North Sandwich Stormwater Conveyance Analysis Study

An EPASWMM Modeling Case Study

Presented By:

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Engineering Enterprises, Inc.

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Presentation Overview

- Background Information
- Communication & Key Decisions
- Stakeholder Outreach Survey
- Stormwater Modeling
- Investigation Areas: Causes & Solutions
- Results & Lessons Learned
- Q&A
Background Information
Background Information
Background Information

- 2017 population of 7,387
- Study Area Limited to North of Tracks
- Residential
  - Central Downtown
  - 3 Newer Subdivisions
Kickoff Meeting
- Pre-Modeling Discussion
- Gather Data Sources
- Confirm Scope and Expectations
- Discuss Key Problem Areas

Stakeholder Outreach
- Combined Stormwater and Sanitary Public Meeting

Progress Meetings
- Post Existing Conditions
- Confirm Problems Areas and Focus Alternatives
Communication & Key Decisions

- EPASWMM 5.1
  - Readily Available
  - City can update for future design and development
Conjunction with Sanitary Evaluation

Survey Statistics
- 1,855 Delivered
- 385 Respondents
- 20.8% Return Rate
- 187 Experienced Flooding

Stakeholder Outreach Survey

City of Sandwich Public Works Department
Resident Flooding Survey

Applicable: The purpose of conducting the survey is to collect pertinent information to be considered during the comprehensive engineering evaluation of the surface water and basement flooding issues in the City of Sandwich. The responses of the study will be greatly valued by the involved teams, but surveys from all locations are being requested.

Instructions: Please provide accurate responses to the questions regarding the flooding issues associated with your property. It is also helpful if you include any pictures of your property and the flooding issues, as well as your contact information for follow-up.

City of Sandwich
1442 Railroad Street
Sandwich, IL 60548

Questions: If you have any questions related to the form, please contact Tom Hash, Director of Public Works, at (630) 569-4500 ex. 24 or thash@sandwich.il.us.

Meeting: The City Council will hold a special meeting on Tuesday, July 19, 2016 at 7:00 PM at 120 E. Railroad Street as part of the regular Council & Aldermen Council Meeting to finalize the existing flood prevention measures and report on the assessment results. The purpose of this meeting is to provide the public an opportunity to voice their concerns and provide feedback.

1. Has storm or sewage water ever flooded your property? Yes: No
   If yes, what were the details of the flooding? Yard: Basement: Other:

2. In the past two years, how many times did your home flood? Never: 1 time: 2 times: 3 times: 4 times: 5 or more times:
   If you have experienced flooding, how did the flood water enter your home (check all that apply)? Sewer Drain: Door: Window: Cracks in Wall: Other: N/A

3. Have you experienced sanitary sewer backups (through drain, toilet, etc.)? Yes: No:
   If yes, how deep was the basement flooding? (Please complete the back side of the survey, also.)

4. During the flood events that occurred on July 21, 2017 and/or October 14, 2017, what area of your home flooded (check all that apply)? No Flooding: Crawl Space: Basement: First Floor: Garage:

5. Do you have a basement? Yes: No: N/A:
   If so, please provide the measurements from the floor slab to the top of your foundation (Dimension "A" in the diagram):

6. Do you have a crawl space? Yes: No: N/A:
   If so, please provide the measurements from the floor slab to the top of your foundation (Dimension "B" in the diagram):

7. Do you have a sump pump? Yes: No: N/A: Not Here:
   If so, where does the sump pump discharge? Yard: Plumbing: N/A: Other:

8. Do you have a waste (sewer) ejector pump? Yes: No: N/A: Not Sure:

9. Do you employ any of the following sanitary sewer backup protections? Floor Drain Plug: Standpipe: Overhead Sewer: Check Valve: Other:

Thank you for taking the time to complete the survey!
Stakeholder Outreach Survey

Percentage of Respondents With Flooding
- 51% Respondents With Flooding
- 49% Respondents Without Flooding

Number of Times Flooded Over Last Ten Years
- 59% 0
- 14% 1
- 9% 2
- 4% 3
- 3% 4
- 9% 5+
- 1% Unknown
Stakeholder Outreach Survey

