

USA
XP Software, Inc
2000 NE 42nd Ave, Suite 214,
Portland, Oregon, 97213, USA
Tel: 1-888-554-5022 Fax: 1-888-554-5122
Email: info@xpsoftware.com

Canada
XP Software, Inc
9-75 First Street, Suite 224
Orangeville, Ontario, L9W 5B6, CANADA
Tel: 1-877-533-4533 Fax: 1-519-941-7966
Email: Canada@xpsoftware.com

Australia
XP Software, Inc
PO Box 3064
Belconnen, ACT 2617
Tel: (02) 6253 1844 Fax: (02) 6253 1844
Email: sales@xpsoftware.com.au