North Sandwich Stormwater Conveyance Analysis Study

An EPASWMM Modeling Case Study

Presented By:

Timothy N. Paulson, P.E., CFM
Tyler A. Meyer, E.I., CFM
Engineering Enterprises, Inc.

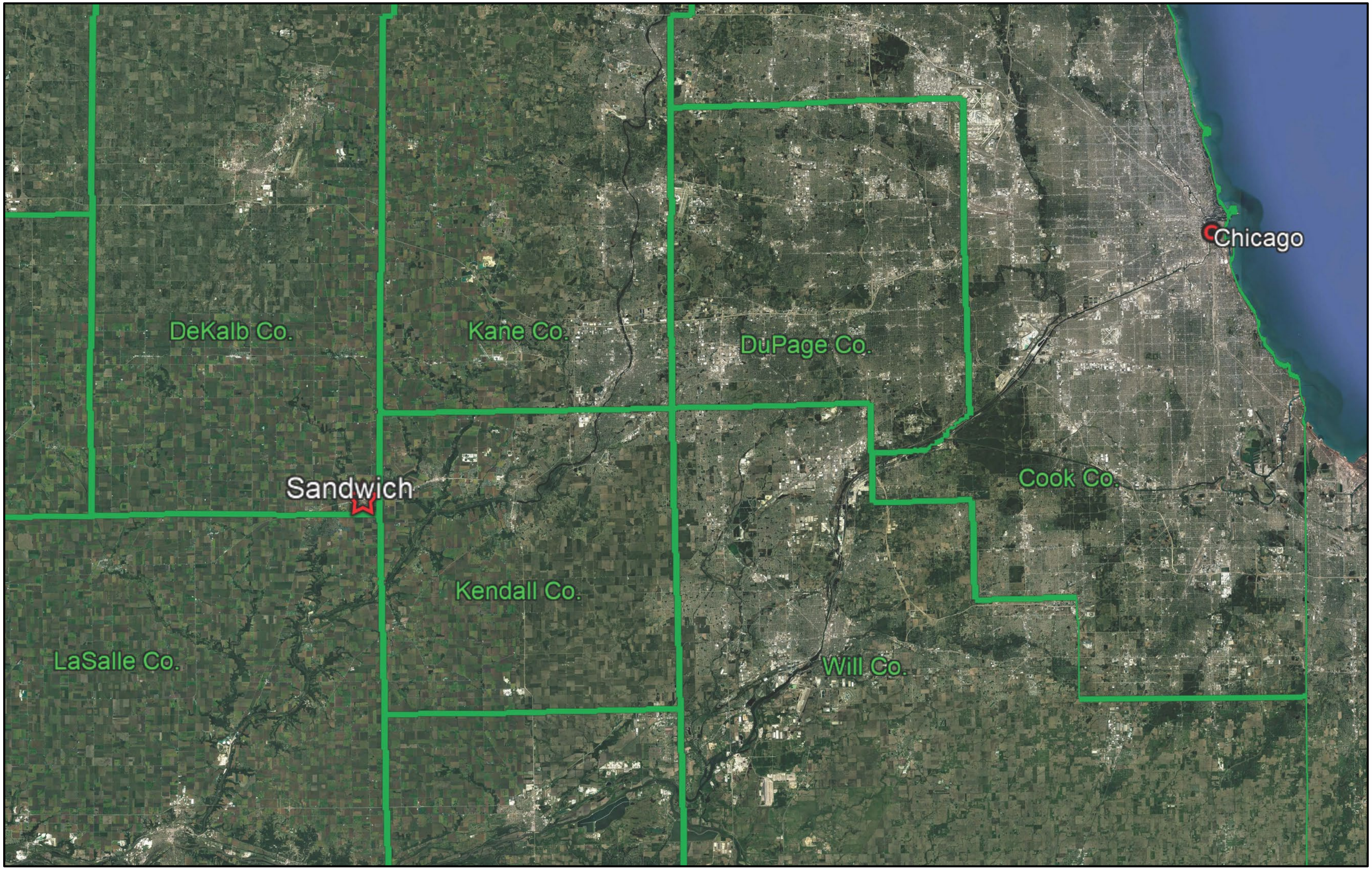
IAFSM 2019 Annual Conference
March 13, 2019

Presentation Overview

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

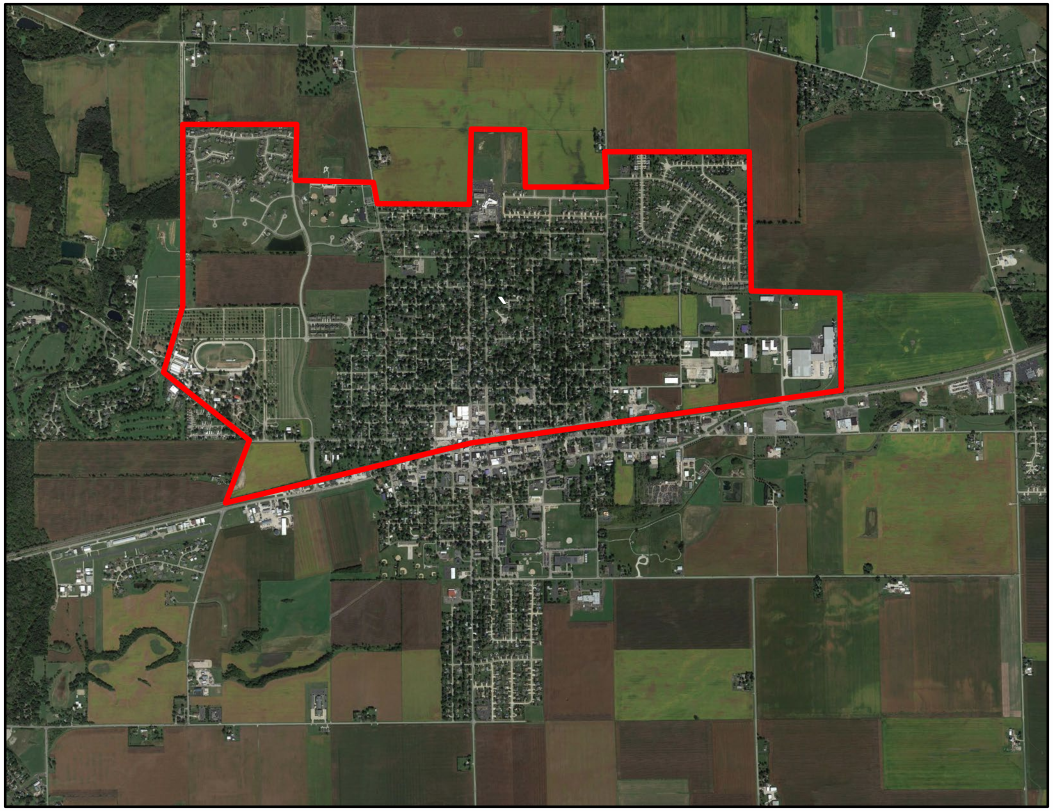
Background Information

Background Information



Background Information

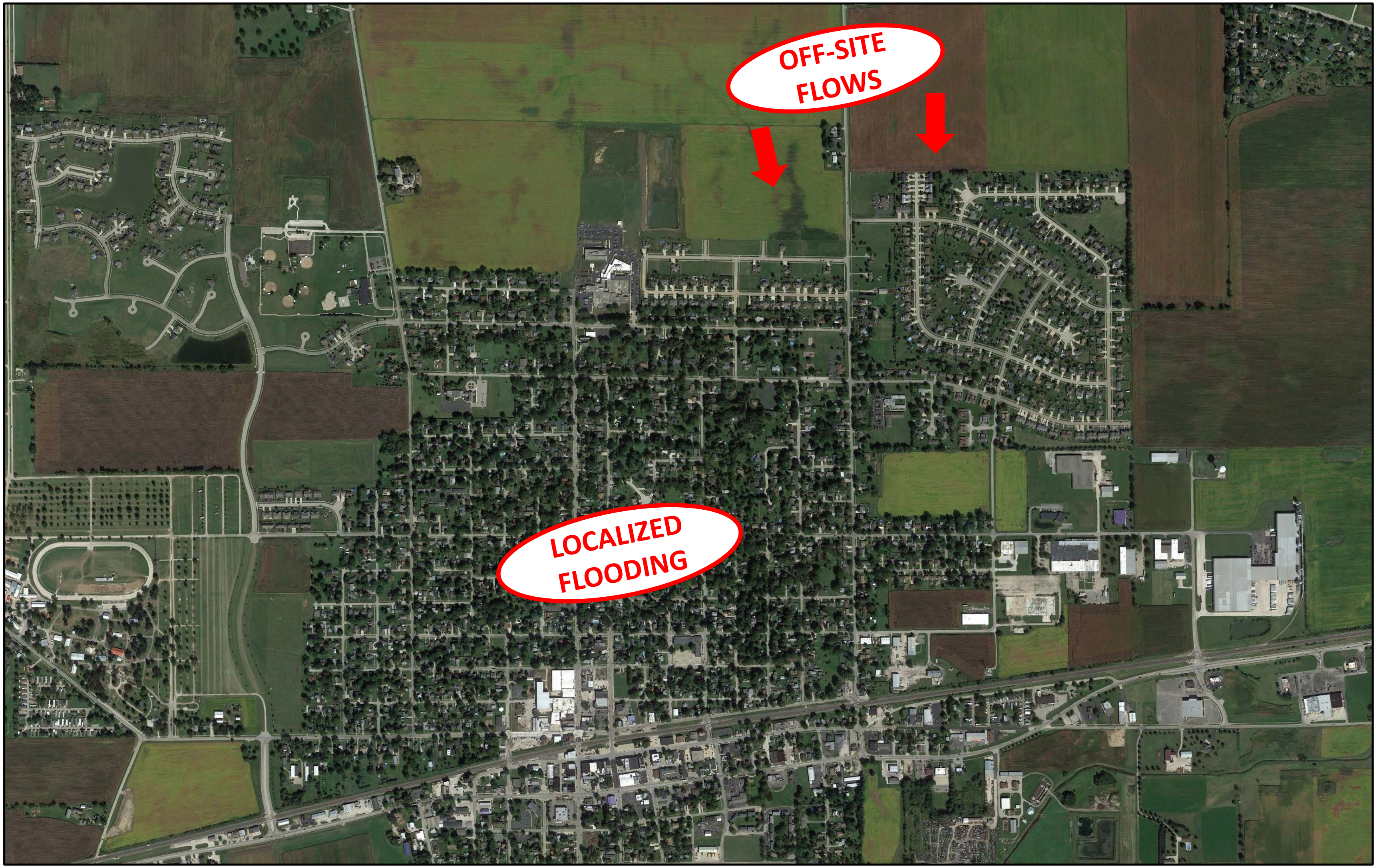
- 2017 population of 7,387
- Study Area Limited to North of Tracks
- Residential
  - Central Downtown
  - 3 Newer Subdivisions



