Agenda – Workshop 3

Project:	CR STORM WATER MASTER PLAN
Subject:	Project Team Meeting
Date:	Wednesday, October 14, 2015
Attendees:	Garrett Prestegard, David Wallace, Jonathan Durst, Sandy Pumphrey, Ryan Bemrich, Loren Snell, Mike Kuntz, Bill Bogert, Terry Tiedemann, Michael Butterfield, David Dechant, Mike Schubert, Julie Stein

Agenda

Objectives

- Review and discuss preliminary results of macro-level model
- Review and affirm model selection
- Follow up on Existing System TM comments from City
- Initiate discussions of policy and other considerations

Phase 1 - FY 2017 CIP Development

- Revised CIP Development spreadsheet – will include most current version with Final TM 1.

Phase 2 – Stormwater Master Plan Development

- Refresh Phase 2 Master Plan Goals
- Existing System TM – City has reviewed, HDR is incorporating comments.
- Macro-Level Model – Preliminary Results
    - Modeling Approach
    - Model Overview (Basin Characteristics, 1D Flow Network, Rainfall Events)
    - Preliminary Macro-Level Results & Discussion
- Select basin for Basin Level Modeling
- Policy Considerations
- Set Date for Workshop 4

Meeting Discussion

Phase 1:

- The Council Infrastructure Committee is aware that there is a list of projects for the FY 2017 CIP; the City has not yet issued the list publicly nor has it received public reaction.
- Sandy P. met with Rockhurst neighborhood residents; they are please to be at top of list.
- A press release for the FY 2017 list is being drafted (part of the communications plan).
- The Infrastructure Committee is particularly interested in the financial plan and asked about bonding.
    - Dave W. noted to the committee that $1 million of bonds leads to $80,000 of annual debt service. Annual rate increases of 2-3% would be needed just to keep up with the debt service.
    - City would prefer revenue bonds; GO bonds are not likely an option.
    - City wants to have several options to consider. Rate increases and conversion to an ERU (Equivalent Residential Unit) stormwater fee system are both future options.

- The Cedar Lake Study Committee is moving towards Phase 1 and Phase 2 environmental studies. While the goals of Friends of Cedar Lake are primarily recreational, the study group is hoping for brownfields grants.

Phase 2:

- Goals of Phase 2 were reiterated – developing a document for long-term planning with continual updates. The Master Plan is to be a living document, updated as new or better information is learned, projects are completed, and new policies and practices are implemented.
- The City asked that Existing Systems TM (TM 1.0) be resubmitted after initial City comments are incorporated before making it a "final" draft.
- It was acknowledged that not all TMs that will become chapters of the Master Plan will be "100%" and future efforts will improve some.
- Goals for several of the TMs (generally) are to document what is the City is doing, what the City will be done, and what the City can or should be doing.
- TM 2.0 Asset Management will be an upcoming deliverable.
    - The City noted that they are working internally to update their asset management practices and tools. Therefore, much of what was in the preliminary draft prepared by the City may be out of date soon.
    - A critical focus of the asset management program will be metrics and defining how much they should be doing.
    - HDR will schedule a meeting with key City staff to discuss current and anticipated practices to document in the TM.
- TM 5.0 Financial Plan will be an upcoming deliverable. Will likely need to shift effort from other tasks to focus more on the Financial Plan given interest from committee.
- TM 6.0 Policy Considerations will be an upcoming deliverable.
    - A critical policy of the Cedar River Flood Control System (FCS) is the appropriate sizing of stormwater pump stations to operate at high river levels. The policy could put a significant burden on finding areas and ways to provide detention upstream in the watersheds.
    - Policy Considerations need to start with a brainstorm list of what the issues are.

MACRO-LEVEL MODEL

HDR presented an overview of the macro-level model of the stormwater system and preliminary results. A copy of the power point presentation is available.

Model Overview & General Discussion

- Aerial photography was used to update and clarify land-use from the GIS database. HDR will note the date of the aerial photography used.
- LiDAR data was generally good data (from 2012, processed and provided by the City).
    - The City is looking at flying planimetrics every 2 years for ERU and looking for economies of scale; LiDAR updates would be an option.
- Quality of data for Cedar Rapids vs. other communities was discussed:
    - LiDAR, planimetrics, and land-use were all good.
    - Pipe network data had significant holes – about 80% of system missing. Supplemental survey filled in about 30% of the missing data, but there are still numerous gaps in the overall network.

