A Systematic and Connected Approach to Siting Green Infrastructure

Addressing multiple urban stormwater management challenges through connected thinking - a case study in Pittsburgh, PA

Ohio Water Environment Association

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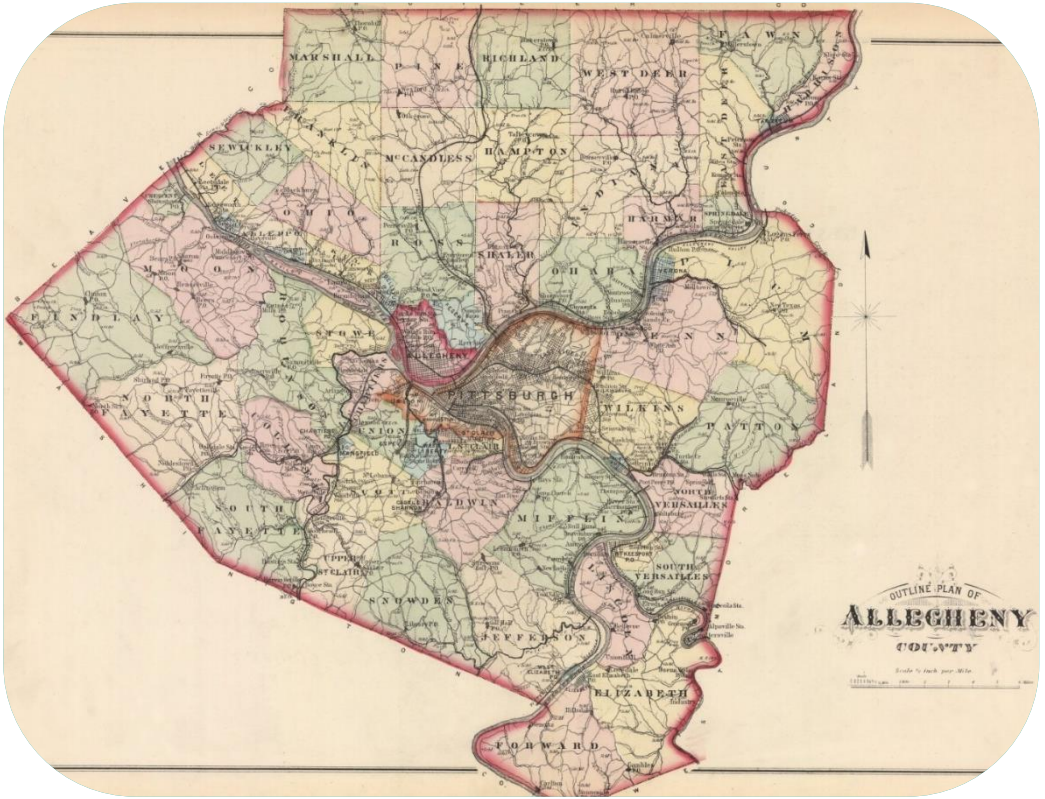
Presentation Overview

- Background and history of the Pittsburgh region's stormwater challenges

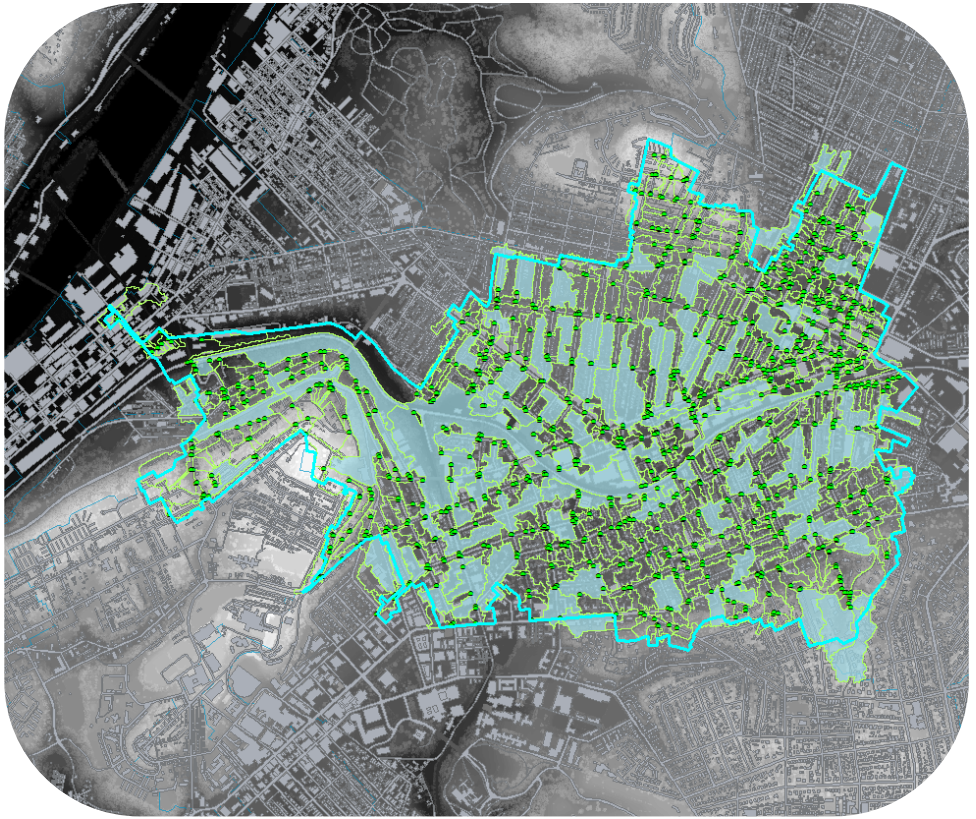


Presentation Overview

- Background and history of the Pittsburgh region's stormwater challenges

- Overview of stormwater and green infrastructure hydrologic and hydraulic modeling tools developed

- Demonstrate a walkthrough example using the tools developed



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- Overview of stormwater and green infrastructure hydrologic and hydraulic modeling tools developed
- Demonstrate a walkthrough example using the tools developed
- Summary and conclusions

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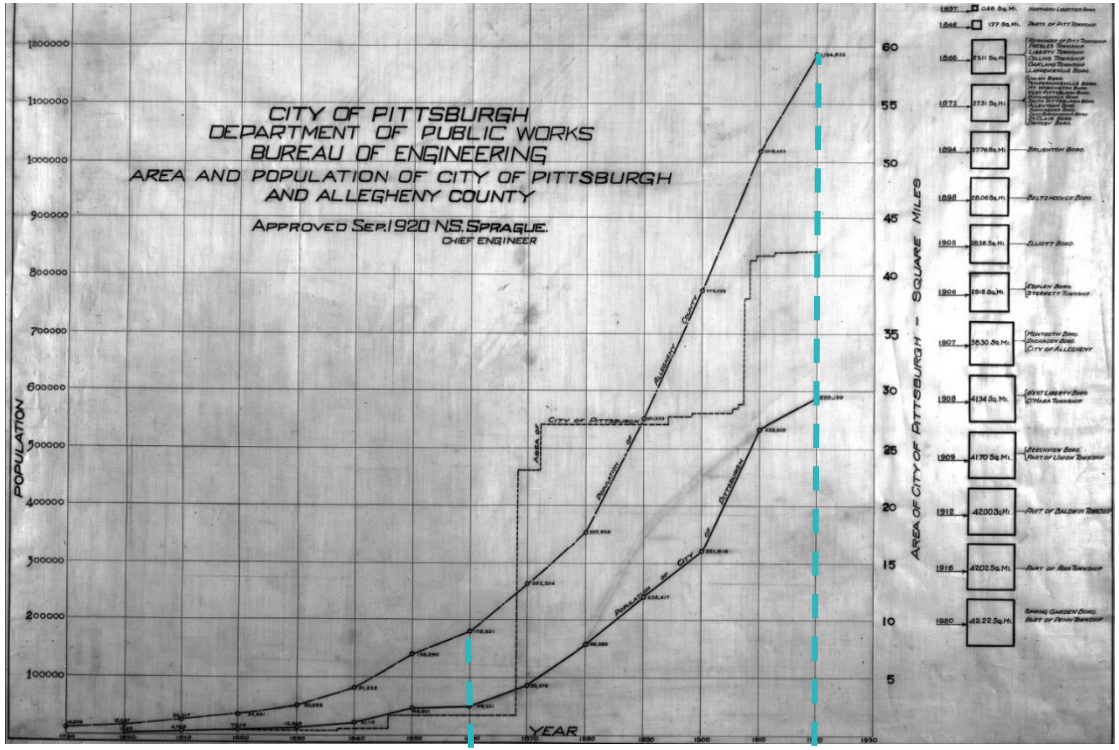
Background and History

History of sewage and stormwater in the City of Pittsburgh

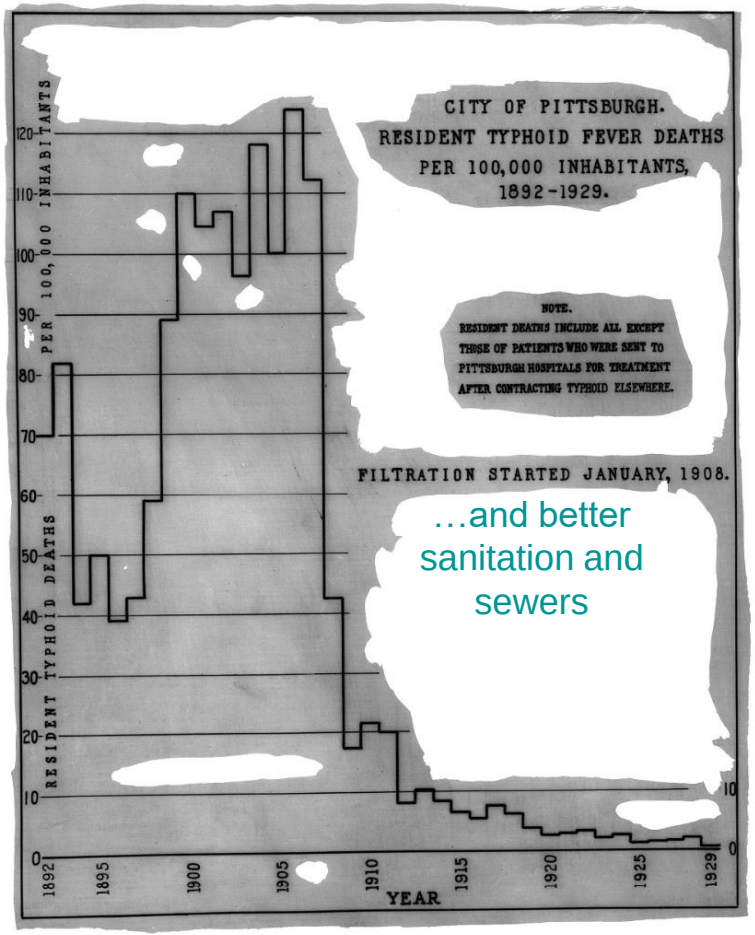
Pittsburgh in the early 20th century

Explosion of population and poor sanitation



1850 (0.2 M)