Communication & Key Decisions

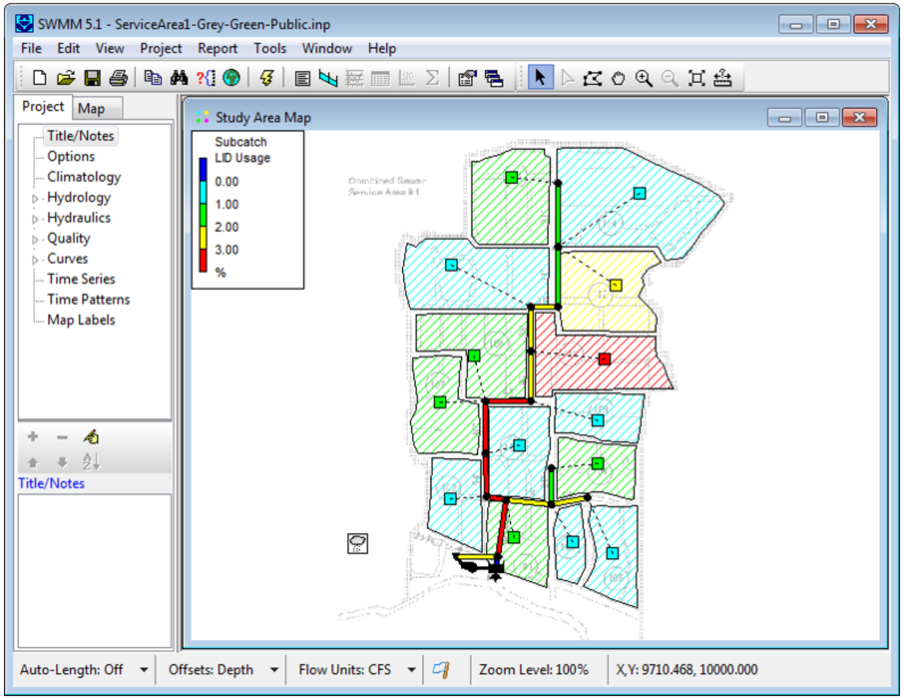
- Kickoff Meeting
  - Pre-Modeling Discussion
  - Gather Data Sources
  - Confirm Scope and Expectations
  - Discuss Key Problem Areas
- Stakeholder Outreach
  - Combined Stormwater and Sanitary Public Meeting
- Progress Meetings
  - Post Existing Conditions
  - Confirm Problems Areas and Focus Alternatives

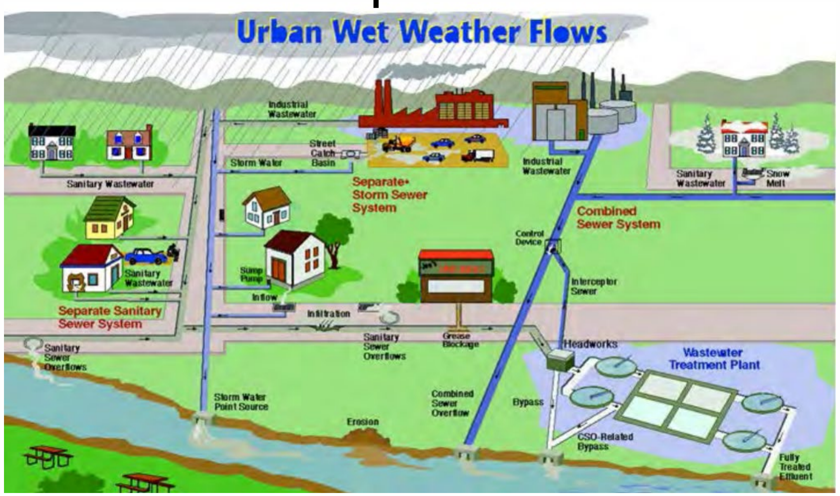
Communication & Key Decisions



Communication & Key Decisions

- EPASWMM 5.1
  - Readily Available
  - City can update for future design and development

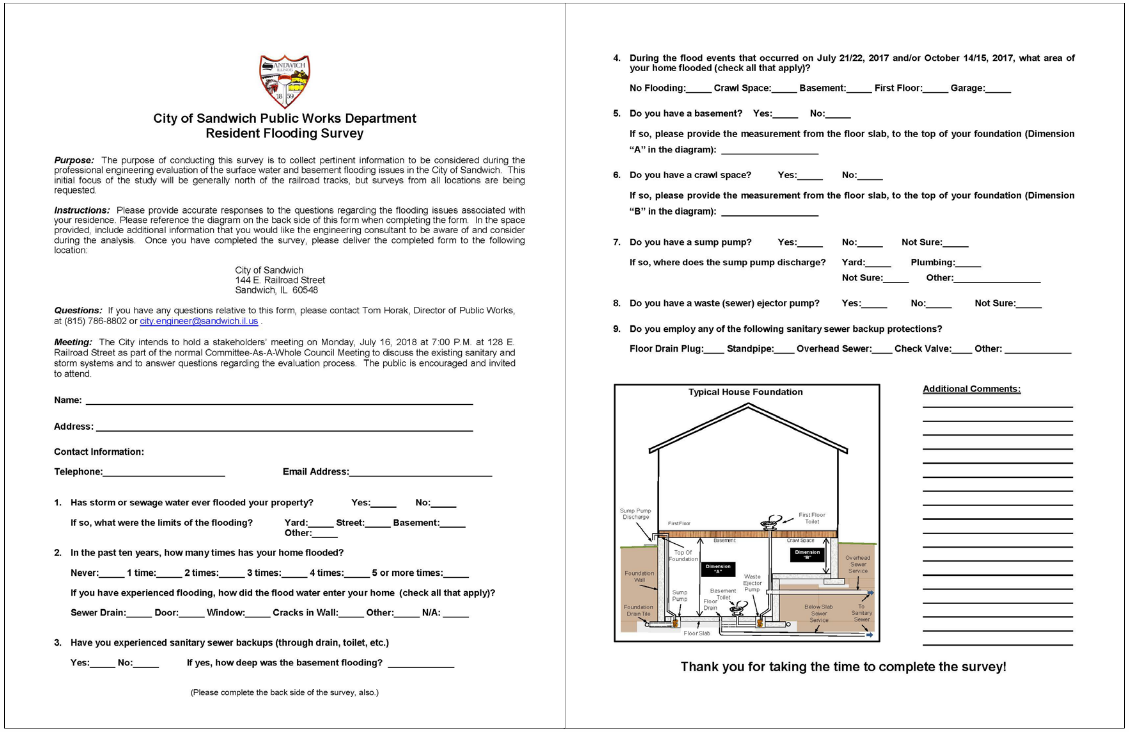




52 Wheeler Road, Sugar Grove, IL 60554 ~ (630) 466-6700 tel ~ (630) 466-6701 fax ~ www.eeiweb.com

Stakeholder Outreach Survey

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



City of Sandwich Public Works Department
Resident Flooding Survey

Purpose: The purpose of conducting this survey is to collect pertinent information to be considered during the professional engineering evaluation of the surface water and basement flooding issues in the City of Sandwich. This initial focus of the study will be generally north of the railroad tracks, but surveys from all locations are being requested.

Instructions: Please provide accurate responses to the questions regarding the flooding issues associated with your residence. Please reference the diagram on the back side of this form when completing the form. In the space provided, include additional information that you would like the engineering consultant to be aware of and consider during the analysis. Once you have completed the survey, please deliver the completed form to the following location:

City of Sandwich
144 E. Railroad Street
Sandwich, IL 60548

Questions: If you have any questions relative to this form, please contact Tom Horak, Director of Public Works, at (815) 786-8802 or city.engineer@sandwich.il.us .

Meeting: The City intends to hold a stakeholders' meeting on Monday, July 16, 2018 at 7:00 P.M. at 128 E. Railroad Street as part of the normal Committee-As-A-Whole Council Meeting to discuss the existing sanitary and storm systems and to answer questions regarding the evaluation process. The public is encouraged and invited to attend.

Name: ____________________

Address: ____________________

Contact Information:

Telephone:____________ **Email Address:**____________

1. **Has storm or sewage water ever flooded your property? Yes:_____ No:_____**

   If so, what were the limits of the flooding? Yard:_____ Street:_____ Basement:_____ Other:_____

2. **In the past ten years, how many times has your home flooded?**

   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 21/22, 2017 and/or October 14/15, 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:_____**

   If so, please provide the measurement from the floor slab, to the top of your foundation (Dimension "A" in the diagram): ______________

6. **Do you have a crawl space? Yes:_____ No:_____**

   If so, please provide the measurement from the floor slab, to the top of your foundation (Dimension "B" in the diagram): ______________

7. **Do you have a sump pump? Yes:_____ No:_____ Not Sure:_____**

   If so, where does the sump pump discharge? Yard:_____ Plumbing:_____ Not Sure:_____ Other:______________

8. **Do you have a waste (sewer) ejector pump? Yes:_____ No:_____ Not Sure:_____**

9. **Do you employ any of the following sanitary sewer backup protections?**

   Floor Drain Plug:____ Standpipe:____ Overhead Sewer:____ Check Valve:____ Other: ___________

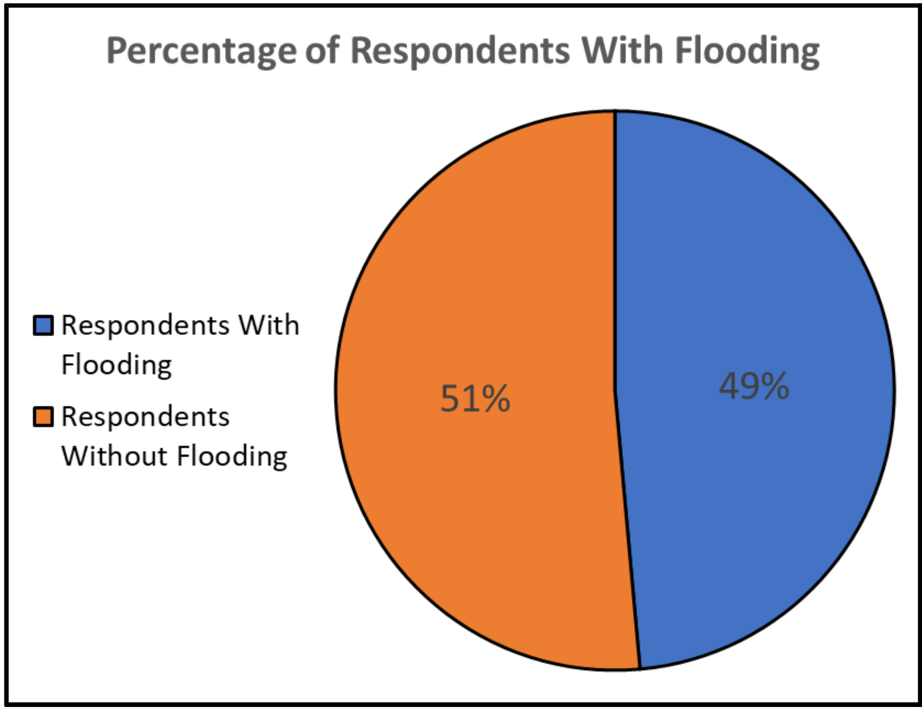
Typical House Foundation

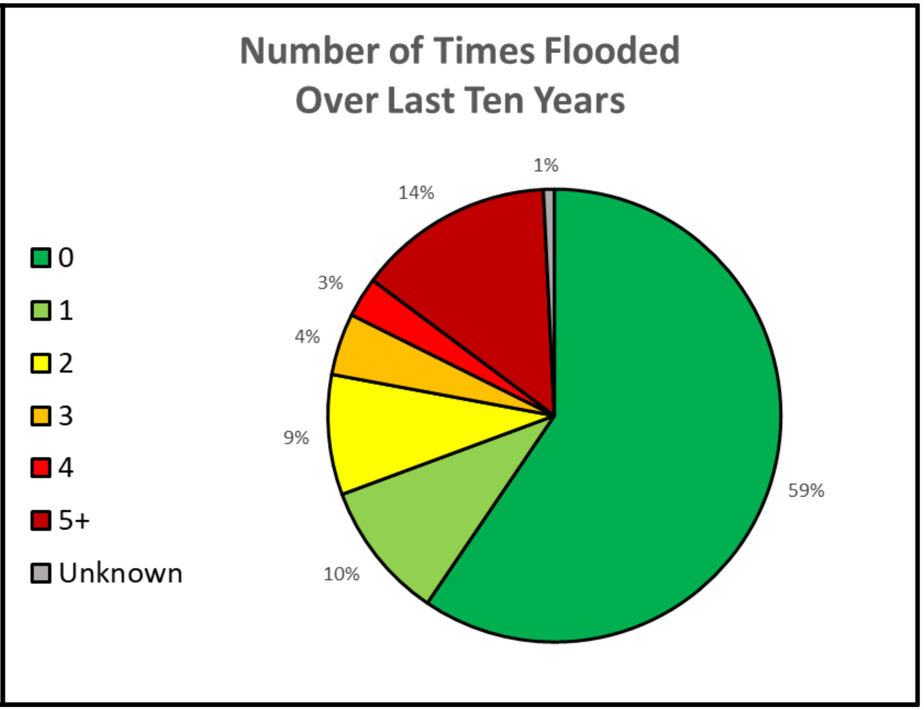
Additional Comments:

Thank you for taking the time to complete the survey!