    - Additional data is needed on geometry of major in-line basins and control structures; HDR will send a request to the City.
    - City has requested 3 permanent, real-time rain gauges from Iowa Flood Center – Public Works, Northwest Water Plant, and Water Pollution Control Facility.
    - HDR is continuing to reconcile differences and anomalies in the data; the West Side Interior Drainage model was recently received and is being assessed.
- Future modeling will provide opportunity to look at tailwater impacts on outfalls into various creeks and the Cedar River. Model currently assumes no tailwater.
- The macro model is a 1-D model (that is, it does not look at surface ponding), therefore only a 5-year storm was evaluated since the pipe network is intended to convey runoff for the 5-year storm per Metro Area Standards.
- Model results are shown for watersheds with sub-catchments delineated within the watershed.

Results: "O" Avenue Sub-Watershed

- Pipe segment at the outfall is shown as less than half full.
- City calculations have shown that the pipe can hold a 5-year storm without detention near 11th St.
- There is a segment of pipe missing (based on data) just east of Edgewood; for connectivity it was assumed that a pipe exists.
    - HDR will document and provide to the City a list of critical data gaps such as this.
    - There is a pipe bottleneck at this location. It might be possible to upsize the pipe or make improvements with a related project (Paving for Progress).

Results: "E" Avenue Sub-Watershed

- Large in-line detention facilities are *not* included in the model yet.
    - Detention pond just west of the E Ave crossing should improve downstream results IF the detention pond is capable of handling a 5-year storm.
- Bottleneck at the west side of Edgewood Road (Walgreens). Park upstream adds some detention around Johnson Ave west of Edgewood.
- Detention basin at 16th Ave & Edgewood is small based on the catchment size; a number of problems have been noted.
- Bottleneck at "A" Ave & 4th Street NW.

Results: 4th Avenue Sub-Watershed

- Possibly a missing pipe near Rockford Road.
- Similar issues in this watershed as identified in the West Side Interior Drainage model.
- Known issues underneath the 15th/16th Ave viaduct.
- City is building a new detention basin north of Wilson Ave between 18th Ave and Balsam Dr. SW.
- There is open channel flow on the north side of the railroad and leads to street flow in flat area that ultimately drains to the north. Houses are fairly low in the area.

Results: 13th Avenue/Czech Village Sub-Watershed

- Frequent street ponding between 6th Street SW & I-380, north of 14th Ave.
- Model is showing a bottleneck pipe on the east side of I-380, but the City has not seen many issues there. Need to verify connectivity across I-380.
- Mallory & 19th Ave SW has frequent street ponding.

- City televised sanitary and storm sewers along 6th Street SW from 33rd Ave north to 14th Ave. Found significant amounts of gravel in lower sewers near 14th Ave; source has not been confirmed.

Results: McLoud Run Sub-Watershed

- Open channel sections are assumed to be trapezoidal; further data is needed.
- There is a large (possible private) basin at the northwest corner of Hwy 100 & I-380; basin captures runoff from parking lots for Sam's, Walmart, Lowe's, etc. Detention pond needs to be shown. Catchment boundaries shown on the map are incorrect – HDR will revisit boundaries.
- Hiawatha development and lead to runoff impacting railroad embankment and ultimately lots of sediment in pipes.

Results: Kenwood Sub-Watershed

- Data for the 2 catchments north of 29th Ave NE is in question.
- Per the I&I study, there are a significant amount of private I&I sources that will be disconnected from the sanitary system and reconnected to the storm water system. The model does not discount potential I&I sources. So, the model may be showing more impacts now, but as the I&I sources are reintroduced to the storm water system, impacts will come in-line with the model.
- The Kenwood Ditch outlet into Cedar Lake is generally 75% full (if not 100% full during spring and early summer), so the assumption of a free outfall does not fit with normal conditions for Kenwood. As a result, the model is overestimating pipe capacity.
    - Water in the box culvert starts at about Coe Rd & Oakland Rd NE and gets deeper towards the lake.
    - HDR will adjust the model to assume that the outlet is always submerged since problems usually occur in spring and early summer when the lake is higher.
- The pipe across 1st Ave at 15th St NE is a bottleneck.