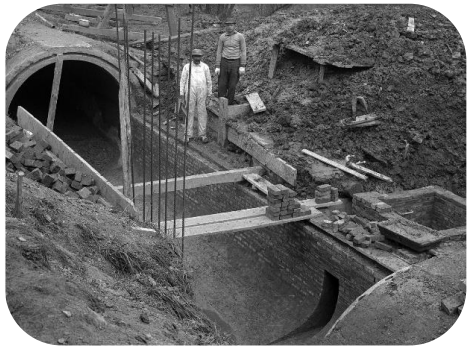
1920 (1.2 M)



…and better sanitation and sewers

http://www.historicpittsburgh.org/

Cork's Run ~1900



Negley Run ~1910

Saw Mill Run ~1950

Saw Mill Run one of the few remaining open streams

Photo of raw sewage discharge

In 1950, no public sewage treatment facility for roughly 2.5 M people in Pittsburgh region

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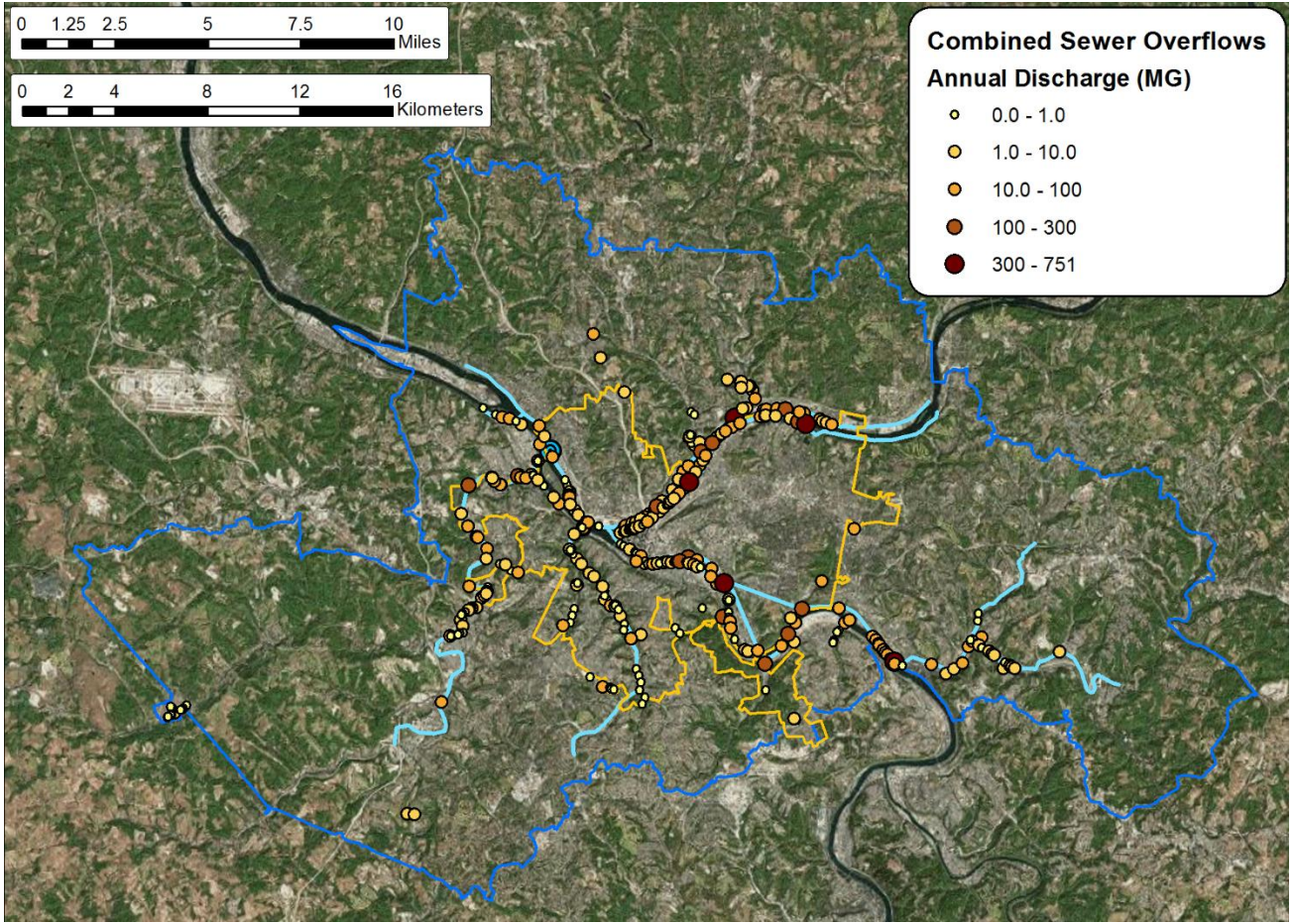

349 CSO Discharge Locations

Current conditions roughly 9.5 BG (34 M m^3) of annual CSO discharge into local waterbodies

City of Pittsburgh:
- primarily a combined system
- many culverted historic streams over a century old
- highly developed
- experiencing more frequent and intense rain events

Recipe for surface and basement sewage flooding and hazardous conditions

The Need for Stormwater Management in Pittsburgh

The Pittsburgh Water and Sewer Authority faced with many connected stormwater challenges

- CSO compliance
- Water quality
- Surface flooding
- Basement flooding

How can proper stormwater management address these issues?

Can a standardized approach be developed for siting and evaluating the effectiveness of stormwater projects?

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Stormwater Management in Pittsburgh

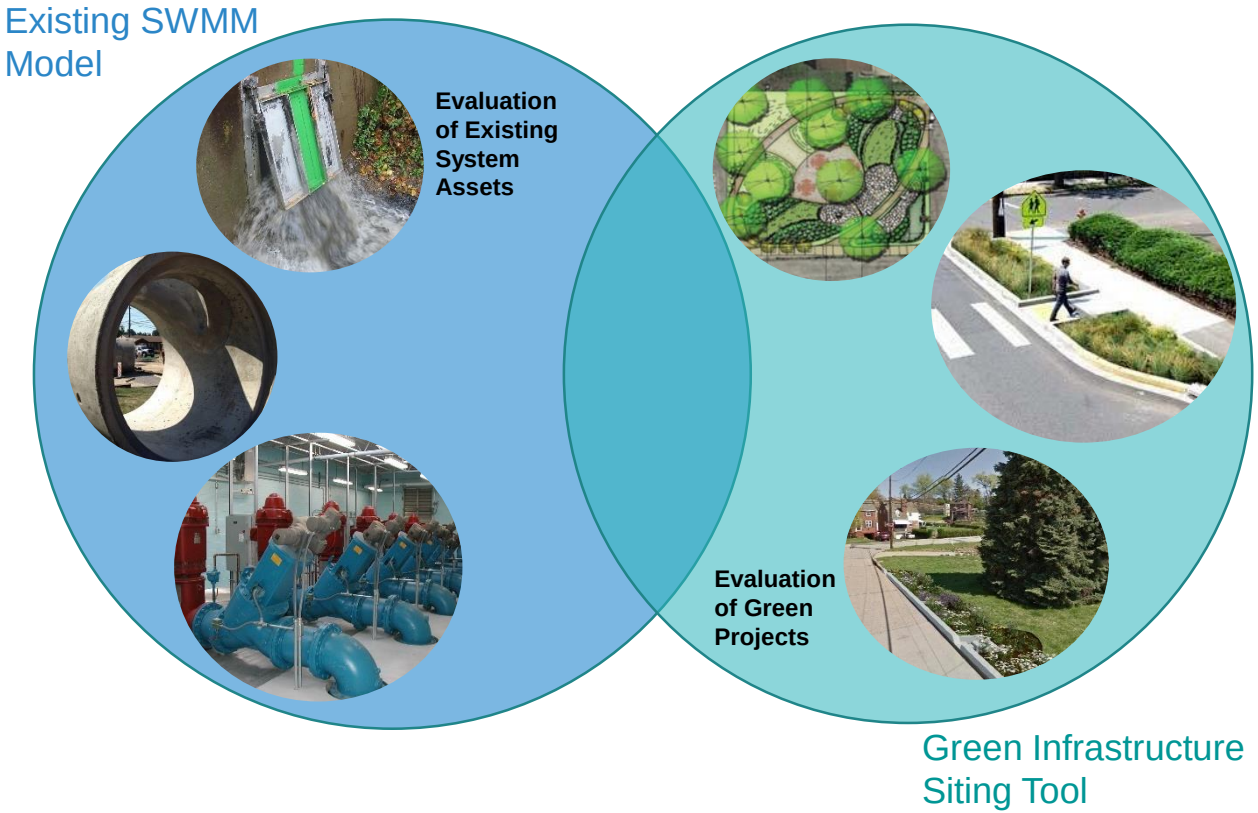
Overview of hydrologic and hydrologic modeling approaches developed

Development of Models

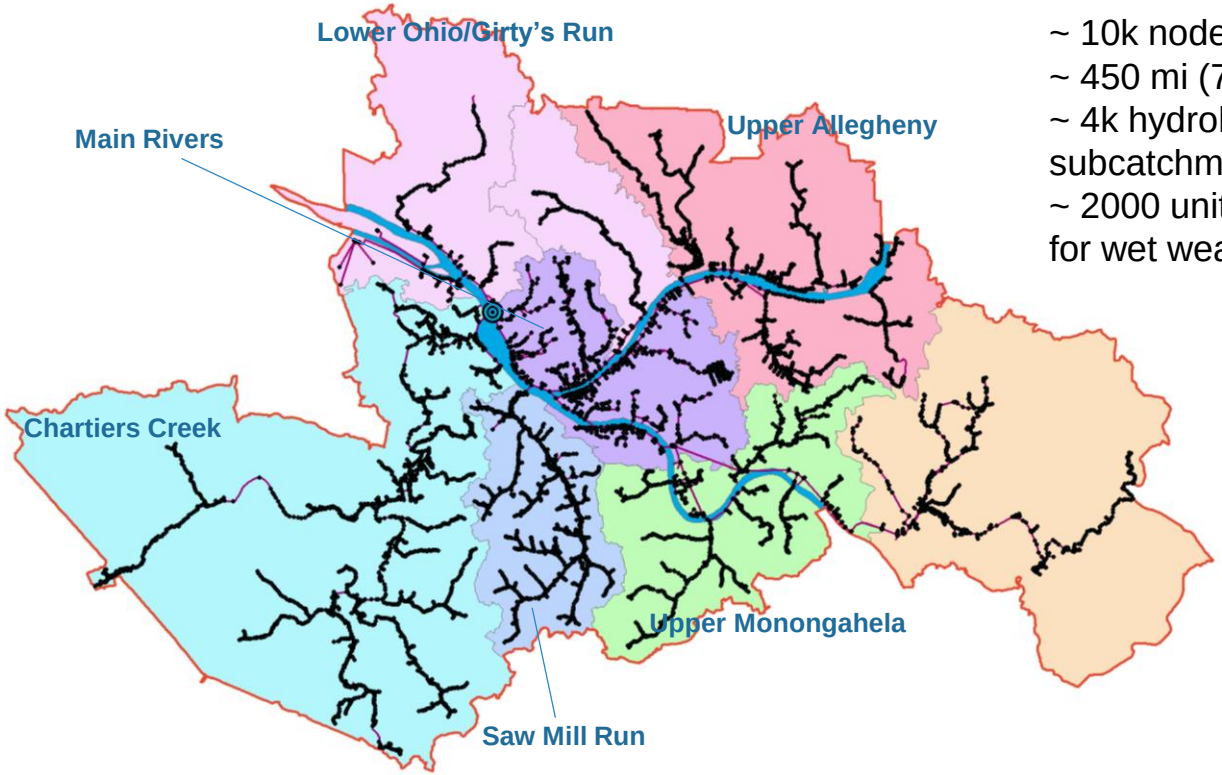
Modeling Needs:

