DEVELOPMENT OF CITY OF NORFOLK
STORM WATER MASTER PLAN
CITY OF NORFOLK
VIRGINIA

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City of Norfolk, Virginia

Abstract

The city of Norfolk is a major urban center in the Hampton Roads, southeast Virginia. Norfolk's storm water system consists of 349 miles of pipes, 137 miles of ditches, 13 storm water ponds, and 10 storm water pump stations. Performing inventory updates, assessing pipes and structures, and setting priorities for major maintenance and improvement initiatives along with reconciling and verifying current GIS mapping and database were the main project goals. The challenge was how to develop systems and protocols in which the Capital Improvement Projects (C.I.P.) process becomes a proactive tool rather than a reactive process. The project includes a study of the modeling systems available to determine which one better fits city needs. Data interchange, intermediate programs, program interfaces, and program integration were deeply discussed through out the projects.

Background

The City of Norfolk with a population of more than 240,000 is the urban center for the Hampton Roads metropolitan area. Norfolk also serves as the cultural center of the area with museums, the home of the Virginia Symphony, the Virginia Opera Company, and other performing and cultural arts treasures. The battleship U.S.S. Wisconsin is permanently berthed in the downtown area next the National Maritime Center, NAUTICUS. Home of the world's largest Naval Base and headquarters for the 3rd Fleet and NATO commands, 48 percent of Norfolk's land is owned by the Federal and State governments.

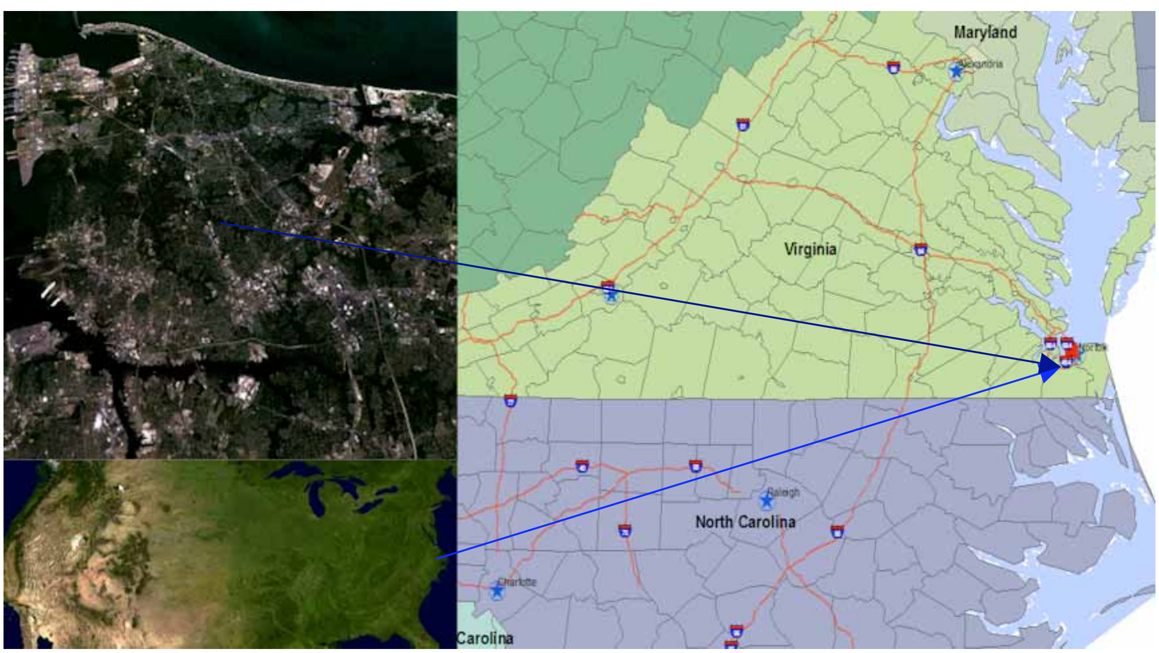

Fig. 1: Location Map

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Norfolk is situated in the mid-Atlantic eastern seaboard with a coastal plain geography, and as such, is very flat and susceptible to flooding from high tides, "Nor'easters", hurricanes and summer thunderstorms. Norfolk is bound to the north by Hampton Roads Harbor and the Chesapeake Bay, to the west and south by the Elizabeth River.