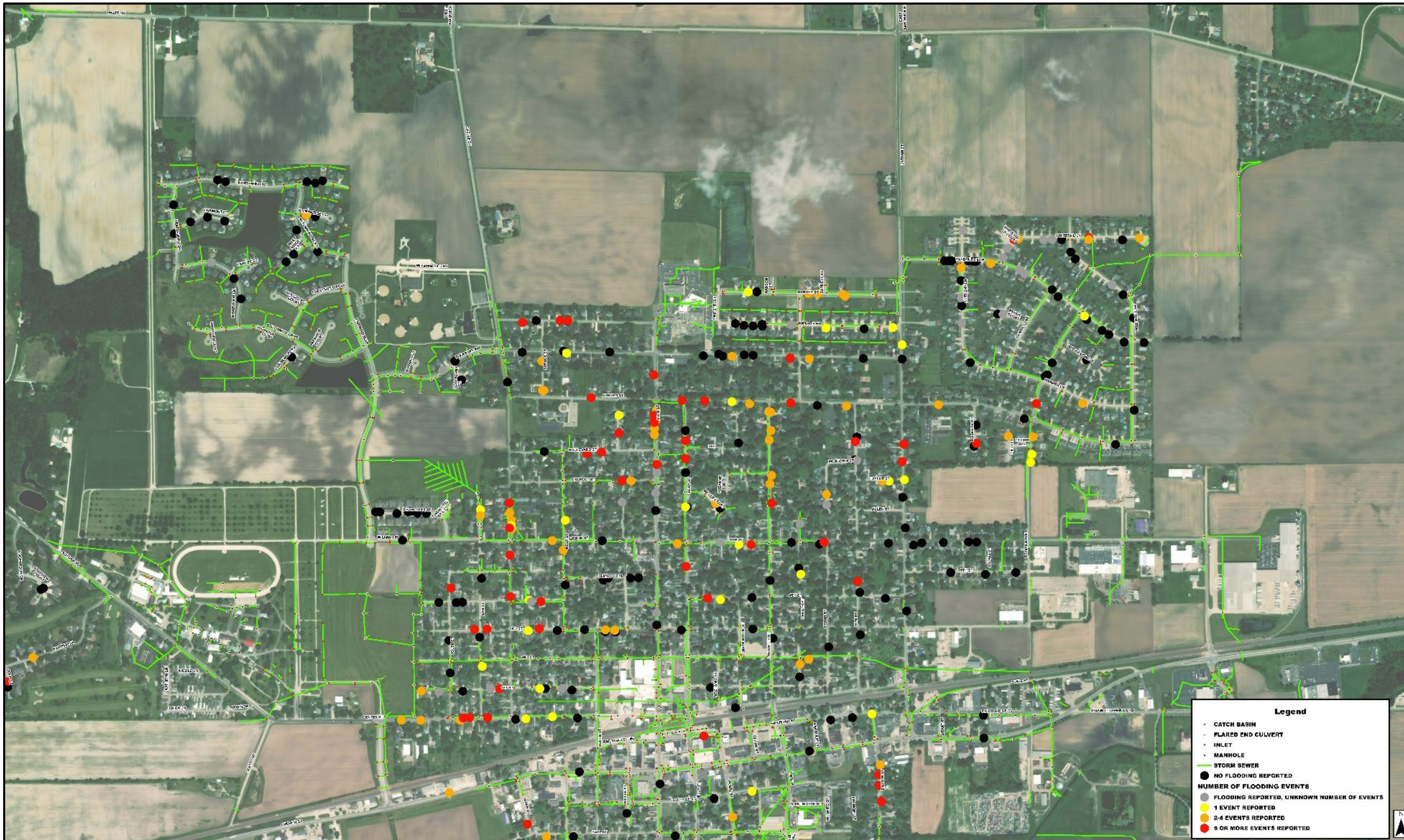
Stakeholder Outreach Survey

Stakeholder Outreach Survey





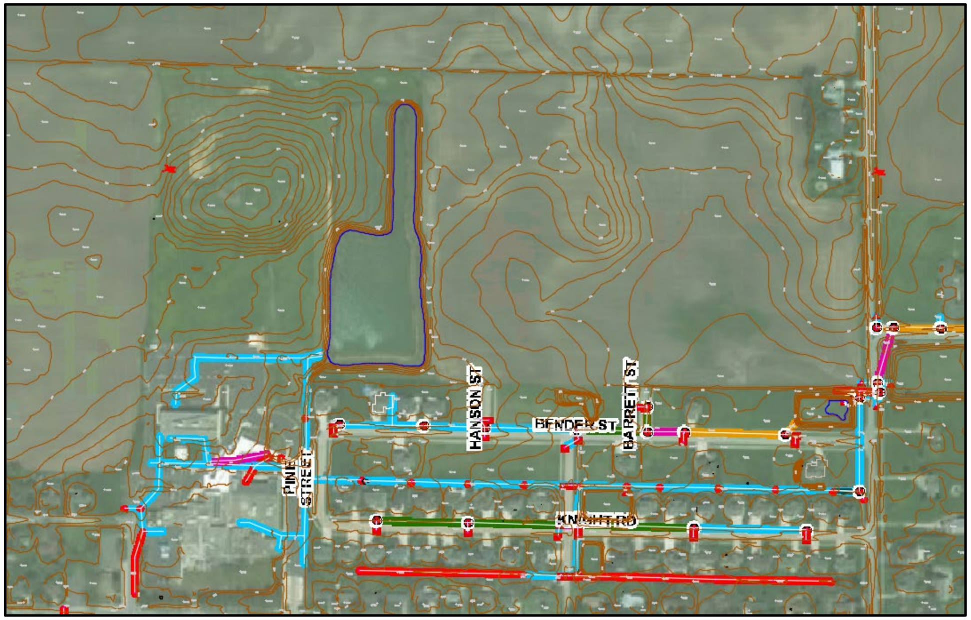
Survey Respondent Flooding Frequency



Stormwater Modeling

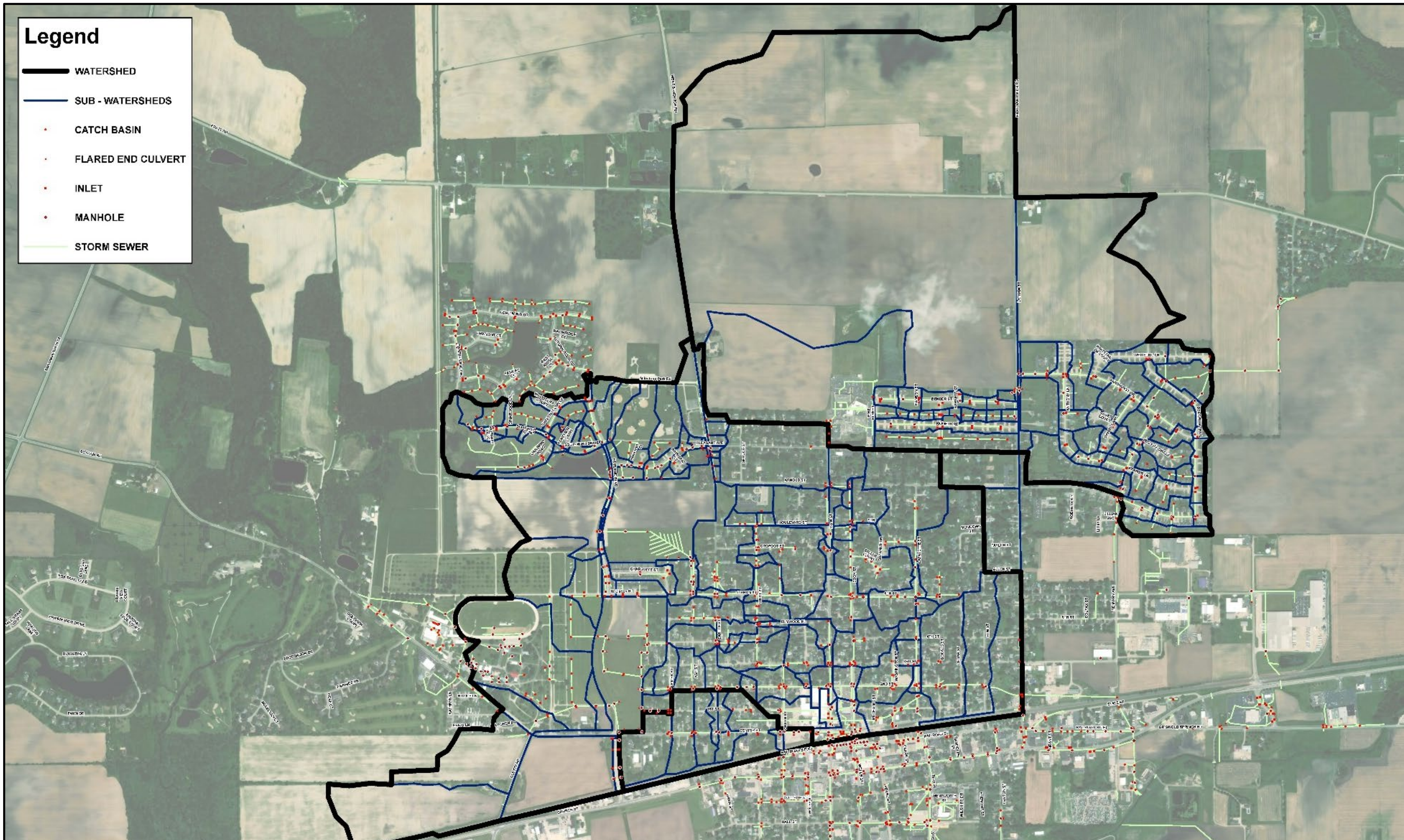
Existing Conditions

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



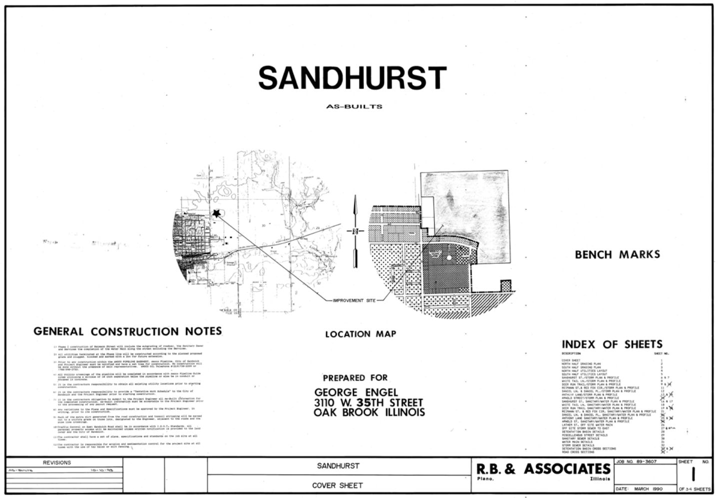
Stormwater Modeling

Sub-Watershed Delineation



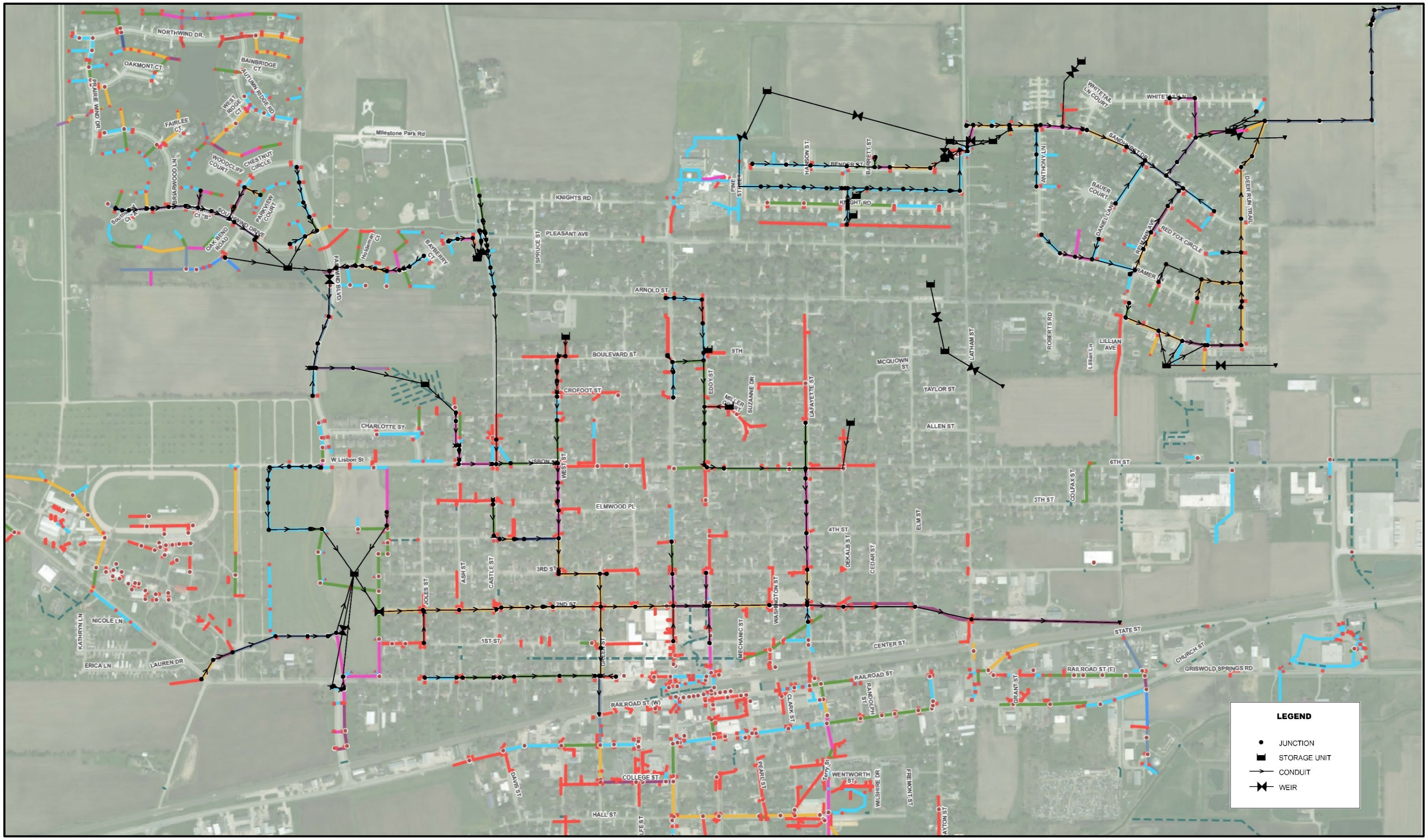
Existing Conditions

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



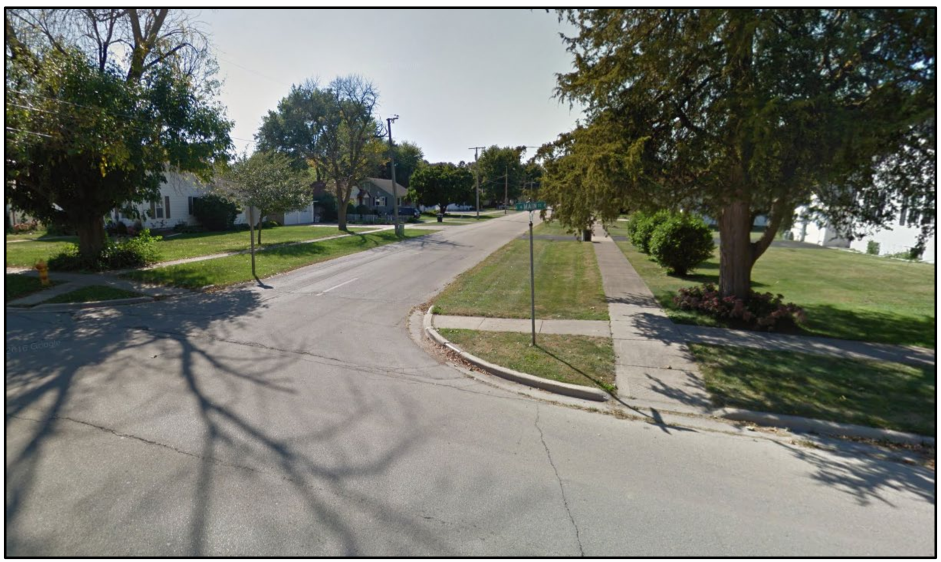
Stormwater Modeling

Existing Conditions Model



Existing Conditions

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



Subcatchment S-2954A

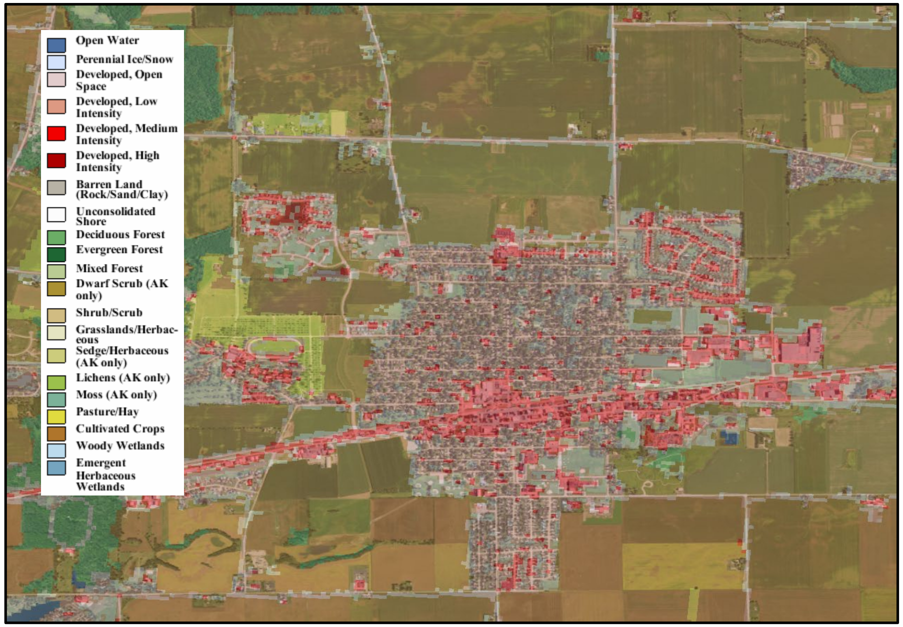
Property	Value
Name	S-2954A
X-Coordinate	909149.711
Y-Coordinate	1819268.270
Description	
Tag	CultivatedCrops
Rain Gage	RAIN_2y_1h
Outlet	D-2954A
Area	89.20
Width	13000
% Slope	0.5
% Imperv	5
N-Imperv	0.015
N-Perv	0.15
Dstore-Imperv	0.1
Dstore-Perv	0.2
%Zero-Imperv	25
Subarea Routing	PERVIOUS