Discussion:

- City noted that the model is generally consistent with known issues.
- North of the 5-in-1 dam, outfalls on the west side of the river are generally submerged 4-5 feet above the invert. HDR will adjust the model accordingly.
- Modeling plan moving forward:
    - Develop TM to document data, data gaps, assumptions, and results.
    - Keep focus on a living document, building model over time.
    - HDR will issue TM to City for comments then finalize.
    - HDR will incorporate additional data collected / provided by the City prior to final TM.
    - Additional data will subsequently be added with development of basin models.
- 100-year storms were run for the macro-level model, but were not shown since the macro-level model is only 1-D and the 100-year storm will primarily be used to address surface flows.
- City has good data on the June 11, 2015 event (close to a 10-year event) which may be helpful for calibration.

CRITICAL BASIN SELECTION:

- Highest density of issues from the heat map following the June 2015 event is the Kenwood sub-watershed.
- The Kenwood area has numerous issues, but the issues and plans to address them are not well known.

    - The area is among the older neighborhoods, has the most restrictions, has had repeat damages, there was a loss-of-life in 2014, has the largest contribution to Cedar Lake, has the least flexibility because of existing development, was developed prior to regular water in Cedar Lake, and has areas with significant potential private source I&I impacts.
    - There is an open loop geothermal at Franklin constantly pumping into Kenwood.
- It was agreed that the Kenwood sub-watershed will be carried forward for the critical basin-level modeling. HDR will document reasoning for selecting Kenwood in the TM.

POLICY CONSIDERATIONS

Anderson-Bogert led discussion of potential policy considerations based on the preliminary draft of the policy chapter provided by the City.

Sump Pumps:

- Chapter 13 of Municipal Code addresses sump pumps (not allowed to connect to sanitary and discharged without nuisance). Departmental responsibilities (sewer vs. building services) are not clear as to jurisdictional boundaries – property line vs. building envelope.
- Building code to approve water course out 10 feet from right-of-way.
- Need to determine what an approved water course is, then tie policy into building code.
- Jon D. will provide a flow chart for sump pump discharge.

Grading:

- Per building code update and IBC, home has to be a certain height above nearest inlet, but missing language requiring positive drainage path without adversely impacting other property. Waterloo building code language would be a good reference. Jon D. will send Waterloo language on drainage and also a FEMA reference document.
- Need ordinance language to require positive drainage away from adjacent structures.
- Potential requirement on development/building review to anticipate/prevent issues. Question is how to implement a solution that does not create a problem for someone else.

Drain Tile:

- Will be addressed with private lateral service program.
- Issue is material; corrugated HDPE can be problematic within a year or two.
- Allow subsurface but not surface connection to street drain tile.

Inlet Protection:

- Have bid some projects but have not advanced any policies other than researching the issue.
- The City will forward research it has collected.
- Considering signs, fence, bollards, and other features for inlet solution.
- Sandy Pumphrey noted that any information related to the death during June 2014 flash flood event needs to be retained in its original form; Sandy will forward the legal guidance.

Incentivize Green Practices:

- Cost share is up and running.
- Permeable/impervious for 74 most impacted customers following election.

Funding Non-City Storm Water Losses:

- Keys to issue are negligence and level of service.
- Only looking at public losses, not private.

- Need to clarify policy on how issues get added to CIP list.
- Also need to work with Council members on when issues are appropriate for City to address – related to level of service (5-year, 100-year storms) and normal response to public being to refer them to insurance providers.

Low-Level Openings:

- Issue is related to development and building code.
- Need a design-point on development plans to avoid building openings installed too low.

Regional Detention:

- Part of community development – want to avoid micro-basins.
- Need developers to buy into larger detention basins.
- Clarify policy, specifically how City would pay for initial construction, condemnation, etc.

Drainage Easement Encroachment:

- Might need incentive program to implement.
- How to roll back problems already their incentive?

Drainage Easements:

- Links to grading policy.

Targeted Buy-Outs:

- Flood program is a good starting point.
- Kenwood could be area for consideration.

Educational Programs:

- Hydro, know the flow.
- Have held workshops, informational sessions, etc.
- Working with Fusion Farm on educational videos related to storm water.