1. Need to integrate the approach with existing SWMM model to understand downstream benefits to collection system

2. Need a green infrastructure hydrologic “siting tool” to adequately identify green infrastructure locations



Existing SWMM Model Snapshot



~ 10k nodes
~ 450 mi (730 km) in pipe
~ 4k hydrologic subcatchments
~ 2000 unit hydrographs for wet weather

7 SWMM "planning basin" models

Developed for the Pittsburgh region by Allegheny County Sanitary Authority

Development of a Stormwater Source Reduction Siting Tool

Goals of the tool:

Develop a **standardized process** for future green infrastructure planning work

Identify **“high-yield” stormwater capture areas** – where to get the biggest “bang for your buck” with green infrastructure

Easy integration with **SWMM and SWMM LID Low Impact Development Tool** to simulate stormwater benefits

ArcGIS based and easily replicable as new source data becomes available

Green Infrastructure Siting Tool

1. Identify impervious surfaces in sewershed (from imagery or near infrared):

- Buildings
- Parking Lots
- Streets

Software Training circles display areas selected to train the software for surface type:

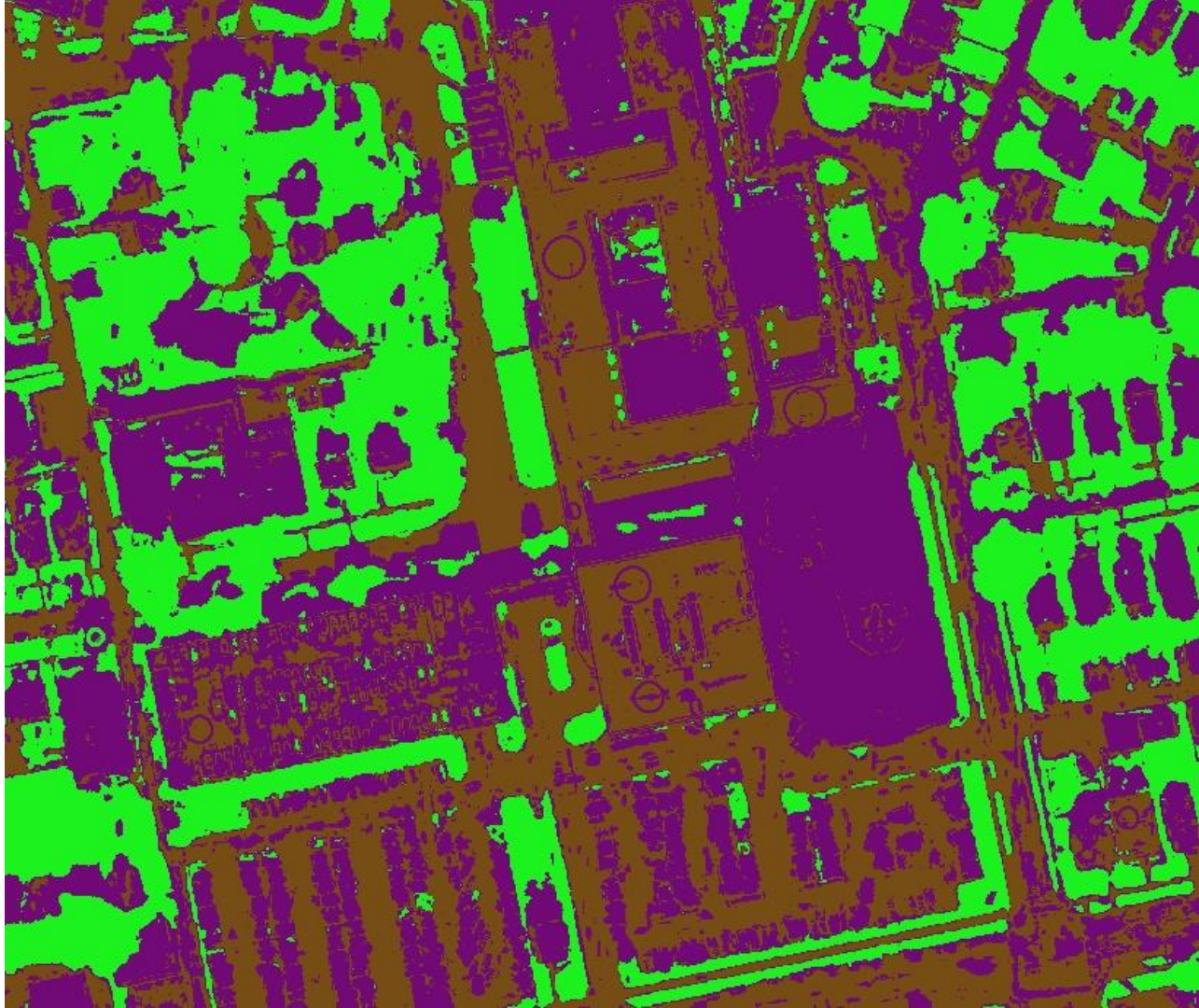
Pavement (Brown)
Buildings (Purple)
Vegetation (Green)

1. Identify impervious surfaces in sewershed (from imagery):

- Buildings
- Parking Lots
- Streets

Surface type classification:

Pavement (Brown) = 7.5 Ac (3.0 ha)
Buildings (Purple) = 11.1 Ac (4.5 ha)
Vegetation (Green) = 8.0 Ac (3.2 ha)



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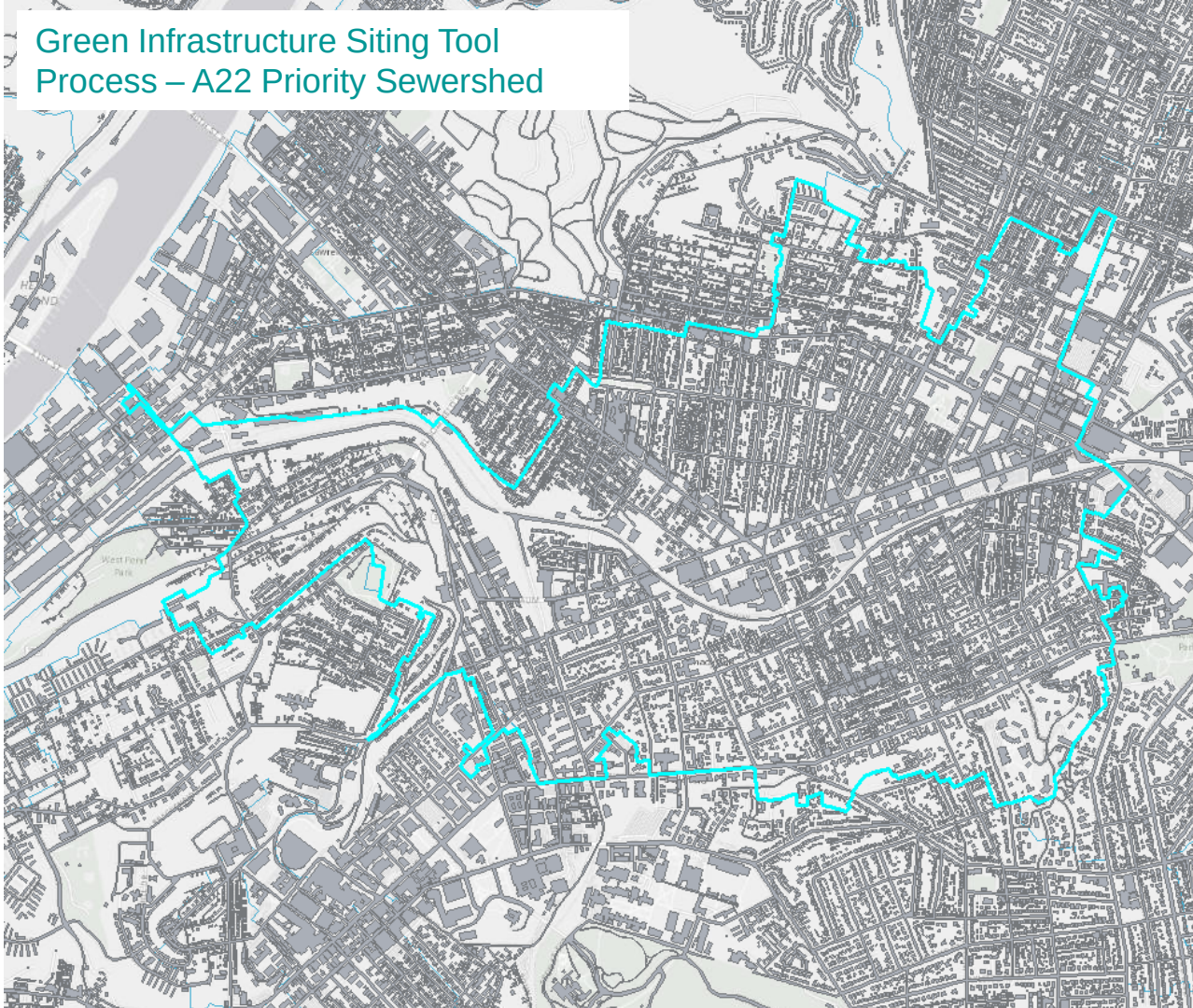