Storm water System

The City's separated storm water system ranges from complex urban infrastructure in the downtown to more suburban areas with roadside and off road ditch systems. The downtown area has underground pipe and large scale box culverts. The system includes flood control walls and gates and a 100,000-gallon per minute flood control pumping station. The City has approximately 350 miles of storm water pipe and more than 27,000 storm water structures. As part of the City's storm water infrastructure, 9 pumping stations pump storm water from railroad and roadway underpasses.

In 1975 the City completed a comprehensive mapping and inventory of the storm water infrastructure. The mapping was updated sporadically until 1994. The updating primarily relied upon as-built drawings of various improvements. This being the case, an issue with multiple datums has brought the storm water database into question.

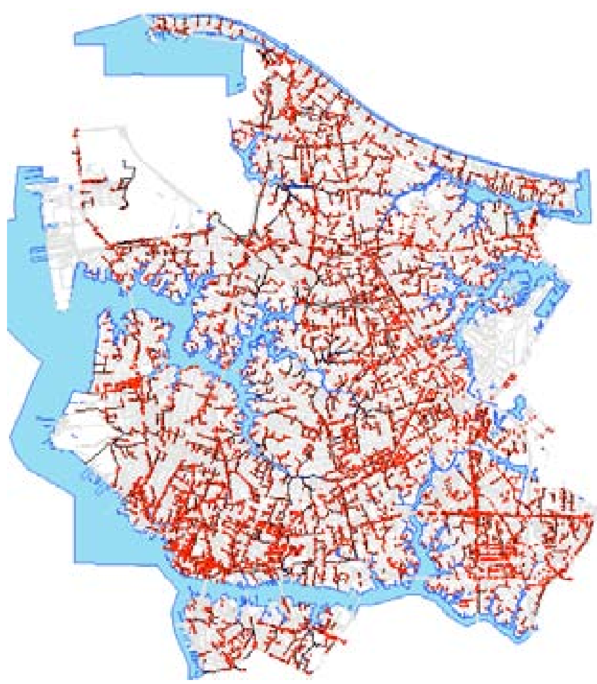

Fig. 2: Storm system overview

Norfolk, as with most old established cities, has seen several stages of redevelopment in the past 30+-years. The confidence in the storm water mapping is very much in question because of no specific plan for updating the mapping and database.

Norfolk is a NPDES Phase I community and the Division of Environmental Storm Water Management under The Department of Public Works is responsible for maintaining the NPDES permit for the City. Norfolk was one of the first cities in the country to start a storm water utility fund. The fund presently generates in excess of $7 million a year, which funds the divisions' general operation and maintenance budget and a $2 million capitol improvement program.

Project Goals

- ❑ Perform statistical quality control review of existing vertical data to use in GIS input for modeling analysis
- ❑ Review of regional and watershed BMP and strategies to improve water quality
- ❑ Internal audit of mission function regarding enforcement of State Storm Water Management Regulations

Future Vision

The City's Public Works Department desires to update and go beyond their current mapping and inventory into an integrated information system that will link the Asset Management Systems, Billing Systems, and Storm Water modeling systems with GIS.

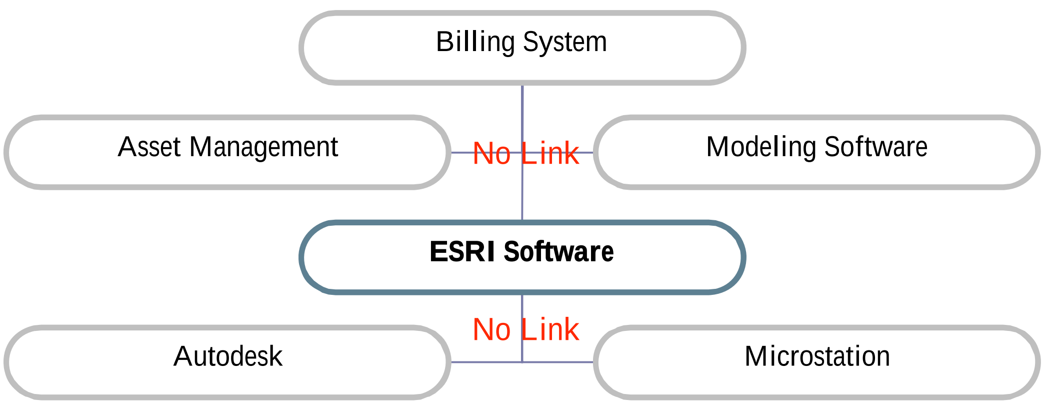

Fig. 3: Current System

Project Approach

To updating current mapping and database the following tasks were included in the study:

- ❑ Review and Update Mapping with Current GIS Mapping and Database Information, to include:
  - o Digital Inventory
  - o Vertical Data
  - o VDOT Projects
  - o Reports

    - As-Builts
    - GIS Files
    - Private and Municipal Projects
    - Surveys
- ❑ Review and Update Database with Past and Current Collection Data, Reports, Studies, and Plans
- ❑ Review City Watershed Definition
- ❑ Collection of Topographic Data
- ❑ Rim Elevations and Locations using Total Stations, GPS, and aerials
- ❑ Vertical Datums - City of Norfolk MLW 99, NGVD 1929 (FEMA Maps) and NAVD 88
- ❑ Open selected number of Storm Water Structures
- ❑ Review of Regional and Watershed BMPs
    - Establish BMP Service Areas
    - Determine Effective Urban BMPs
    - Review Pro Rata Options for Regional Storm
    - Water Facilities
- ❑ Internal Audit of Storm Water Regulations Enforcement
    - State Storm Water Management Regulations
    - Chesapeake Bay Preservation Act
    - NPDES Storm Water Permit
- ❑ Assess Condition of Pipes and Structures
- ❑ Set Priorities for Major Maintenance/Improvements
- ❑ Develop and implement systems and protocols for future system data updates and maintenance of the Master Plan

GIS Tasks

The GIS tasks were divided into three phases, Phase one included review of the city's planimetric maps, the review included the following layers:

- ❑ Street Centers
- ❑ Building
- ❑ Street Edges
- ❑ Aerial Photos Index
- ❑ Railroad
- ❑ Parcels
- ❑ Contours
- ❑ Water Bodies
- ❑ water Lines

The review also included support layers - created by different agencies - that included the following layers:

- ❑ Land Use
- ❑ Soil Type
- ❑ Wetland

Phase two is the implementation of the storm water layers - inventory layers - this phase includes:

- ❑ Stormwater Pipes
  Up Structure, Up Invert, Up Assumed, Down Structure, Down Invert, Down Assumed, Pipe Name, Geometry, Size, Material, Condition, Length, Tidal, Drainage Basin
- ❑ Stormwater channels
  Up Structure, Up Invert, Up Assumed, Down Structure, Down Invert, Down Assumed, Pipe Name, Geometry, Depth, Side Slope, Top Width, Bottom Width, Length, Material, Condition
- ❑ Stormwater structures
  Structure#, Type, Condition, Rim, Invert, Outfall, Tidal, Year Installed, City Grid, Drainage Basin
- ❑ Stormwater pump stations
  Pump#, Type, Location, Operation Method
- ❑ Stormwater ponds
  Pond#, Type, Size, Location
- ❑ Stormwater CIP
  Project#, Name, Location, Manager, Status

<u>Phase three</u> is the implementation of application layers, these layers are driven from the modeling system analysis:

- ❑ Drainage Basins
  Drainage Basin#, Watershed Name, Size
- ❑ Catch Basin
  Basin Name, 'C' factor, TC, Drainage Basin, Area

Modeling issues

- ☐ Hydraulic modeling results could only viewed in modeling software interface
- ☐ Access to the modeling program is limited to the sotrm water engineers meaning that majority of users in the city do not have access to such programs
- ☐ The need to show the modeling result in the GIS interface is crucial, so more city personnel can have access to the information without need to have the modeling software
- ☐ Updating the hydraulic models when changes are made to the GIS is important so that the engineers will have the most recent data
- ☐ The hydraulic model input is driven from GIS database, but the output is not always useful or needed for the city's GIS users outside the division
- ☐ What is the best Scenario? the best scenario is to maintain each one separately, but meanwhile the hydraulic model has to be updated when any changes are made to the GIS.
- ☐ The differences between the hydraulic model and the typical GIS model have to be considered, the most common differences are:
  - o while the GIS model is detailed oriented, the hydraulic model contains only the elements that are of interest of the users of the model.

- while the GIS model serves a wide range of users, the hydraulic system serves just the division engineers.
- while the GIS model is one scenario oriented, the hydraulic model could include mutable scenarios.
- while the GIS model can handle links with as-built drawings, construction drawings, and billing information, the hydraulic model has no capabilities for such links

The use of GIS for creating the hydraulic model proved to be very useful. New structures are added to the model after verifying the spatial and attributes using the GIS. In the intended workflow, the model will be automatically updated from the GIS data.

After analyzing the model for different scenarios, each scenario should be exported to the master storm water scenarios geodatabase as a separate dataset. Bringing the modeling results into a common platform is crucial to allow simplicity, portability, search ability, and on-the-fly map production.