Percent Routed	50
Infiltration Data	GREEN_AMPT

User-assigned name of subcatchment

Subcatchments

- Percent Impervious
  - Developed, Low Intensity = 30%
  - Cultivated Crops = 5%

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



Land Cover Imperviousness Coefficients (from Civco et al 2006)

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

Stormwater Modeling

Subcatchments

- Impervious Check
  - 9^{th} & Eddy St Block
    32% Impervious
  - Model Assumption
    30% Impervious

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

Surface	n
Smooth asphalt	0.011
Smooth concrete	0.012
Ordinary concrete lining	0.013
Good wood	0.014
Brick with cement mortar	0.014
Vitrified clay	0.015
Cast iron	0.015
Corrugated metal pipes	0.024
Cement rubble surface	0.024
Fallow soils (no residue)	0.05
Cultivated soils	
Residue cover < 20%	0.06
Residue cover > 20%	0.17
Range (natural)	0.13
Grass	
Short, prarie	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

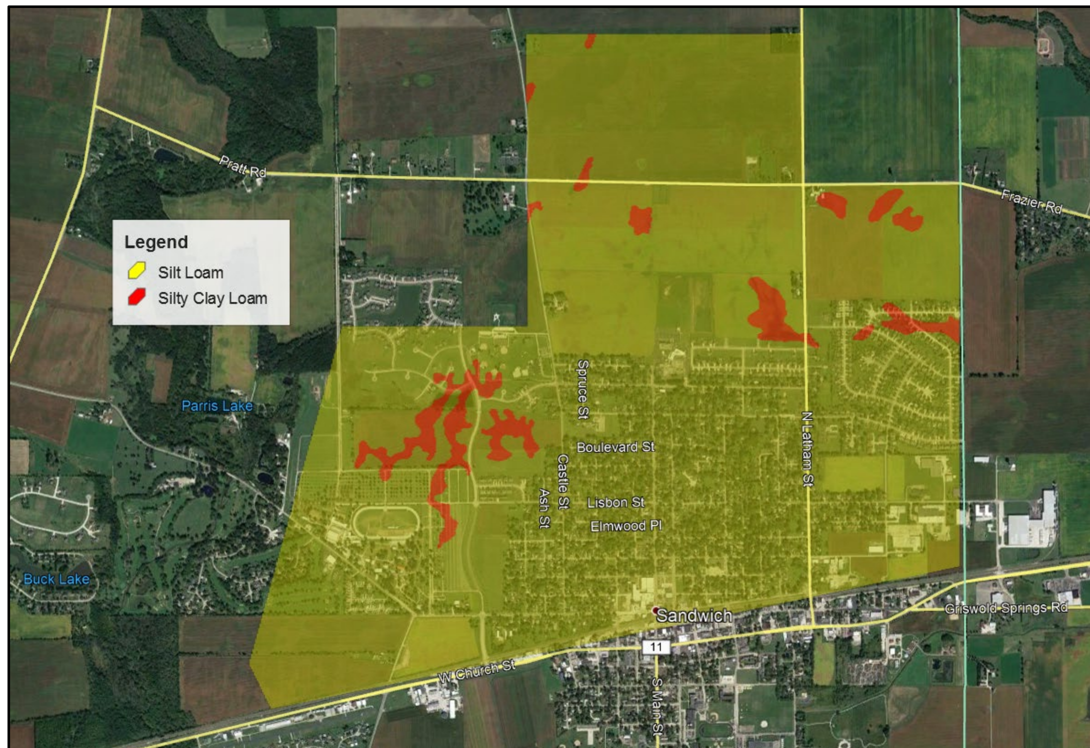
<u>**Typical Depression Storage Values**</u>