Survey Respondent Flooding Frequency
Stormwater Modeling

Existing Conditions

- Sub-Watershed Delineation
  - City One Foot Topography
  - Survey Critical Points
  - Field Investigations
Stormwater Modeling

Sub-Watershed Delineation

Legend
- WATERSHED
- SUB - WATERSHEDS
  - CATCH BASIN
  - FLARED END CULVERT
  - INLET
  - MANHOLE
  - STORM SEWER
Stormwater Modeling

Existing Conditions

- Build Existing Conditions Model
  - City-wide GIS Database, Record Drawings, Previous Studies, Field Investigations
  - Existing Storm Sewer, Manholes, Basins, Depressional Storage
Stormwater Modeling

Existing Conditions Model
Stormwater Modeling

Existing Conditions

- **Subcatchment Inputs/Assumptions**
  - Percent Impervious
  - Manning’s N and Depth of Depression
  - Infiltration
  - Model Results Check

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Name</td>
<td>S-2954A</td>
</tr>
<tr>
<td>X-Coordinate</td>
<td>909149.711</td>
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<tr>
<td>Y-Coordinate</td>
<td>1819268.270</td>
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<tr>
<td>Description</td>
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<td>Tag</td>
<td>CultivatedCrops</td>
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<td>Rain Gage</td>
<td>RAIN_2y_1h</td>
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<td>Outlet</td>
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<td>Area</td>
<td>89.20</td>
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<td>Width</td>
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<tr>
<td>% Slope</td>
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<tr>
<td>% Imperv</td>
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<tr>
<td>N-Imperv</td>
<td>0.015</td>
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<tr>
<td>N-Perv</td>
<td>0.15</td>
</tr>
<tr>
<td>Dstore-Imperv</td>
<td>0.1</td>
</tr>
<tr>
<td>Dstore-Perv</td>
<td>0.2</td>
</tr>
<tr>
<td>%Zero-Imperv</td>
<td>25</td>
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<tr>
<td>Subarea Routing</td>
<td>PERVIOUS</td>
</tr>
<tr>
<td>Percent Routed</td>
<td>50</td>
</tr>
<tr>
<td>Infiltration Data</td>
<td>GREEN_AMPT</td>
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</table>

User-assigned name of subcatchment
Stormwater Modeling

Subcatchments

دامتعاً فينقاً
- تطوير، منخفضة الإشراقية = 30%
- محاصيل سليمة = 5%

NLCD 2011 (CONUS) Land Cover, 30m x 30m resolution

Land Cover Imperviousness Coefficients (from Civco et al 2006)

<table>
<thead>
<tr>
<th>Land Cover Code</th>
<th>Description</th>
<th>Imperviousness Coefficient</th>
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<tbody>
<tr>
<td>11</td>
<td>Open water</td>
<td>1.1</td>
</tr>
<tr>
<td>21</td>
<td>Developed, open space</td>
<td>13.4</td>
</tr>
<tr>
<td>22</td>
<td>Developed, low intensity</td>
<td>29.1</td>
</tr>
<tr>
<td>23</td>
<td>Developed, medium intensity</td>
<td>48.7</td>
</tr>
<tr>
<td>24</td>
<td>Developed, high intensity</td>
<td>63.0</td>
</tr>
<tr>
<td>31</td>
<td>Barren land (rock/sand/clay)</td>
<td>24.7</td>
</tr>
<tr>
<td>41</td>
<td>Deciduous forest</td>
<td>4.1</td>
</tr>
<tr>
<td>42</td>
<td>Evergreen forest</td>
<td>8.0</td>
</tr>
<tr>
<td>43</td>
<td>Mixed forest</td>
<td>2.5</td>
</tr>
<tr>
<td>52</td>
<td>Shrub/scrub</td>
<td>6.8</td>
</tr>
<tr>
<td>71</td>
<td>Grassland/herbaceous</td>
<td>5.2</td>
</tr>
<tr>
<td>81</td>
<td>Pasture/hay</td>
<td>5.8</td>
</tr>
<tr>
<td>82</td>
<td>Cultivated crops</td>
<td>5.8</td>
</tr>
<tr>
<td>90</td>
<td>Woody wetlands</td>
<td>1.5</td>
</tr>
<tr>
<td>95</td>
<td>Emergent herbaceous wetlands</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Stormwater Modeling