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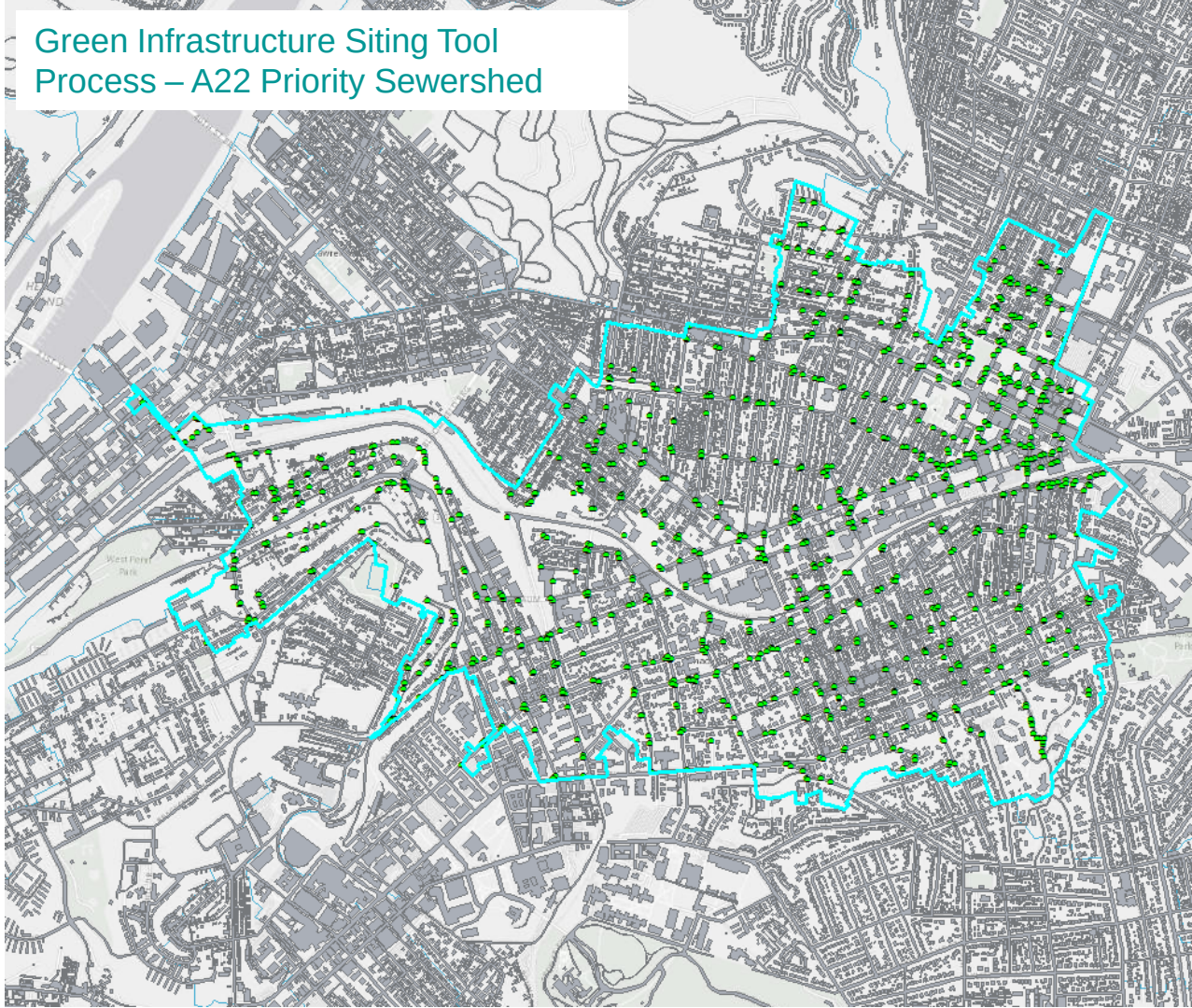
2. Utilize GPS surveyed stormwater inlet locations



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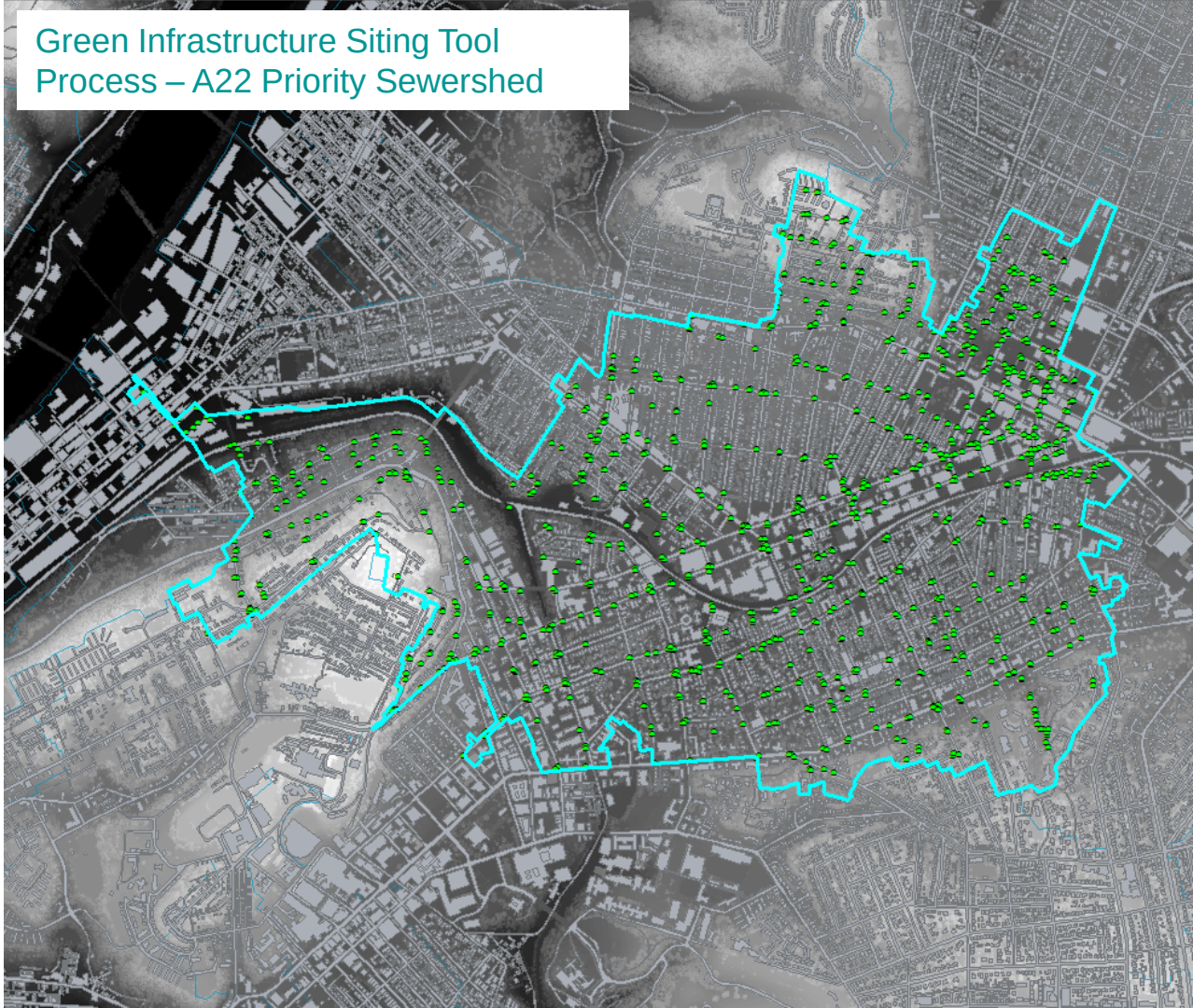
3. Overlay surveyed inlets onto high resolution LiDAR elevation data



Green Infrastructure Siting Tool Process – A22 Priority Sewershed

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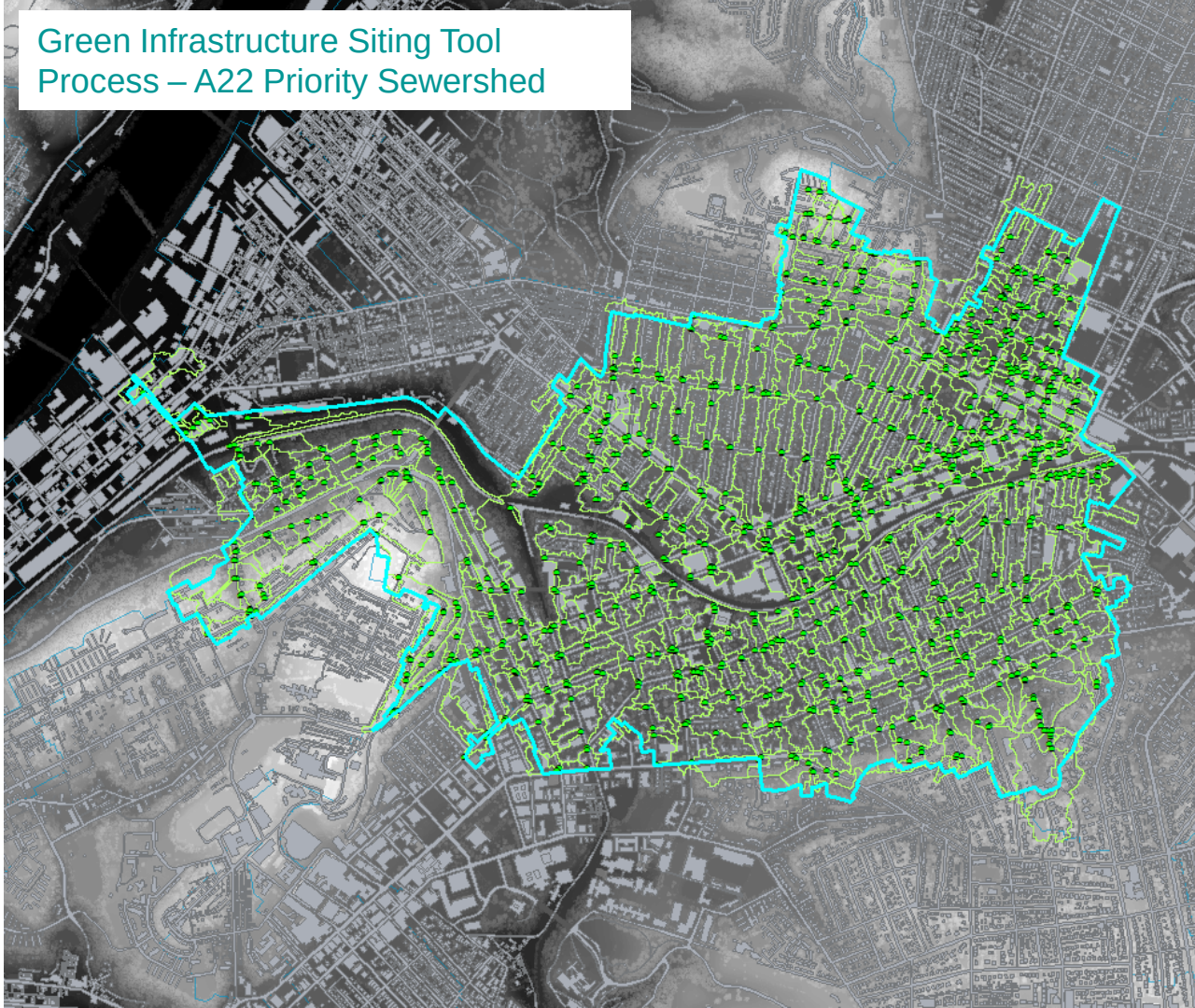
4. Delineate sub-sheds using ArcHydro Toolbox