WORKSHOP 4

Workshop 4 will be held to discuss preliminary results of the critical basin-level model. Workshop date set for December 10th at 9:30 AM; Garrett will send a meeting invitation.

Action Items

1. HDR (Mike B.) – Send updated TM 1.0 Existing Systems for City comment before issuing final version.
2. HDR (Mike B.) – Schedule meeting with Garrett P. and Jon D. to review Asset Management.
3. HDR (Mike S.) – Provide feedback on critical data gaps (i.e. missing pipes) for City comment.
4. HDR (Mike S.) – Revisit catchment boundaries northwest of Hwy 100 & I-380.
5. HDR (Mike S.) – Revise outfall assumptions for outfalls upstream of 5-in-1 dam (typically 4-5 feet of water, rather than open flow).
6. HDR (Mike S.) – Document reasoning for selecting Kenwood as the critical basin.
7. City (Jon D.) – Forward flow chart on water course (sump pump discharge).
8. City (Sandy P.) – Forward legal requirement for retaining any information related to death during June 2014 flash flood event.
9. City (Garrett) – Send invite for Workshop 4, Thursday December 10th, 9:30 AM.
10. Jon – Waterloo language on drainage, FEMA reference document.

11. Garrett – Send research on inlet protection.
12. Mike S. – Send request geometry of in-line detention and control structures.
13. Mike S. – Confirm date of aerial photography used in verifying land-use.

I. SCOPE OUTLINE

A. TASK SERIES 100 – PROJECT MANAGEMENT

Task 110 – Team Management and Project Control
Task 120 – Project Initiation
Task 130 – Project Management Plan
Task 140 – Quality Control

PHASE 1 – FY 2017 CIP Development

B. TASK SERIES 200 – PHASE 1 – FY 2017 CIP DEVELOPMENT

Task 210 – Collect and Review Available Information
Task 220 – Draft Stormwater Master Plan Outline
Task 230 – Workshop 1
Task 240 – Site Visits, Alternative Evaluation, Concept Refinement
Task 250 – Develop/Confirm Costs and Preliminary Priorities
Task 260 – Draft FY 2017 CIP TM
Task 270 – Workshop 2
Task 280 – Finalize FY 2017 CIP Summary TM

PHASE 2 – Stormwater Master Plan

C. TASK SERIES 300 – EXISTING SYSTEM

Task 310 – Compile and Review Existing Background Information
Task 320 – Regulatory Summary
Task 330 – Watershed Summary
Task 340 – Existing System TM

D. TASK SERIES 400 – ASSET MANAGEMENT

Task 410 – Summary of Stormwater Assets
Task 420 – Condition Assessment
Task 430 – Level of Service
Task 440 – Maintenance Levels
Task 450 – Asset Management Plan Improvement Recommendations
Task 460 – Asset Management TM

E. TASK SERIES 500 - HYDRAULIC INVESTIGATION

Task 510 – Model Selection
Task 520 – Critical Area Identification
Task 530 – Hydraulic Model Development
Task 531 – Data Cleanup
Task 532 – Macro-Scale Model Development
Task 533 – Identify System Deficiencies
Task 540 – Workshop 3
Task 550 – Critical Basin-Scale Model Development
Task 560 – Field Investigations
Task 570 – Model Validation
Task 580 – Alternatives Analysis
Task 590 – Workshop 4

F. TASK SERIES 600 – CIP IMPROVEMENTS PLAN

Task 610 – Recommended Projects
Task 620 – Project Prioritization
Task 630 – Workshop 5
Task 640 – Documentation

G. TASK SERIES 700 – TEN YEAR FINANCIAL PLAN

Task 710 – Summary of Expenses
Task 720 – Estimated Cash Flow Projection
Task 730 – Revenue Options
Task 740 – Financial Plan

H. TASK SERIES 800 – POLICY RECOMMENDATIONS

Task 810 – Current Policies and Planning Goals
Task 820 – Floodplain Management
Task 830 – Green Infrastructure BMPs
Task 840 – Future Policies
Task 850 –Policy TM

I. TASK SERIES 900 – FUTURE CONSIDERATIONS

Task 910 – Development and Growth
Task 920 – Regulatory/Water Quality Changes
Task 930 – Maintenance Procedures
Task 940 – Watershed Management Considerations
Task 950 – Stormwater Master Planning