Impervious surfaces	0.05 - 0.10 inches
Lawns	0.10 - 0.20 inches
Pasture	0.20 inches
Forest litter	0.30 inches

(Source: ASCE,(1992), *Design & Construction of Urban Stormwater Management Systems*, New York, NY)

Subcatchments

- Infiltration Method
  - Green-Ampt



Characteristics of Various Soils

Soil Texture Class	K	Ψ	ϕ	FC	WP
Sand	4.74	1.93	0.437	0.062	0.024
Loamy Sand	1.18	2.40	0.437	0.105	0.047
Sandy Loam	0.43	4.33	0.453	0.190	0.085
Loam	0.13	3.50	0.463	0.232	0.116
Silt Loam	0.26	6.69	0.501	0.284	0.135
Sandy Clay Loam	0.06	8.66	0.398	0.244	0.136
Clay Loam	0.04	8.27	0.464	0.310	0.187
Silty Clay Loam	0.04	10.63	0.471	0.342	0.210
Sandy Clay	0.02	9.45	0.430	0.321	0.221
Silty Clay	0.02	11.42	0.479	0.371	0.251
Clay	0.01	12.60	0.475	0.378	0.265

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

Source: Rawls, W.J. et al., (1983). *J. Hyd. Engr.*, 109:1316.

52 Wheeler Road, Sugar Grove, IL 60554 ~ (630) 466-6700 tel ~ (630) 466-6701 fax ~ www.eeiweb.com

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.