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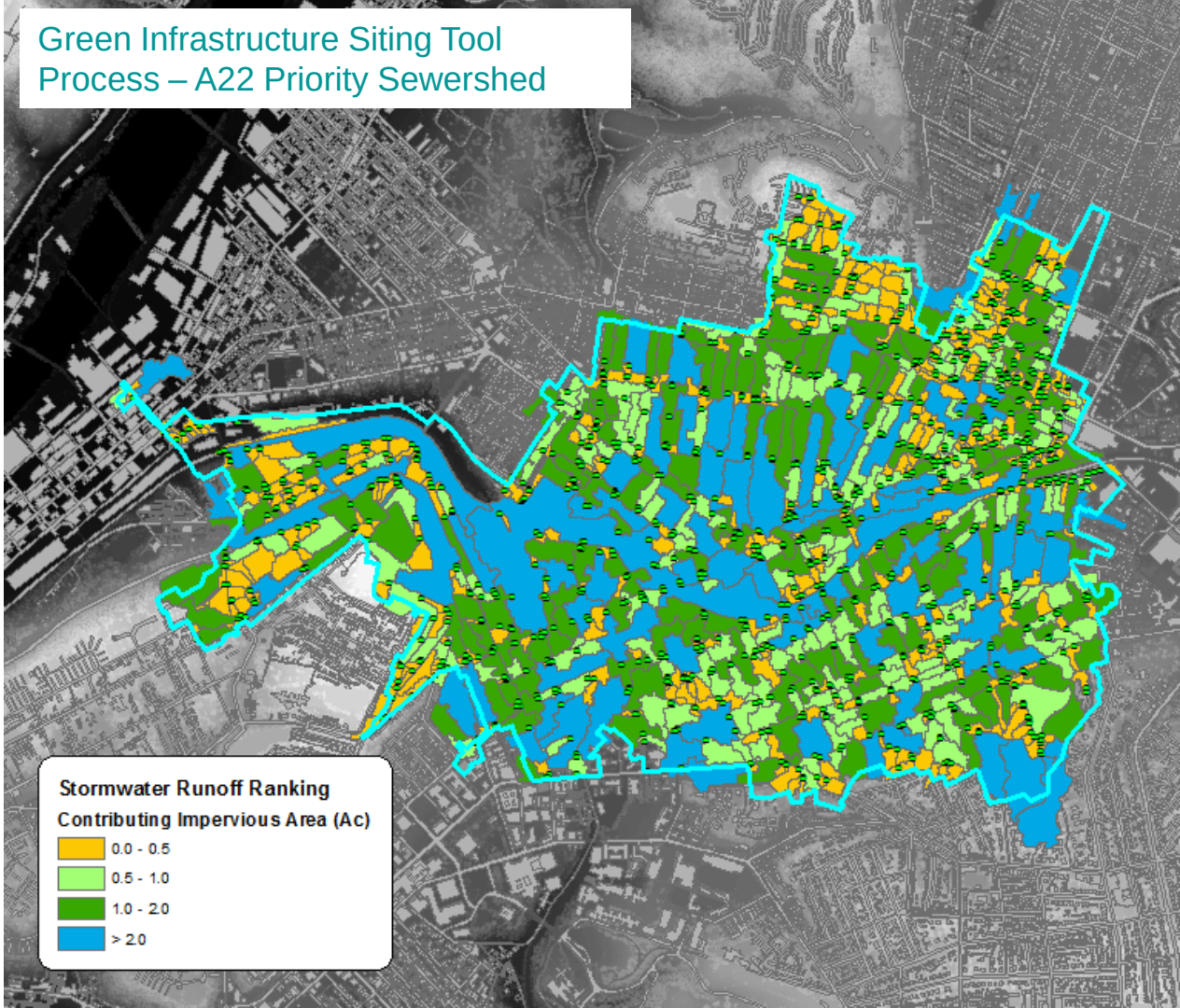
5. Rank sub-sheds based on potential stormwater runoff to each inlet



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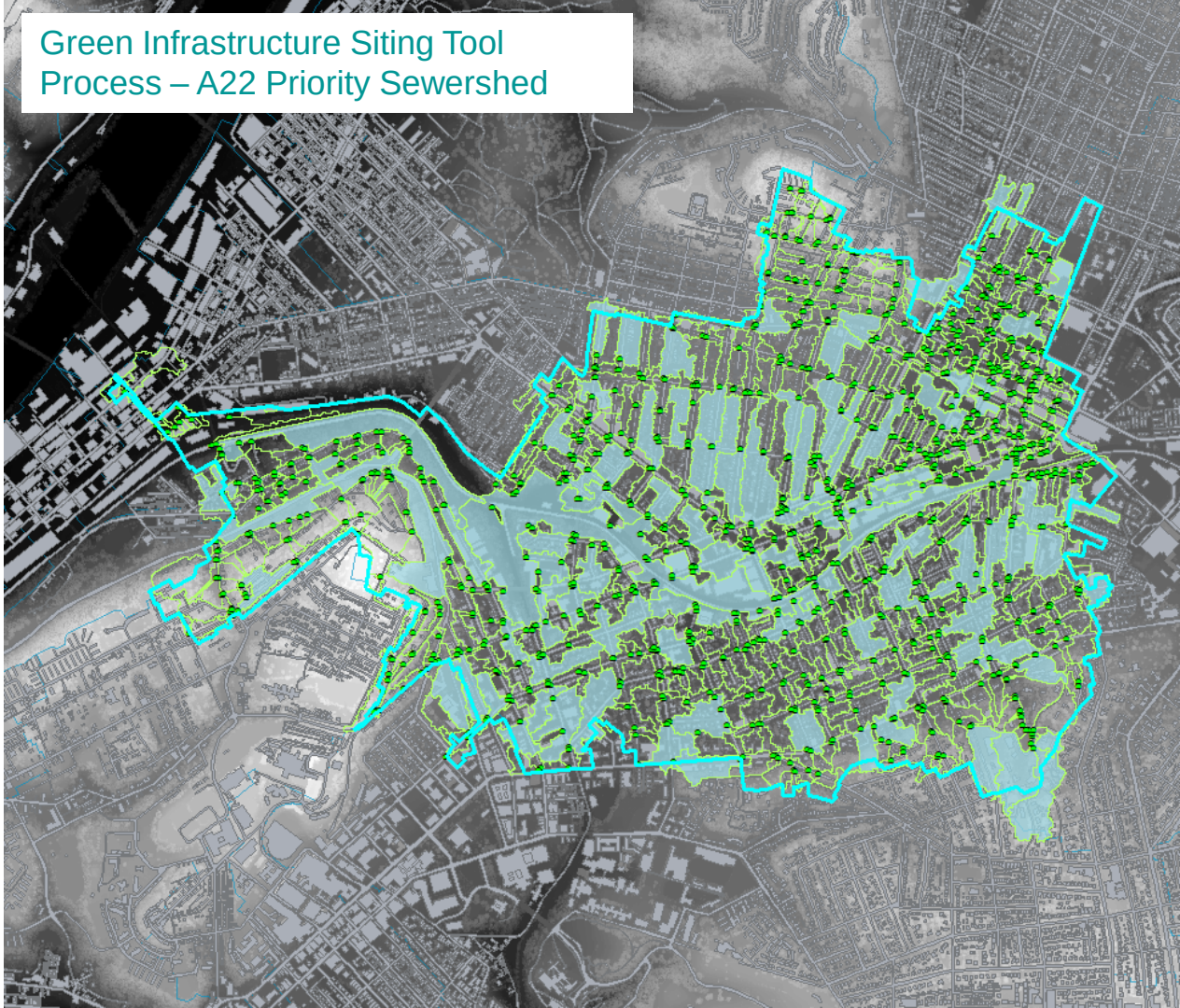
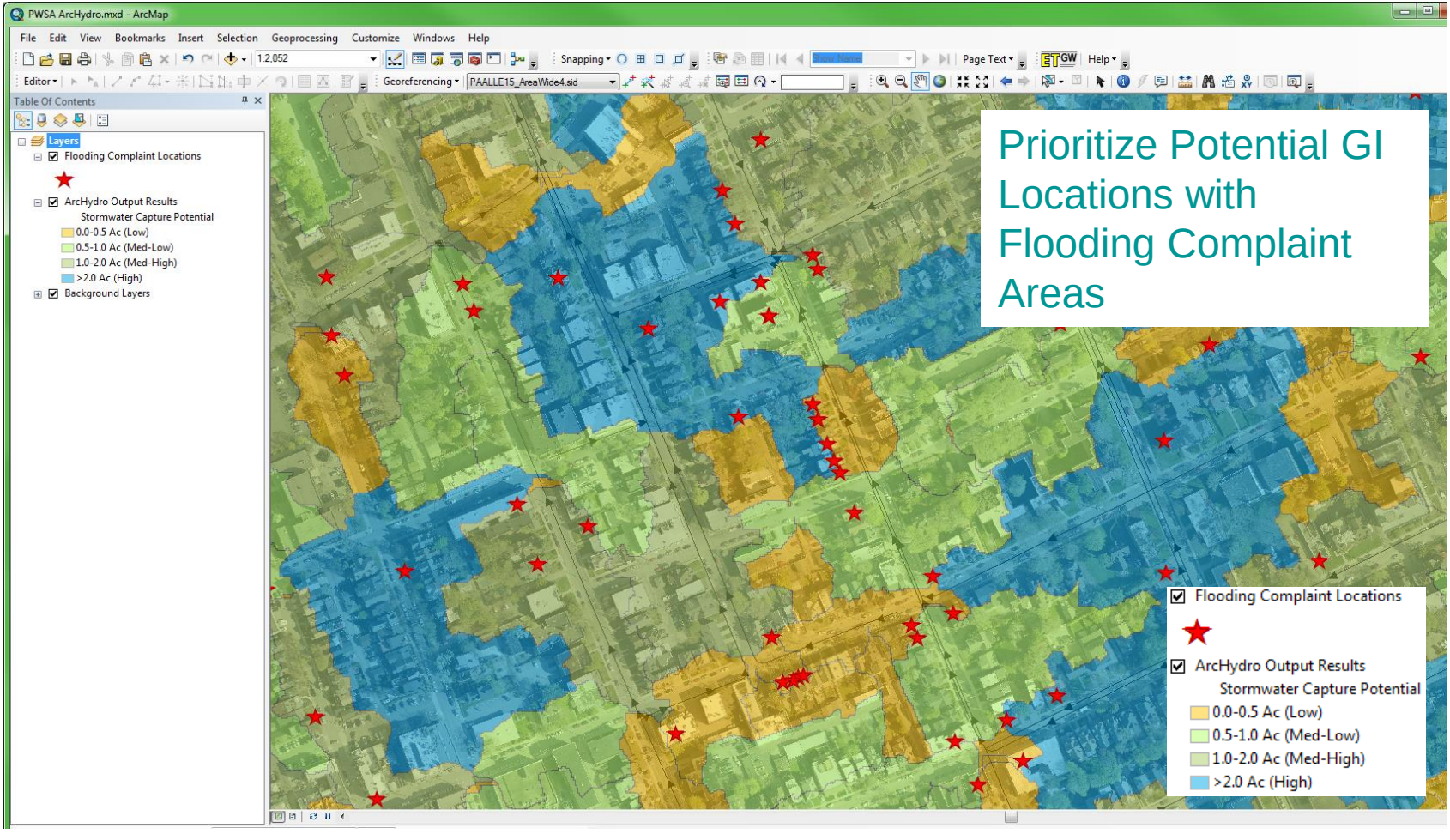
6. Select highest ranking sub-sheds to achieve stormwater management goals (CSO, Surface and Basement Flooding, Water Quality Targets)