Subcatchments

📍 Impervious Check
- 9th & Eddy St Block
  32% Impervious
- Model Assumption
  30% Impervious
Stormwater Modeling

Subcatchments

- Manning’s N Value
  - N-Perv = 0.15 short grass
  - N-Imperv = 0.015 rough asphalt

- Depth of Depression Storage
  - Dstore-Perv = 0.20
  - Dstore-Imperv = 0.10

### Manning’s Roughness n for Overland Flow

<table>
<thead>
<tr>
<th>Surface</th>
<th>n</th>
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</thead>
<tbody>
<tr>
<td>Smooth asphalt</td>
<td>0.011</td>
</tr>
<tr>
<td>Smooth concrete</td>
<td>0.012</td>
</tr>
<tr>
<td>Ordinary concrete lining</td>
<td>0.013</td>
</tr>
<tr>
<td>Good wood</td>
<td>0.014</td>
</tr>
<tr>
<td>Brick with cement mortar</td>
<td>0.014</td>
</tr>
<tr>
<td>Vitrified clay</td>
<td>0.015</td>
</tr>
<tr>
<td>Cast iron</td>
<td>0.015</td>
</tr>
<tr>
<td>Corrugated metal pipes</td>
<td>0.024</td>
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<tr>
<td>Cement rubble surface</td>
<td>0.024</td>
</tr>
<tr>
<td>Fallow soils (no residue)</td>
<td>0.05</td>
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<tr>
<td>Cultivated soils</td>
<td></td>
</tr>
<tr>
<td>Residue cover &lt; 20%</td>
<td>0.06</td>
</tr>
<tr>
<td>Residue cover &gt; 20%</td>
<td>0.17</td>
</tr>
<tr>
<td>Range (natural)</td>
<td>0.13</td>
</tr>
</tbody>
</table>

### Grass

- Short, prairie: 0.15
- Dense: 0.24
- Bermuda grass: 0.41

### Woods

- Light underbrush: 0.40
- Dense underbrush: 0.80


(Source: McCuen, R. et al. (1996), Hydrology, FHWA-SA-96-067, Federal Highway Administration, Washington, DC)
Stormwater Modeling

Subcatchments

- Infiltration Method
  - Green-Ampt

### Characteristics of Various Soils

<table>
<thead>
<tr>
<th>Soil Texture Class</th>
<th>K</th>
<th>Ψ</th>
<th>ϕ</th>
<th>FC</th>
<th>WP</th>
</tr>
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<tbody>
<tr>
<td>Sand</td>
<td>4.74</td>
<td>1.93</td>
<td>0.437</td>
<td>0.062</td>
<td>0.024</td>
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<tr>
<td>Loamy Sand</td>
<td>1.18</td>
<td>2.40</td>
<td>0.437</td>
<td>0.105</td>
<td>0.047</td>
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<tr>
<td>Sandy Loam</td>
<td>0.43</td>
<td>4.33</td>
<td>0.453</td>
<td>0.190</td>
<td>0.085</td>
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<tr>
<td>Loam</td>
<td>0.13</td>
<td>3.50</td>
<td>0.463</td>
<td>0.232</td>
<td>0.116</td>
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<tr>
<td>Silt Loam</td>
<td>0.26</td>
<td>6.69</td>
<td>0.501</td>
<td>0.284</td>
<td>0.135</td>
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<tr>
<td>Sandy Clay Loam</td>
<td>0.06</td>
<td>8.66</td>
<td>0.398</td>
<td>0.244</td>
<td>0.136</td>
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<tr>
<td>Clay Loam</td>
<td>0.04</td>
<td>8.27</td>
<td>0.464</td>
<td>0.310</td>
<td>0.187</td>
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<tr>
<td>Silty Clay Loam</td>
<td>0.04</td>
<td>10.63</td>
<td>0.471</td>
<td>0.342</td>
<td>0.210</td>
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<tr>
<td>Sandy Clay</td>
<td>0.02</td>
<td>9.15</td>
<td>0.430</td>
<td>0.321</td>
<td>0.221</td>
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<tr>
<td>Silty Clay</td>
<td>0.02</td>
<td>11.42</td>
<td>0.479</td>
<td>0.371</td>
<td>0.251</td>
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<tr>
<td>Clay</td>
<td>0.01</td>
<td>12.60</td>
<td>0.475</td>
<td>0.378</td>
<td>0.265</td>
</tr>
</tbody>
</table>

\[K\] = hydraulic conductivity, in/hr
\[Ψ\] = suction head, in.
\[ϕ\] = porosity, fraction
\[FC\] = field capacity, fraction
\[WP\] = wilting point, fraction