Stormwater Modeling

Model Results Check

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

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

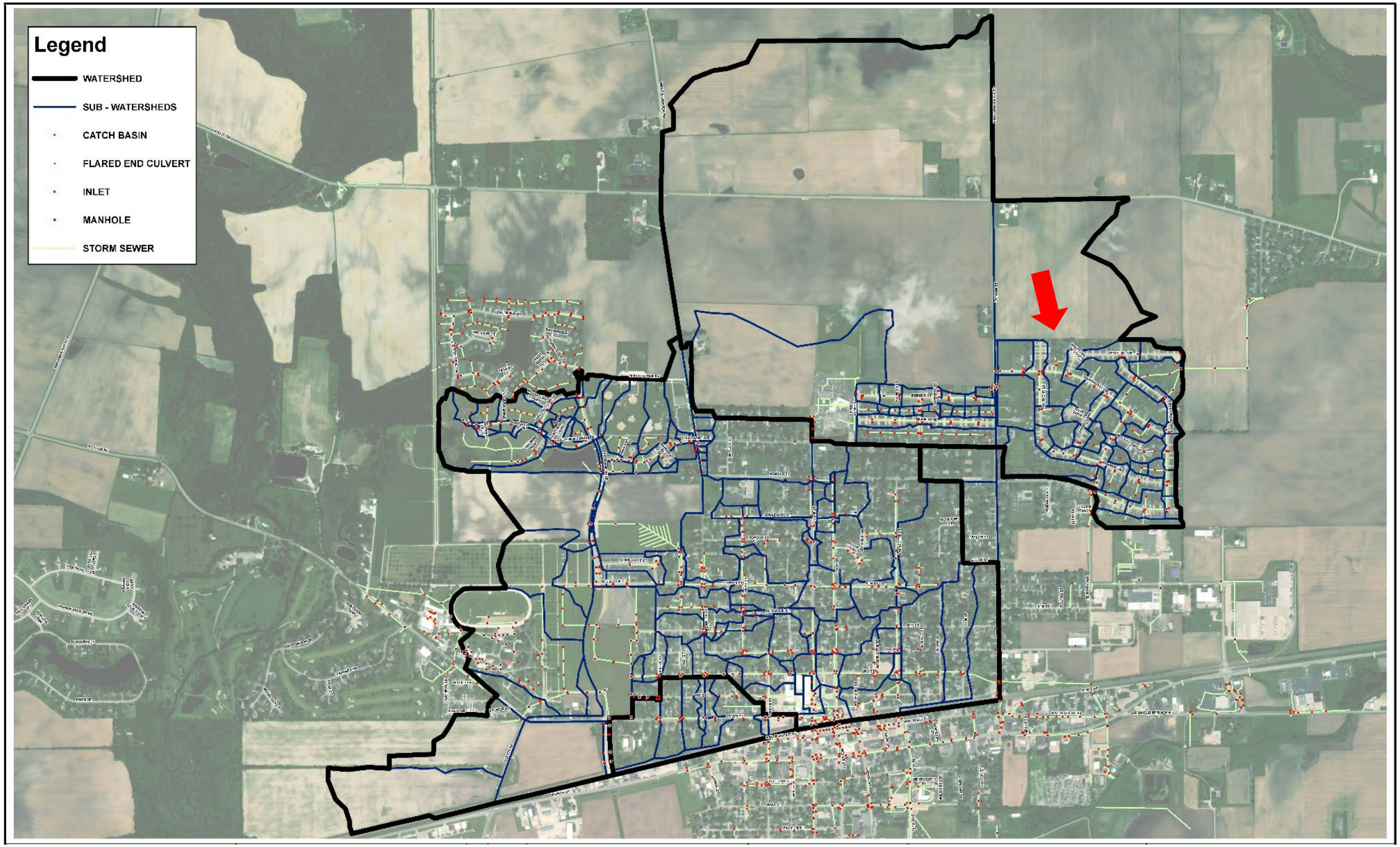
Stormwater Modeling

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

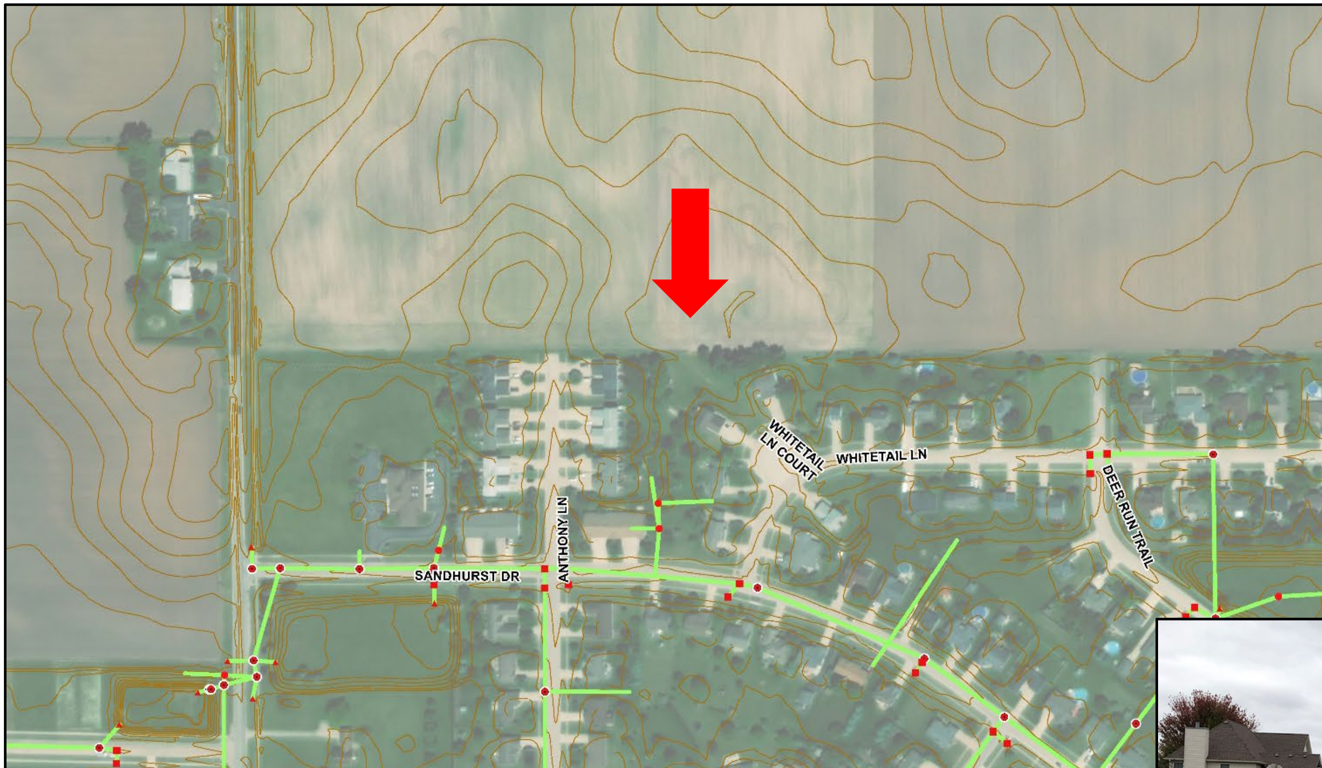
Investigation Areas: Causes & Solutions

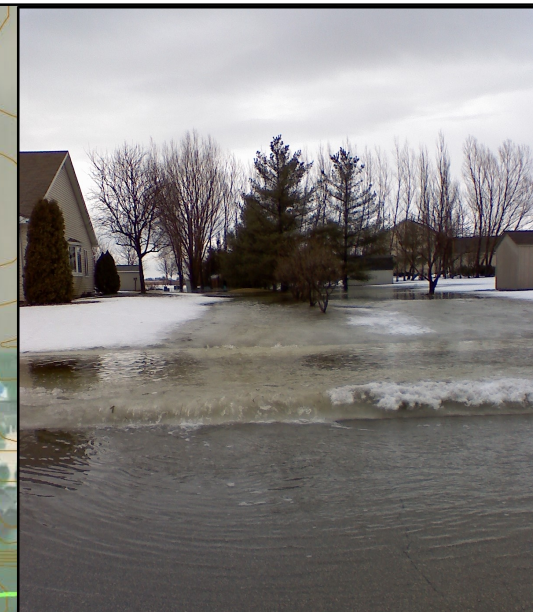
Sandhurst



Investigation Areas: Causes & Solutions

Sandhurst



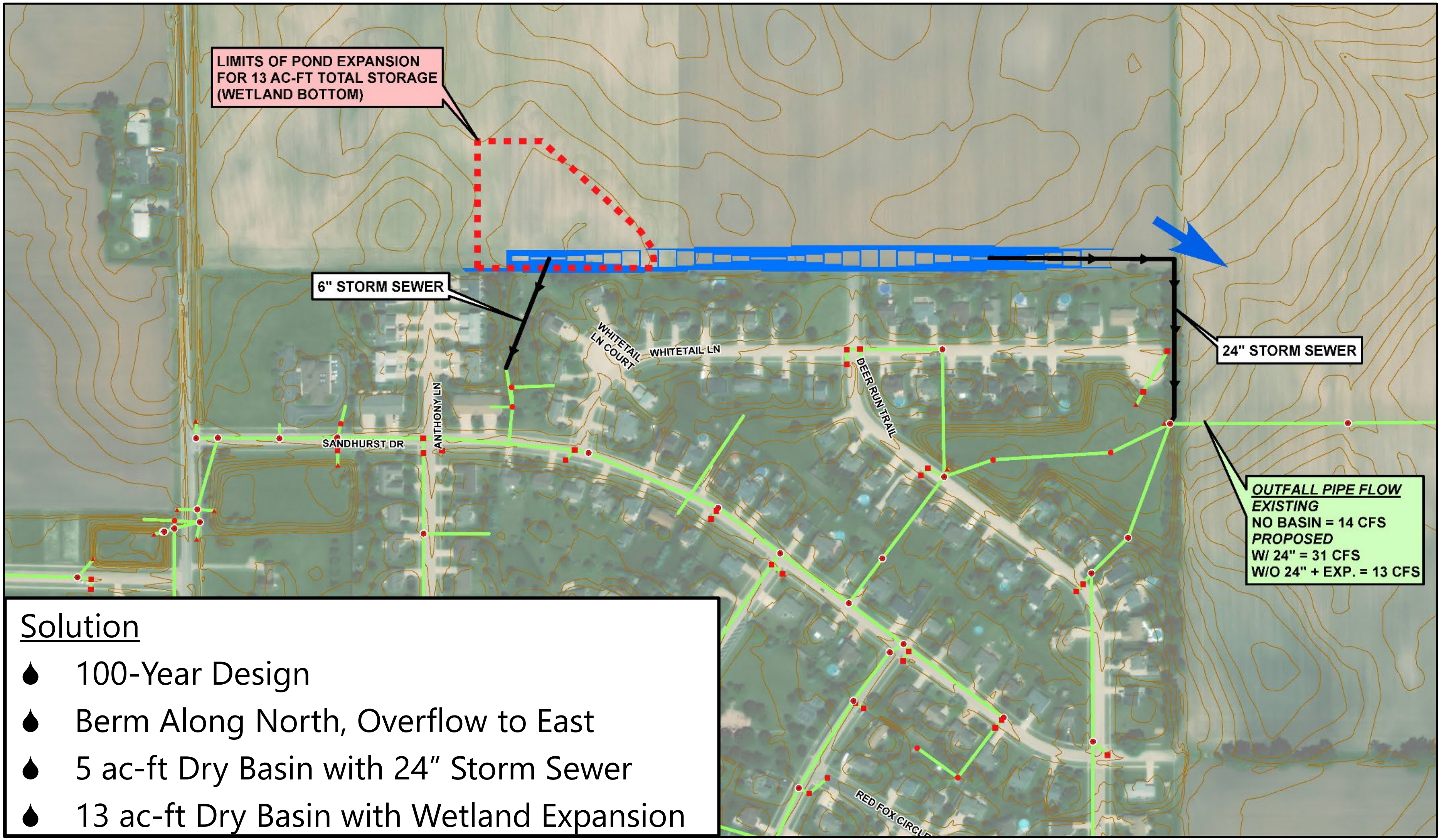


<u>Cause</u>

- ±89 Acres Tributary
- No Depressional Storage
- Un-detained Flow Into Sandhurst