Green Infrastructure Siting Tool Example



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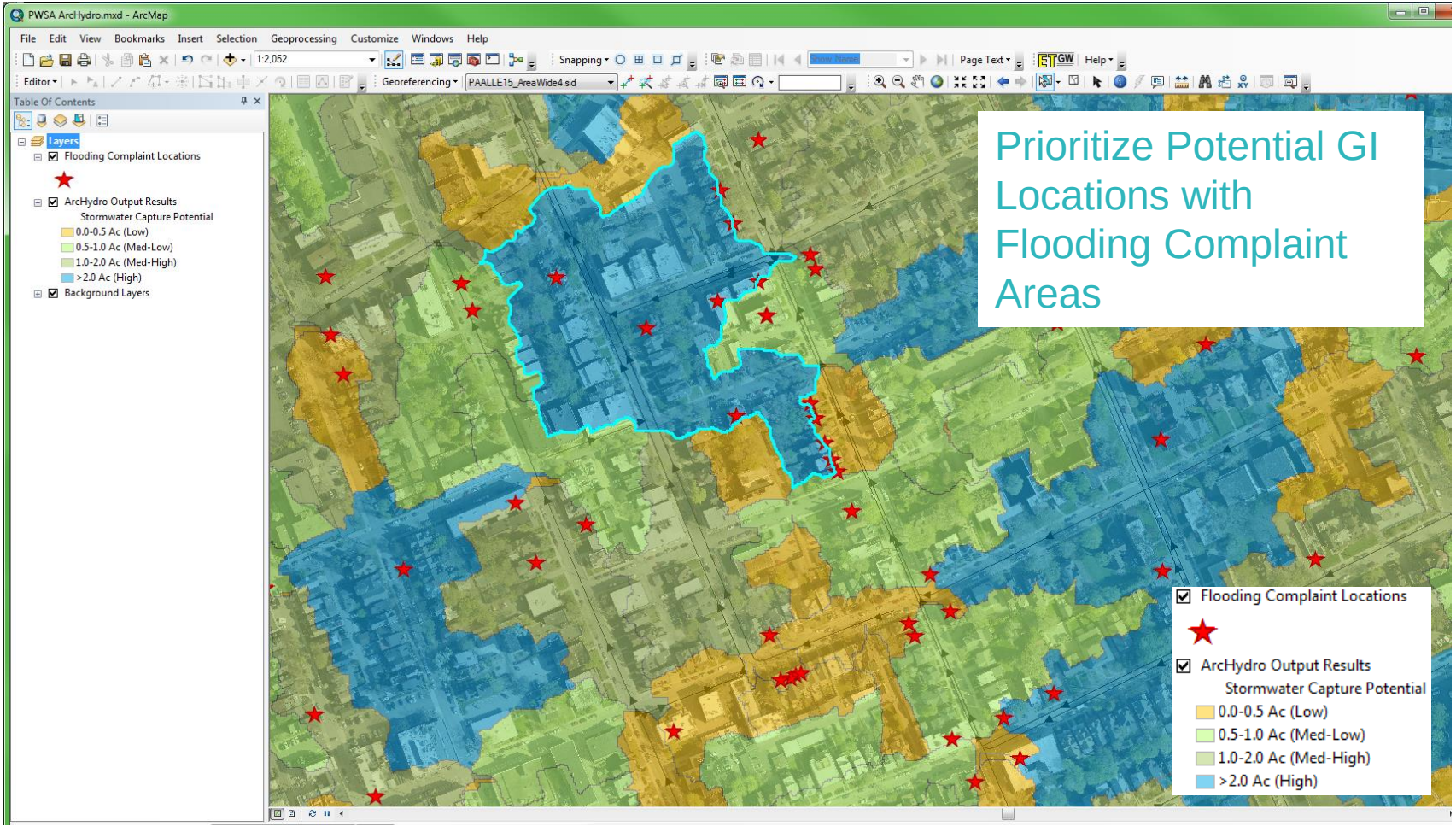

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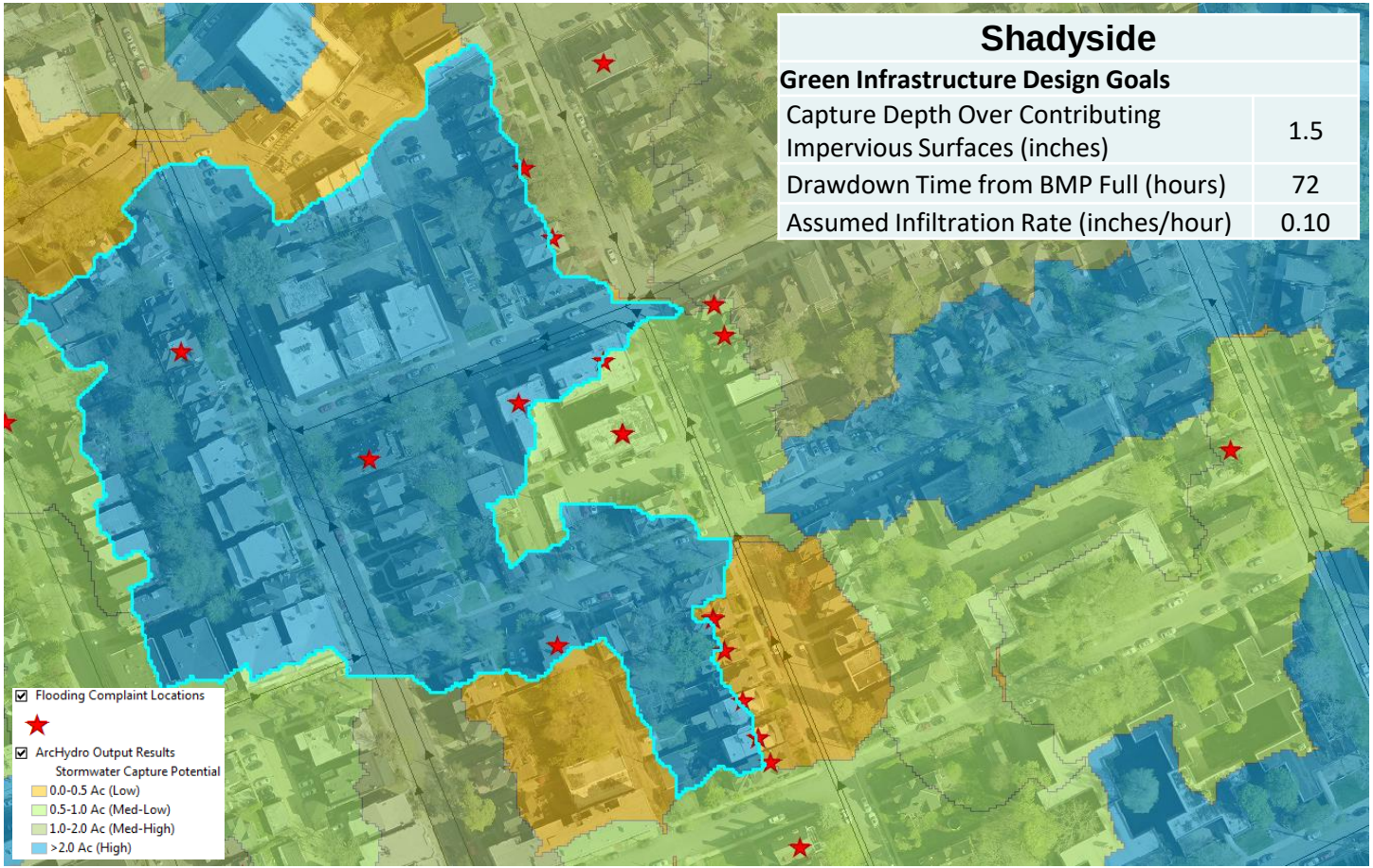

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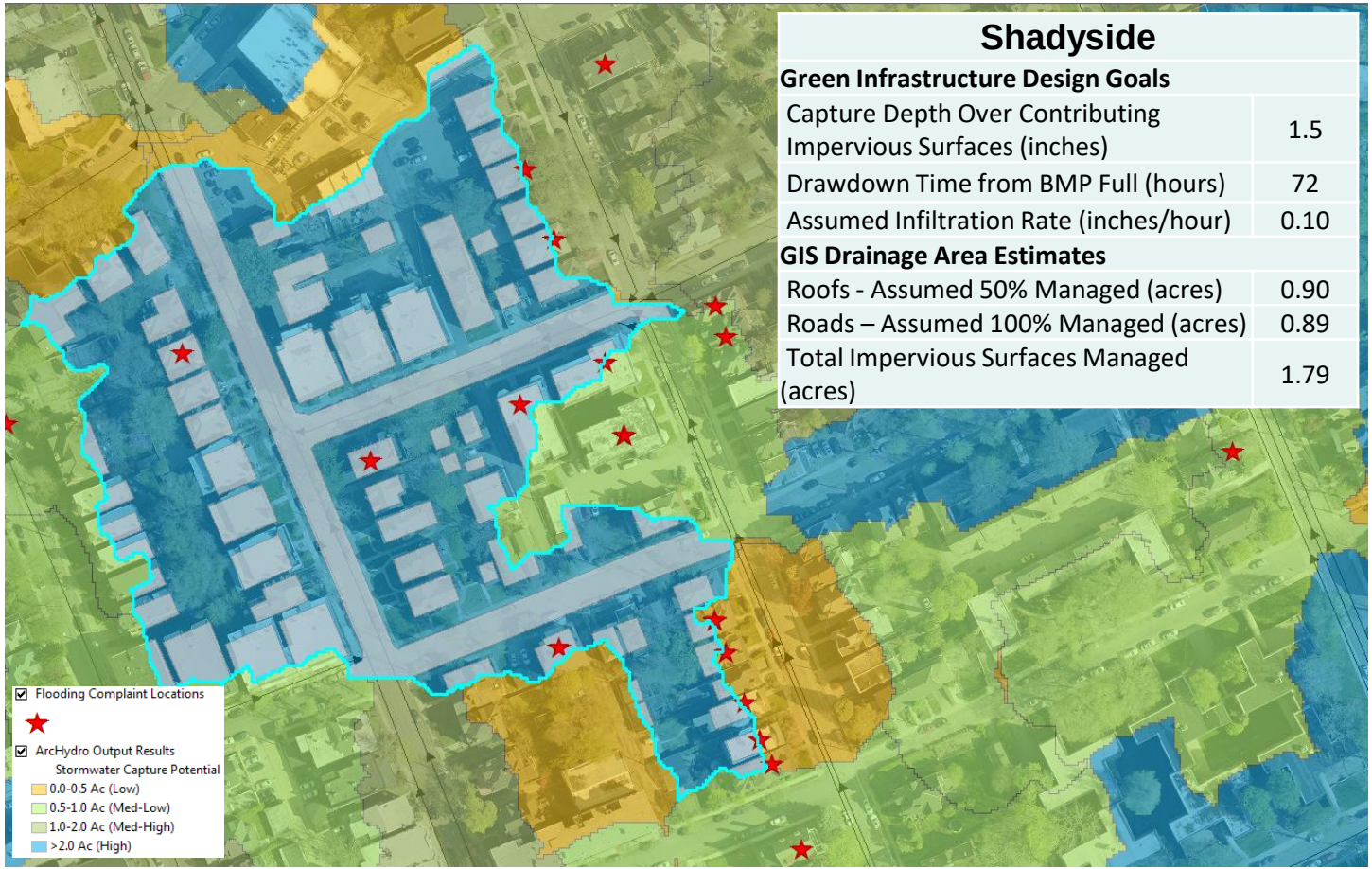