Ultimate system

The ultimate system will solve three problematic relationships:

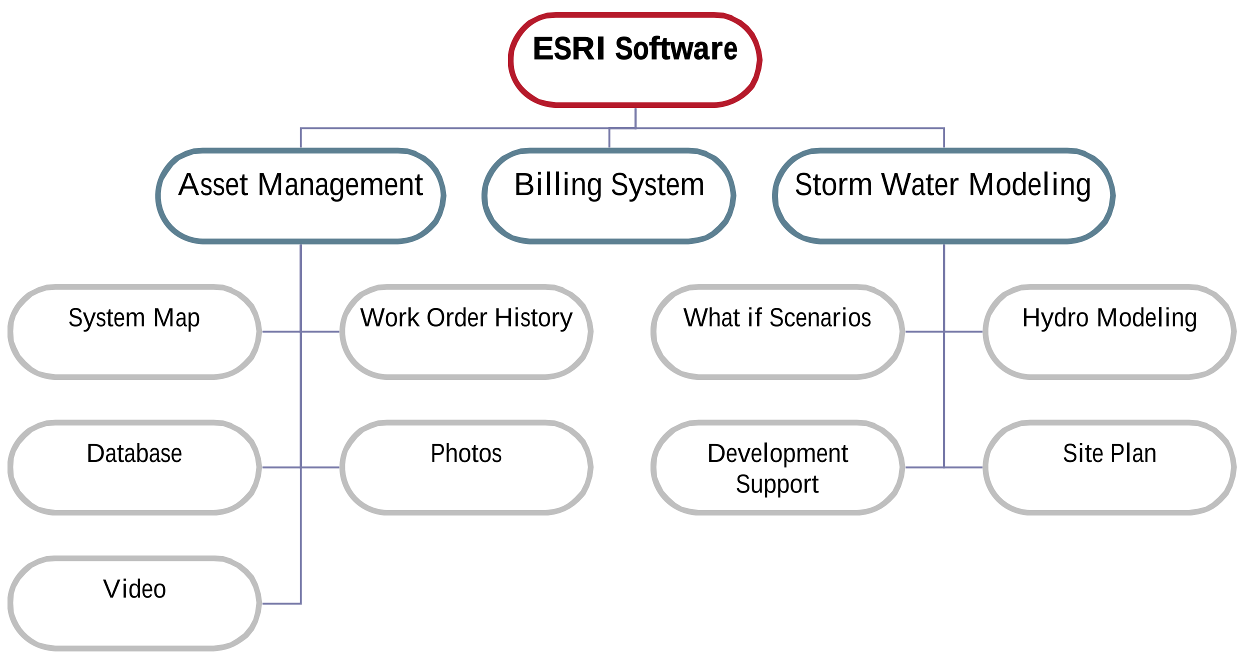

Fig. 4: Ultimate System

1. **GIS and asset Management relationship**

The goal is to integrate seamlessly an internet based system that will link the GIS data with an asset management program. This will enable a maintenance supervisor to access the storm water system from any computer with internet access. Ultimately, wireless access from the field is desirable. The supervisor will have the ability to click on the area in vicinity of the repair, view data of structures and pipes that he or she may be dealing with, and plan crews, equipment, and material needs and generate a work order, all from his truck. The supervisor may further click on a structure and view a picture of the structure, review the repair history of the system in the vicinity and determine if that part of the system is part of capital project planning or another operation division's work area. The supervisor can then offer notes for feedback to his crews, his supervisor, or to technical staff. He may also offer feedback to crews that may have attempted earlier repairs and offer input to technical staff on parts of the system that may no longer be serviceable.

2. GIS and Billing system

Integrating GIS with the storm water billing system offers the ability to reduce billing errors, realize all potential revenues, and accurately predict potential revenue changes from certain redevelopments. The goal is to utilize the GIS with an address database to ensure that the customers are all being billed accurately. Verification with the plat maps can make sure adjacent property owners are not billed for others properties. Commercial accounts may be verified using planimetrics to accurately account for changes in impervious areas.

3. GIS and Storm water Modeling

With Norfolk under constant redevelopment, the ability to run “what if” scenarios becomes critical to making timely and cost effective upgrades to the storm water system. It is important for the City and developers to know that a possible installation of a storm water detention system may greatly enhance the ability of the system to manage the quantity of storm water in a wider variety of conditions. It will be possible to show developers the benefits of possible upgrades and possibly share in some construction costs. This will ensure that the public is getting best value in storm water improvements with public private initiatives.

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