Investigation Areas: Causes & Solutions

Sandhurst

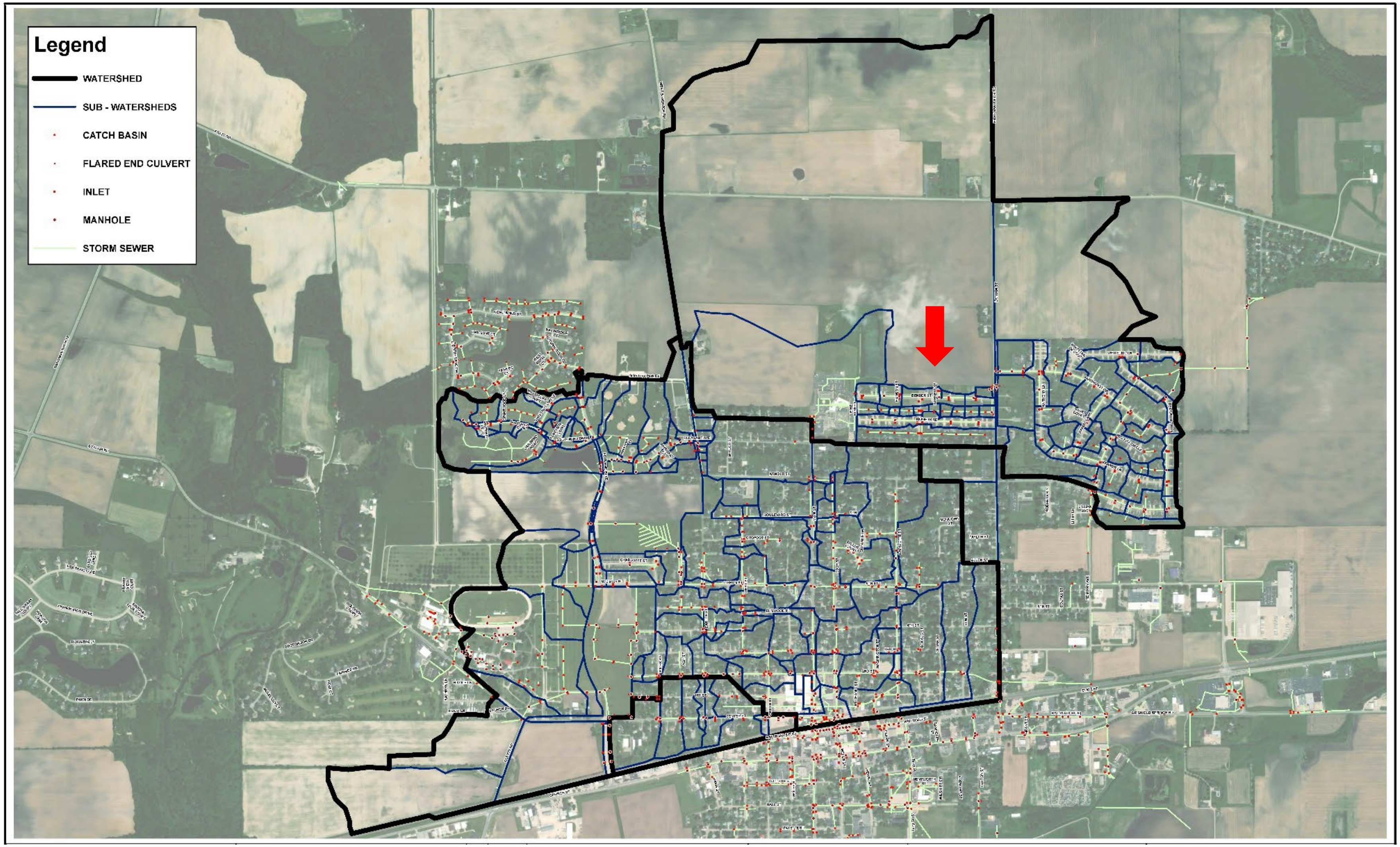


Solution

- 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

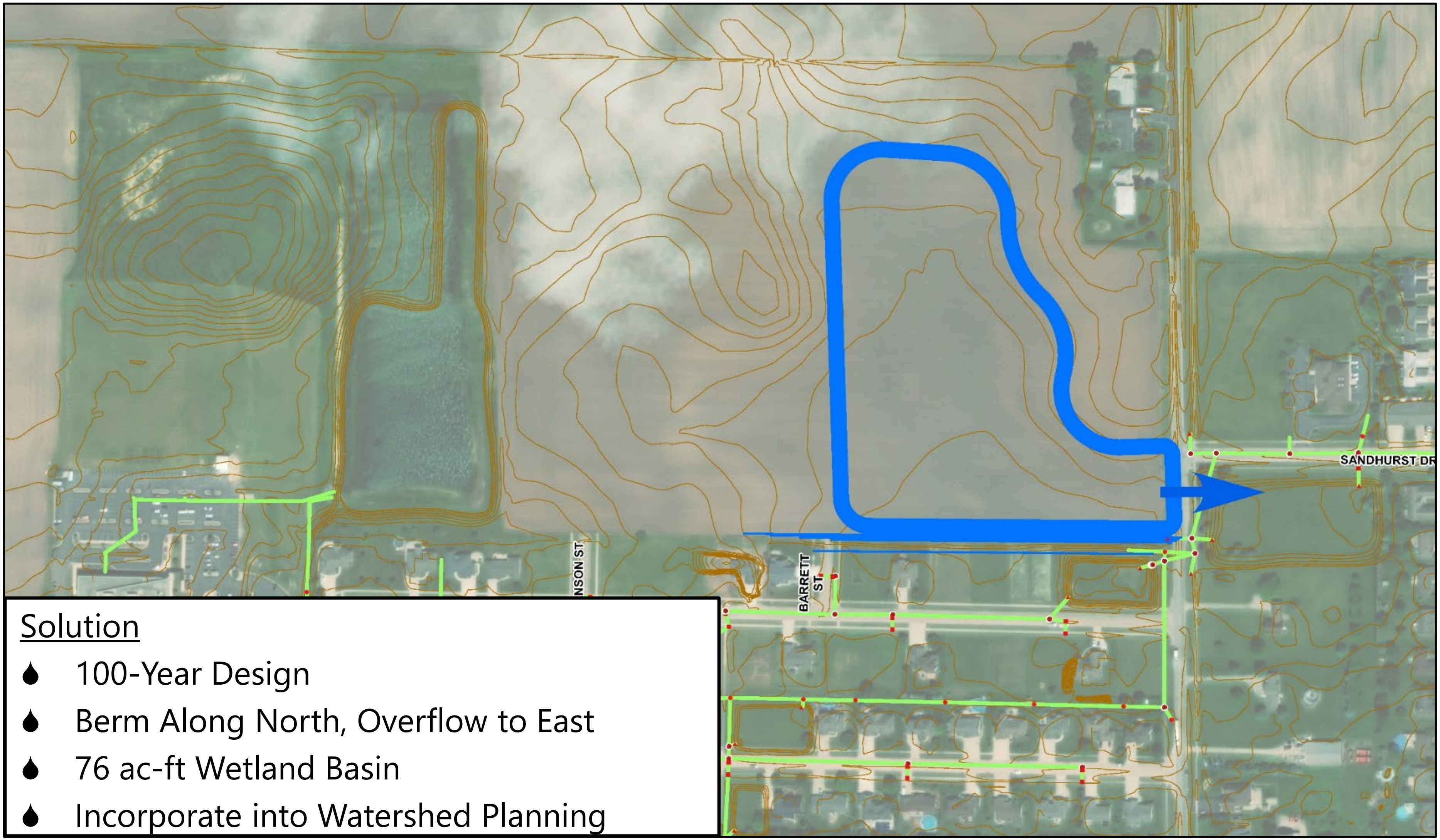
Cause

- ±450 Acres Tributary
- Depressional Storage
- Overflow Into Fieldcrest

Investigation Areas: Causes & Solutions

SANDWICH ILLINOIS 1859

Fieldcrest

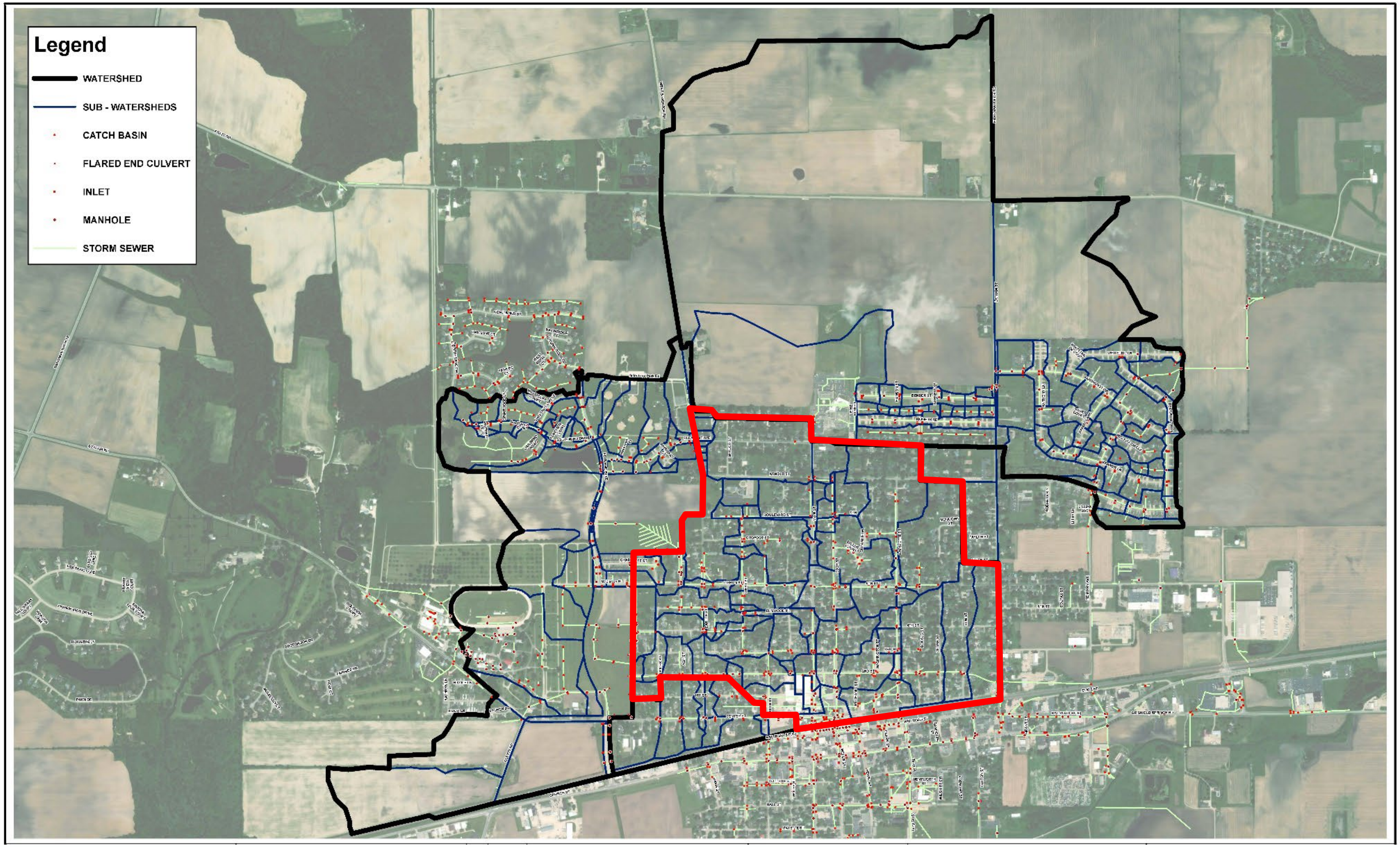


Solution

- 100-Year Design
- Berm Along North, Overflow to East
- 76 ac-ft Wetland Basin
- Incorporate into Watershed Planning