Shadyside	
Green Infrastructure Design Goals	
Capture Depth Over Contributing Impervious Surfaces (inches)	1.5
Drawdown Time from BMP Full (hours)	72
Assumed Infiltration Rate (inches/hour)	0.10
GIS Drainage Area Estimates	
Roofs - Assumed 50% Managed (acres)	0.90
Roads – Assumed 100% Managed (acres)	0.89
Total Impervious Surfaces Managed (acres)	1.79

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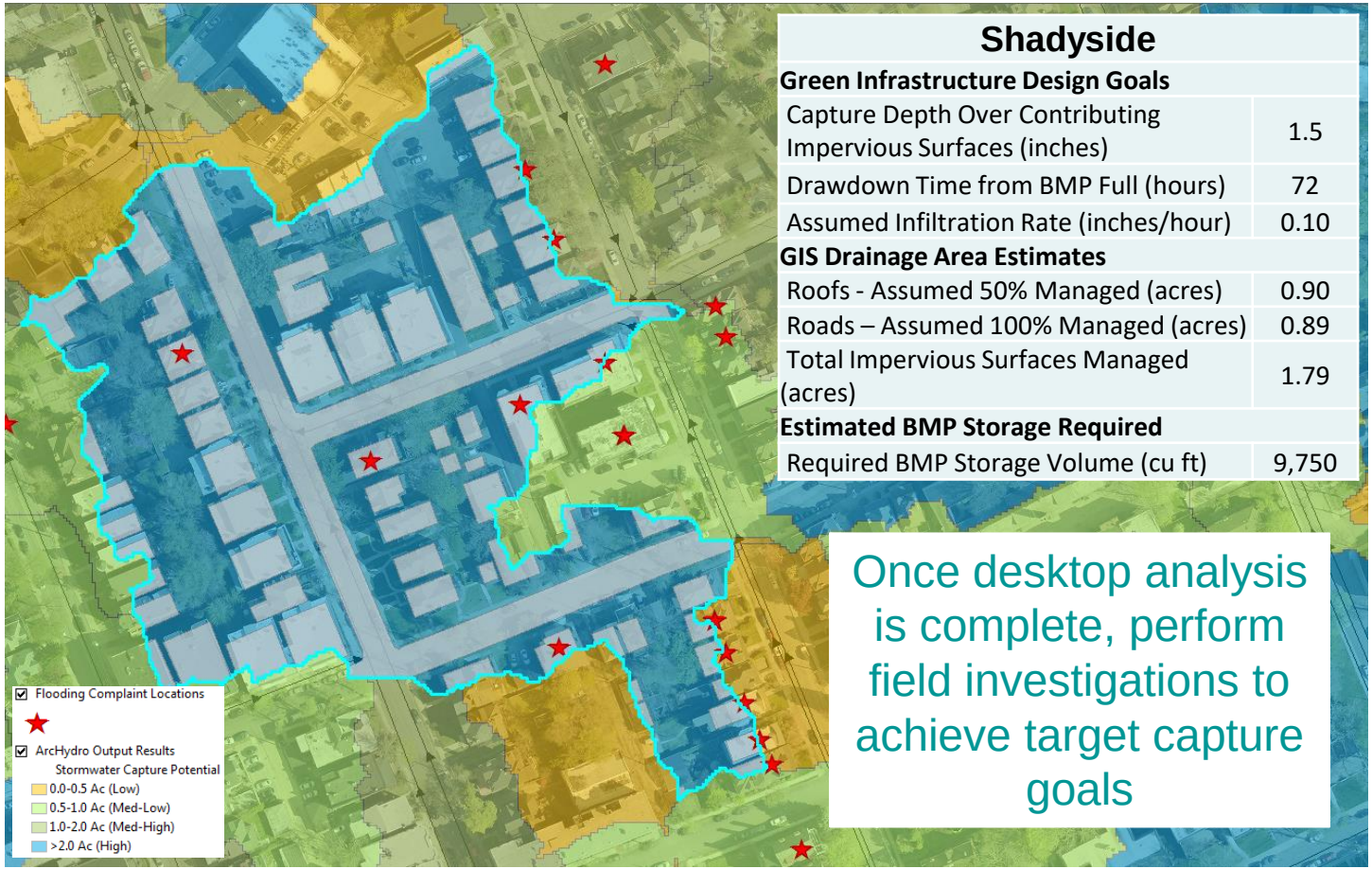

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Estimated BMP Storage Required	
Required BMP Storage Volume (cu ft)	9,750

Once desktop analysis is complete, perform field investigations to achieve target capture goals

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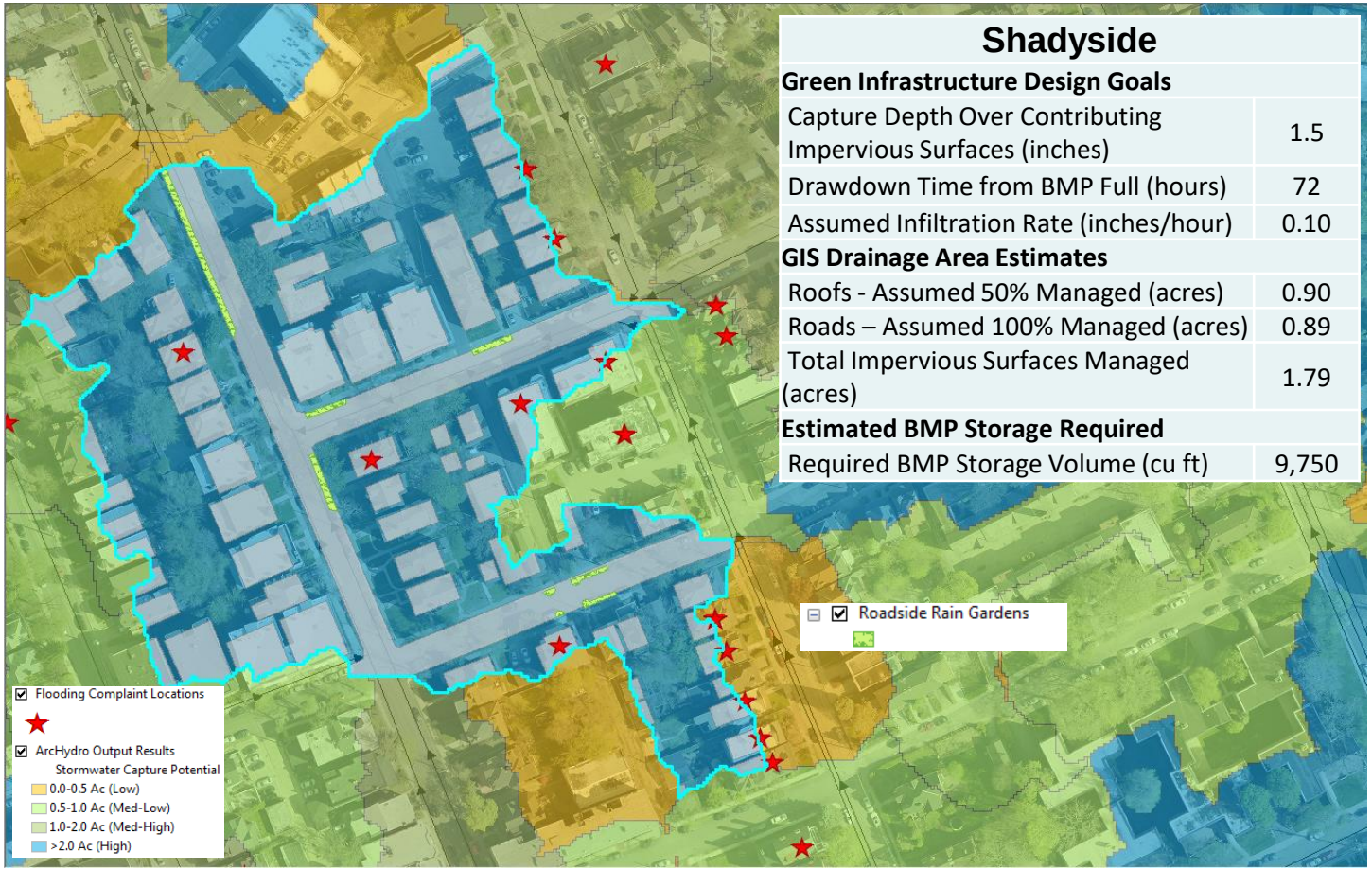