Stormwater Modeling

Model Results Check

- Model for Problem Locations & Relative Magnitude
- Further Calibration
- July 22, 2017 Historical Rainfall Data
  - 4.14” in 24 hours
- ISWS Bulletin 70 NE Sectional Data
  - 4.47” in 24 hours = 10-year event.
Model Results Check

- July 22, 2017: 10-Year 24-Hour Storm Event
Stormwater Modeling

Proposed Conditions

- Identified Key Problem Areas within Model
  - Sandhurst
  - Fieldcrest
  - Downtown Storm Sewer System
- Confirm Investigation Areas with City
- 10 Year Design Capacity for Storm Sewers
- 100 Year Design Capacity for Large Overflow/Flooding Concerns
Stormwater Modeling

Proposed Conditions

- Model Various Alternatives
  - Increase Storm Sewer Sizes
  - Additional Storm Sewers
  - Regional Detention

- Refine Alternatives to Meet City Expectations

- Concept Cost Estimates

- System Wide Improvements Allow for Capacity to Address Localized Problems
  - Local Drainage Relief Concept
Investigation Areas: Causes & Solutions

Sandhurst
Investigation Areas: Causes & Solutions

Sandhurst

Cause
- ±89 Acres Tributary
- No Depressional Storage
- Un-detained Flow Into Sandhurst
Investigation Areas:
Causes & Solutions

Sandhurst

Solution

- 100-Year Design
- Berm Along North, Overflow to East
- 5 ac-ft Dry Basin with 24” Storm Sewer
- 13 ac-ft Dry Basin with Wetland Expansion
Investigation Areas:
Causes & Solutions

Fieldcrest
Investigation Areas: Causes & Solutions

Fieldcrest

Cause
- ±450 Acres Tributary
- Depressional Storage
- Overflow Into Fieldcrest
Investigation Areas: Causes & Solutions

Fieldcrest

Solution
- 100-Year Design
- Berm Along North, Overflow to East
- 76 ac-ft Wetland Basin
- Incorporate into Watershed Planning
Investigation Areas:
Causes & Solutions

Downtown Storm Sewer System

Legend
- WATERSHED
- SUB - WATERSHEDS
- CATCH BASIN
- FLARED END CULVERT
- INLET
- MAINHOLE
- STORM SEWER
Investigation Areas:
Causes & Solutions

6th Street Improvements

Solution
- Separate 2nd St & 6th St Watershed
- Install ±13,000 Feet Storm Sewer
Investigation Areas: Causes & Solutions

2nd Street Improvements

Solution
- Upsize Outfall Provides Relief Upstream
- Install ±3,700 Feet Storm Sewer
Investigation Areas: Causes & Solutions

Storm Sewer Design Storm Capacity Summary

DESIGN EVENT
- 10-YEAR
- 5-YEAR
- 2-YEAR
- LESS THAN 2-YEAR

Existing

6th & 2nd St Improvements
Study Results Meet Project Goals

- Alternatives for Key Problems Areas
- Scope of Overall Improvements
- Scope of Overall Costs
- Identify Future Study Needs
- Roadmap for Implementation
Future Use of Model

- Base Model for Design of Construction Projects
  - Large Scale Projects
  - Neighborhood Drainage Concerns
- Planning Tool for Future Development
- Green Infrastructure
Results & Lessons Learned

Keys to Modeling with Limited Resources

- Take Advantage of Existing Resources
- Customize Modeling Approach to Available Info
- Opportunities for Shared Effort - Sanitary Study
- Level of Detail Required to Meet Project Goals
- Test Global Assumptions
- Communication
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