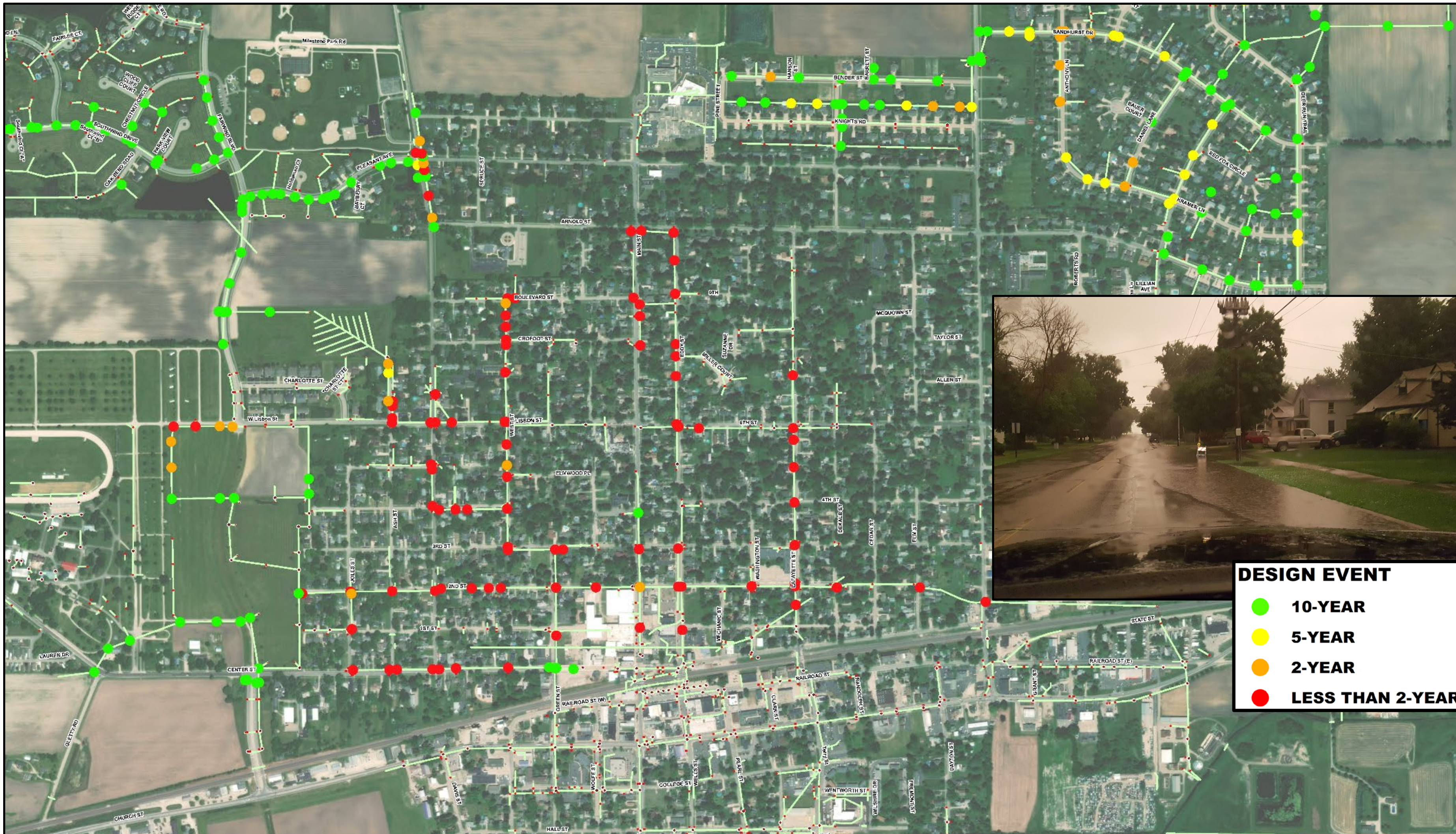
Investigation Areas: Causes & Solutions

Downtown Storm Sewer System



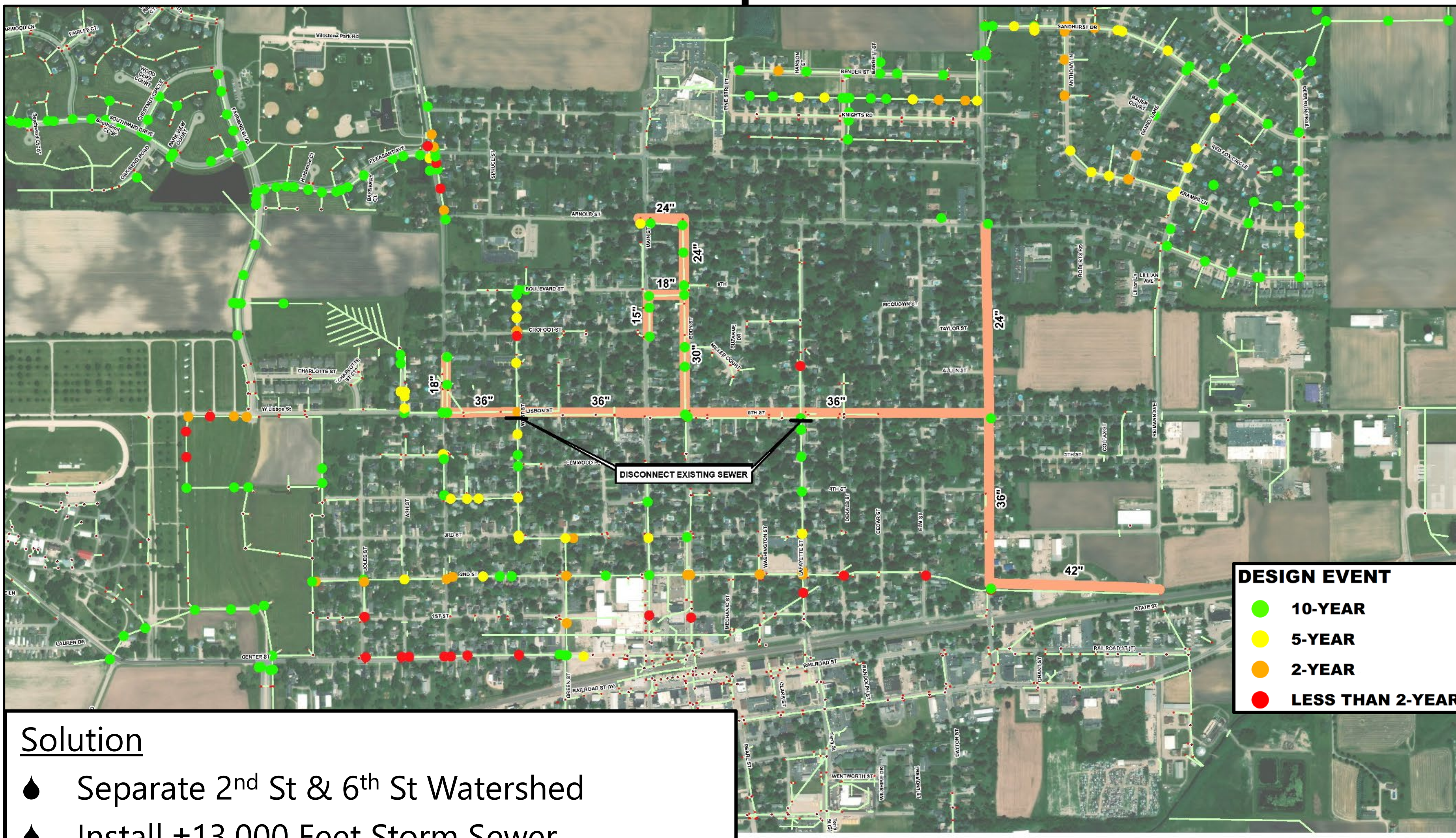
Investigation Areas: Causes & Solutions

Downtown Storm Sewer System Design Storm Capacity



Investigation Areas: Causes & Solutions

6th Street Improvements

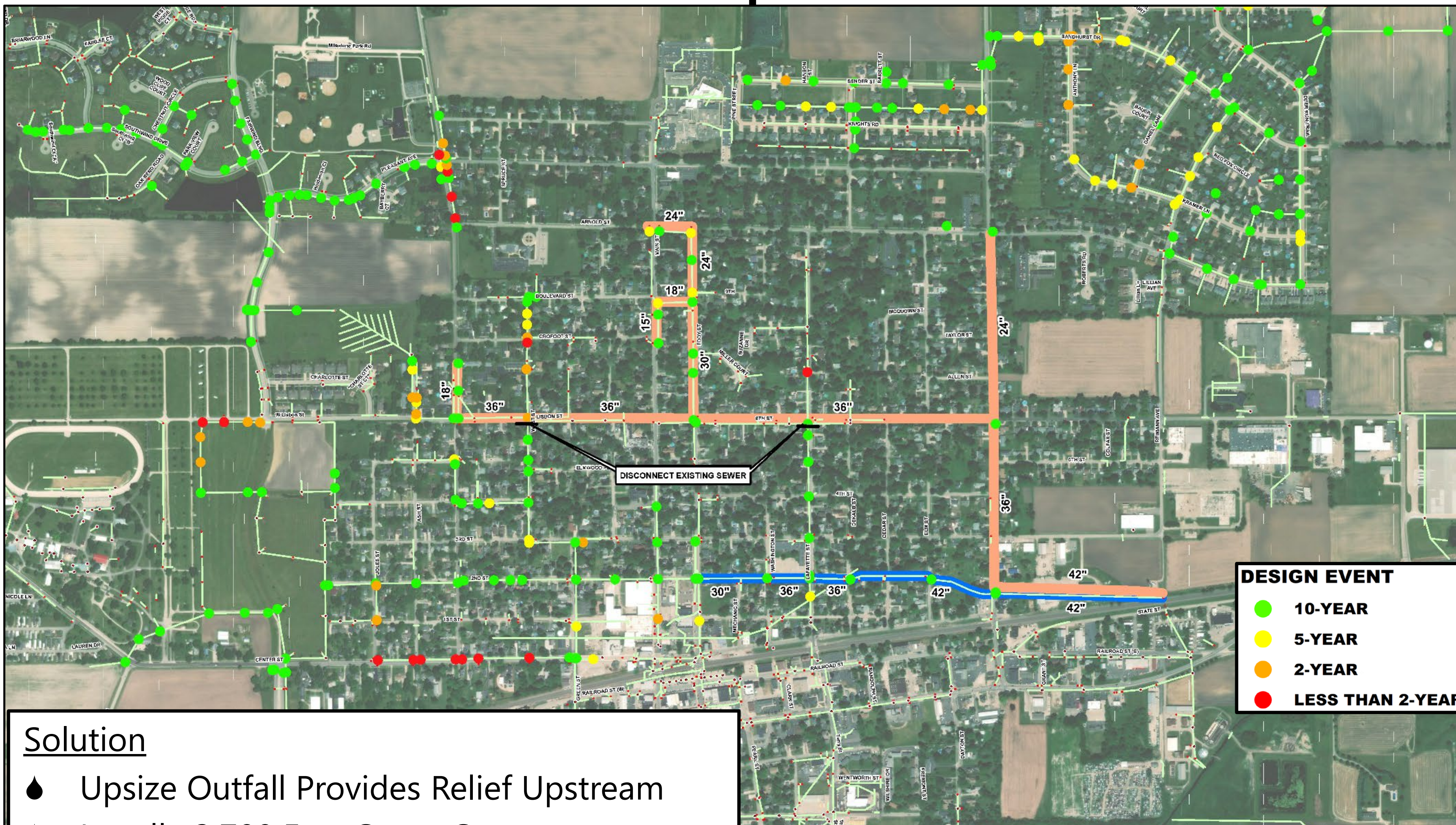


Solution

- Separate 2nd St & 6th St Watershed
- Install ±13,000 Feet Storm Sewer

Investigation Areas: Causes & Solutions

2nd Street Improvements

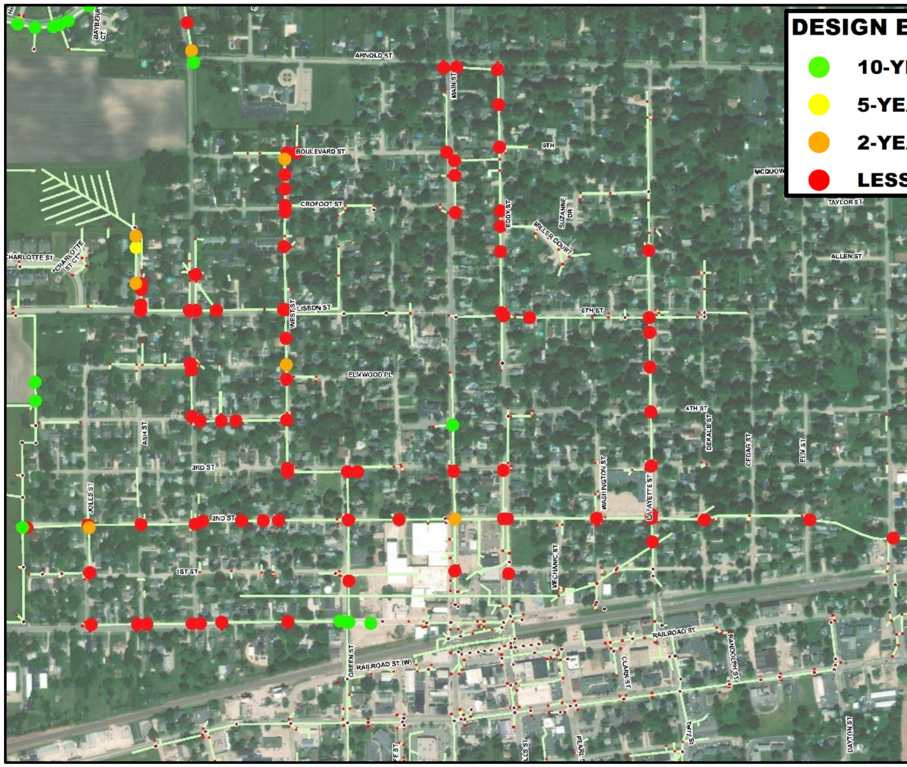


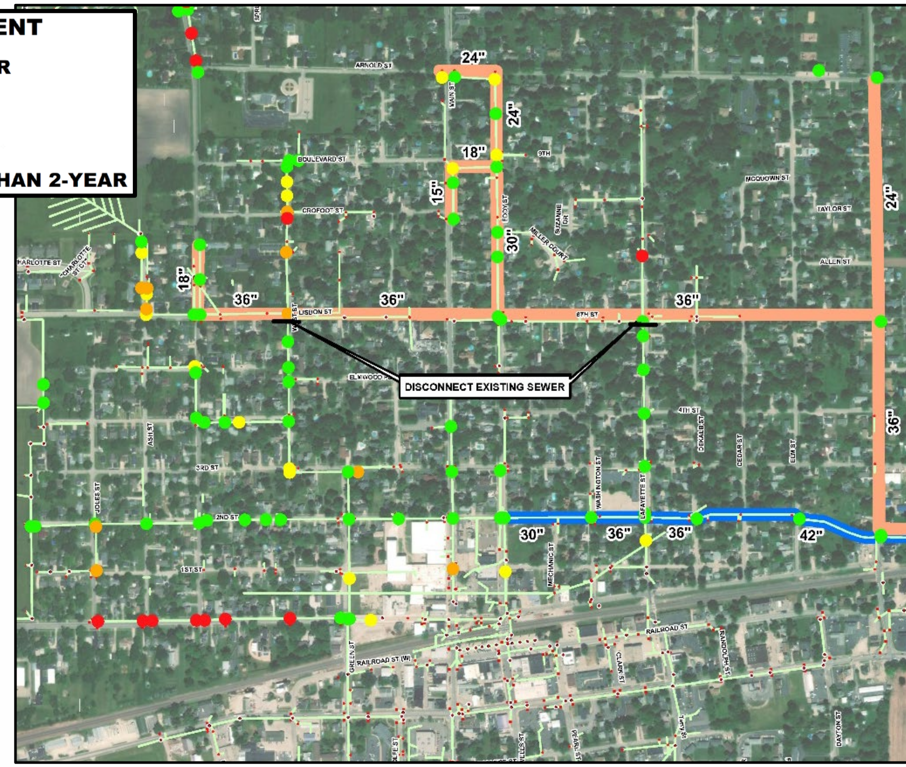
Solution

- Upsize Outfall Provides Relief Upstream
- Install ±3,700 Feet Storm Sewer

Investigation Areas: Causes & Solutions

Storm Sewer Design Storm Capacity Summary

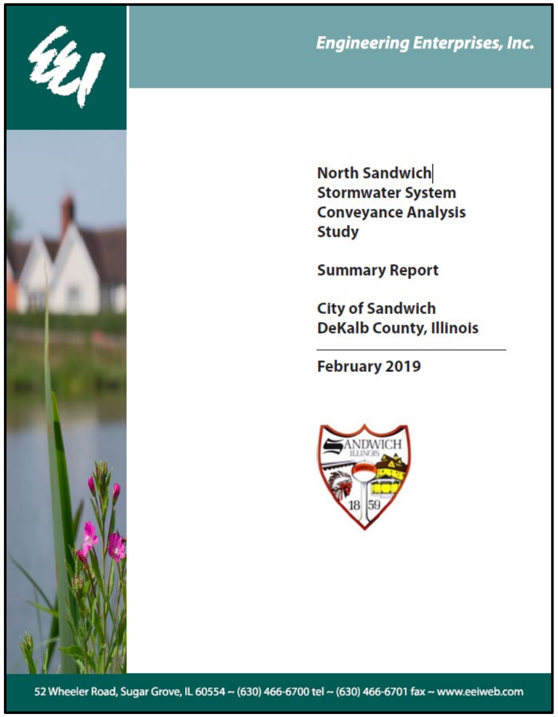




Existing	6th & 2nd St Improvements

Results & Lessons Learned

- 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


Engineering Enterprises, Inc.

North Sandwich
Stormwater System
Conveyance Analysis
Study

Summary Report

City of Sandwich
DeKalb County, Illinois

February 2019

52 Wheeler Road, Sugar Grove, IL 60554 ~ (630) 466-6700 tel ~ (630) 466-6701 fax ~ www.eeiweb.com

Results & Lessons Learned

- 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

Q&A

Timothy N. Paulson, P.E., CFM
Senior Project Manager
Engineering Enterprises, Inc.
tpaulson@eeiweb.com
(630) 466-6700

Tyler A. Meyer, E.I., CFM
Project Engineer
Engineering Enterprises, Inc.
tmeyer@eeiweb.com
(630) 466-6700