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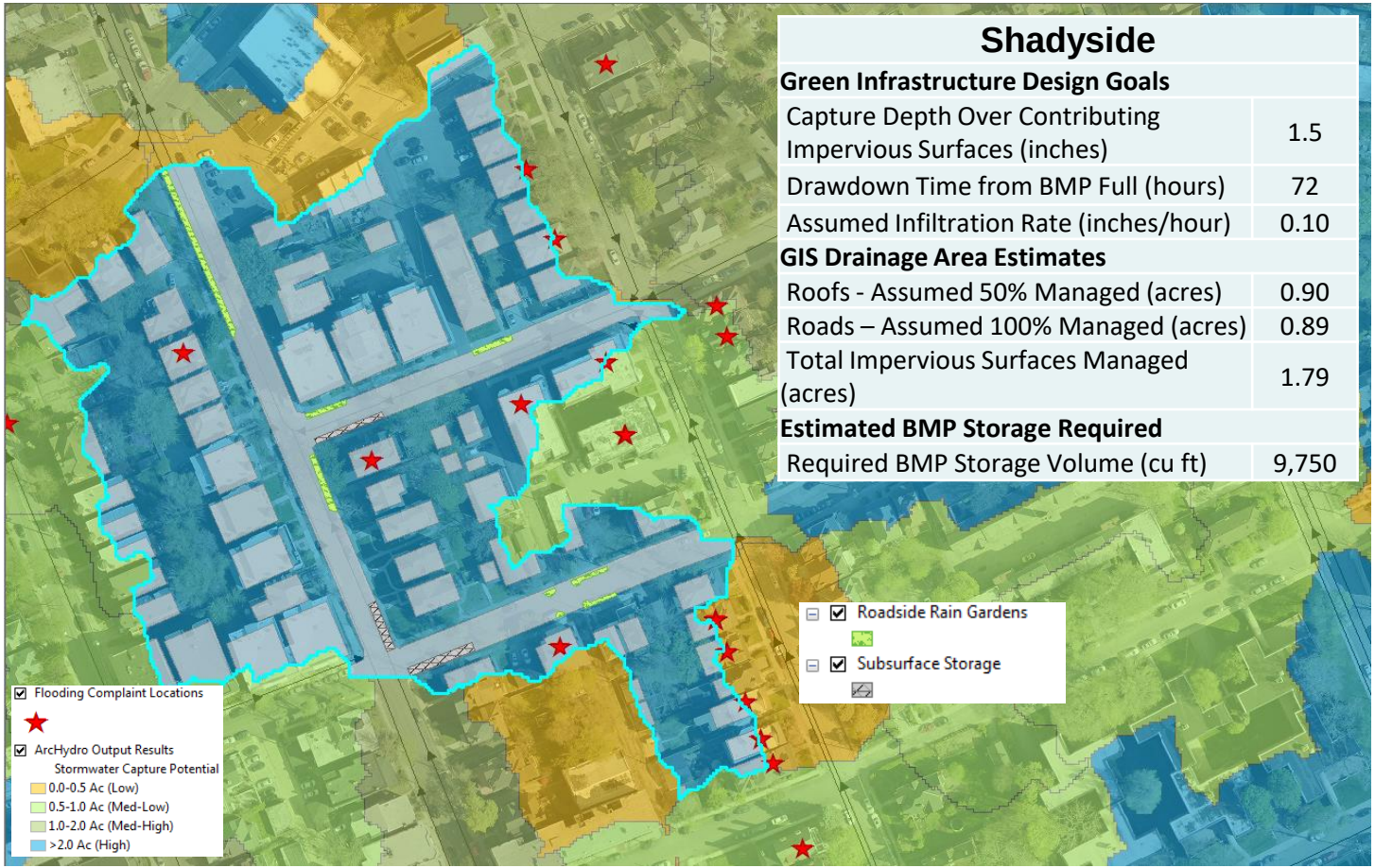

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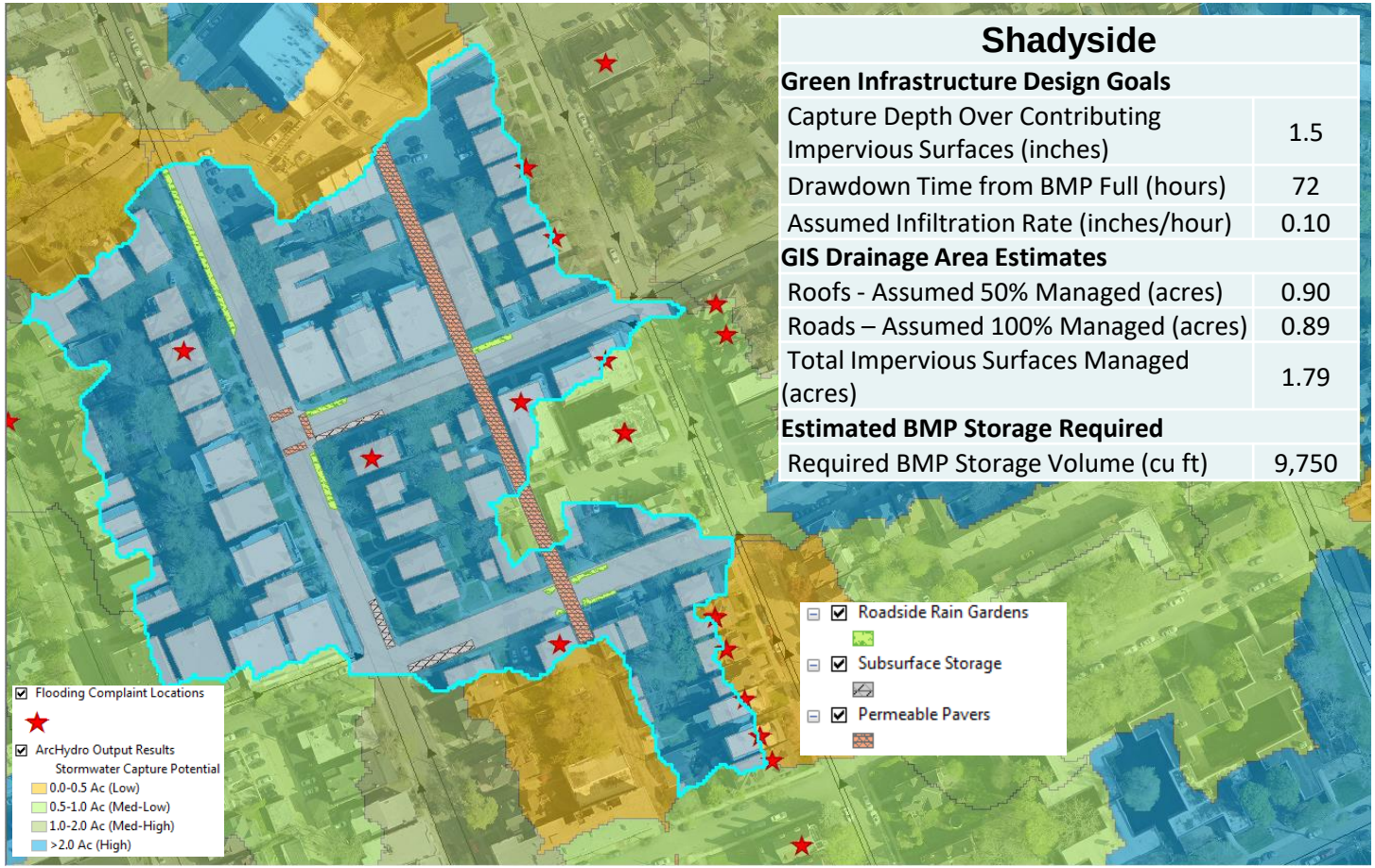
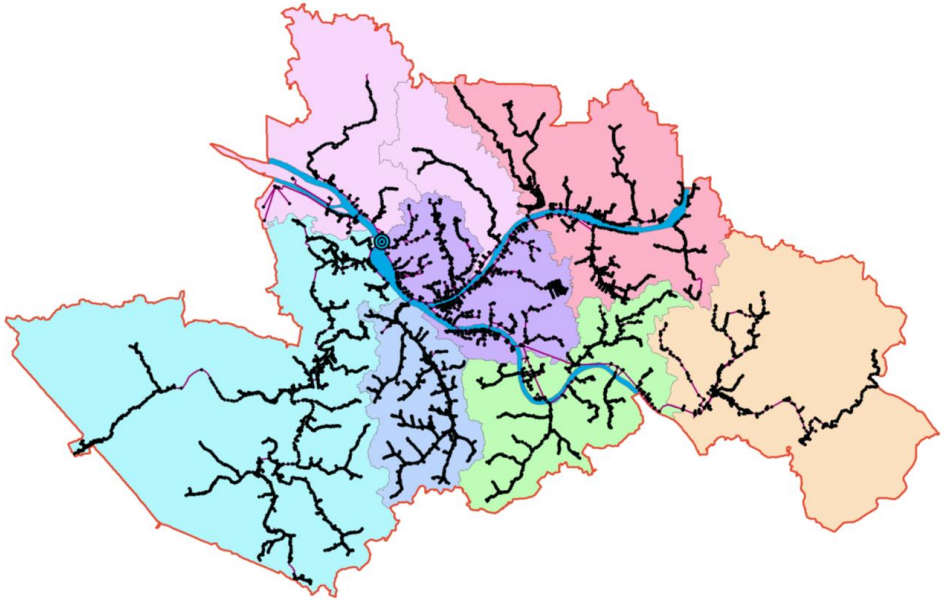
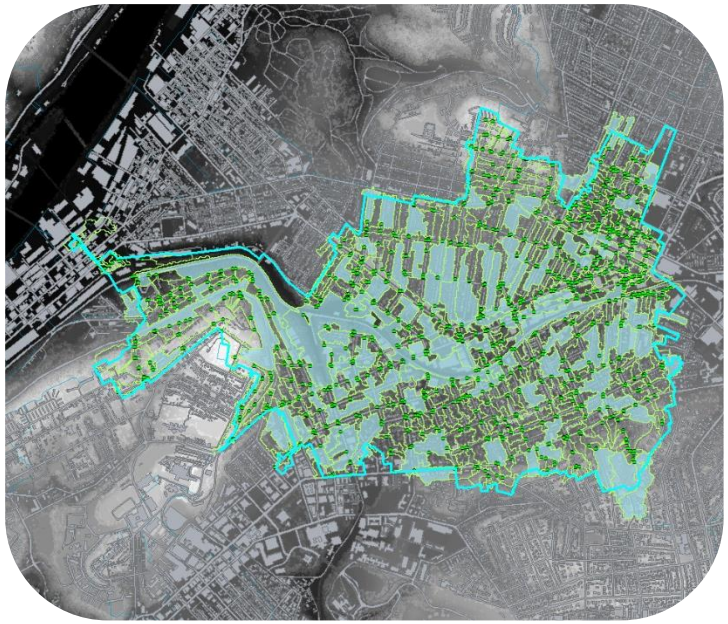




Regional SWMM Model



Green Infrastructure Siting Tool

Integrate Both Models for a Comprehensive Stormwater Analysis Modeling Package

- Quantify Localized Stormwater Runoff Management
- Determine Downstream CSO Reduction
- Evaluate Collection System Capacity Benefits
- Evaluate Reduced Instances of Surface and Basement Flooding
- Quantify Water Quality Benefits

Conclusions

Summary and Conclusions

Successfully developed a **repeatable and standardized process** for future green infrastructure planning work

Allows for the identification of **“high-yield” stormwater capture areas** – where to get the biggest “bang for your buck” with green infrastructure

Developed toolsets are currently being used to **plan, construct, and evaluate the performance** of green infrastructure throughout the City

Flexible toolsets for evaluating stormwater management and source reduction – can be applied in both combined systems (CSO) and separate storm systems (MS4)

Stormwater management and source reduction can **address multiple challenges** with the right toolsets at your disposal

Addressing multiple urban stormwater management challenges through connected thinking

Acknowledgements

The City of Pittsburgh

The Pittsburgh Water and Sewer Authority Green Infrastructure Team

Brandon Vatter, PE, Project Manager - Mott MacDonald

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Eric Gill, Modeling/Coding - Mott MacDonald

Alex Wasko , GIS - Mott MacDonald

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Thank you

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