J. TASK SERIES 1000 – STORMWATER MASTER PLAN

Task 1010 – Stormwater Recommendations Summary
Task 1020 – Executive Summary
Task 1030 – Draft Plan
Task 1040 – Workshop 6
Task 1050 – Final Plan

Stormwater Master Plan

Workshops

1 Kickoff Meeting Phase 1 and 2
2 Review Draft FY 2017 CIP TM
  Discuss Existing System
  Discuss Model Selection / Development
3 Macro Level Model Results
  Initiate Basin Level Model
  Discuss Asset Management
4 Basin Level Model Results
  Discuss Financial Planning
  Discuss Policy Consideration
  Discuss Future Considerations
5 FY18 Capital Improvements Plan
  Financial Plan
  Policy Consideration
  Future Considerations
6 Executive Summary
  Draft Plan

Stormwater Master Plan

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Stormwater Master Plan

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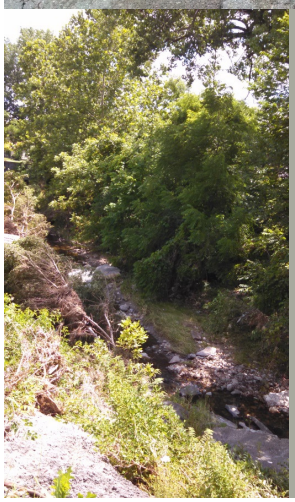


Stormwater Master Plan Workshop 3

Macro-scale Stormwater Modeling
October 14, 2015

HDR

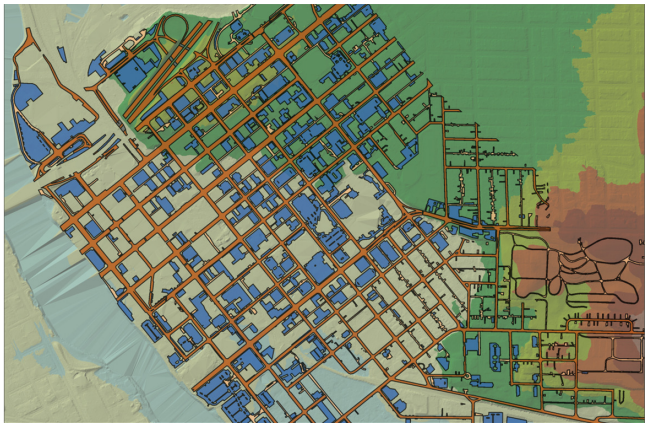
01 OBJECTIVES

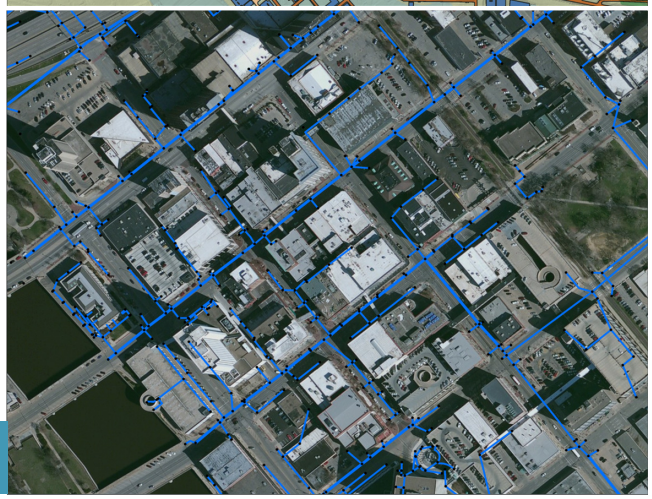
STORMWATER MASTER PLAN UPDATE TASKS

- Phase 1
  - FY 2017 CIP Development
- Phase 2
  - Existing System Summary
  - Asset Management
  - **Hydraulic Investigation**
  - CIP Improvement Plan
  - Ten Year Financial Plan
  - Policy Recommendations
  - Future Considerations

HYDRAULIC INVESTIGATION OBJECTIVES

- Select a suitable computational model
- Use the model to evaluate the City's stormwater system
- Develop recommendations based on model results
- Validate the model as data is made available
- Use model to formulate for conceptual-level projects
- Additional modeling in subsequent years

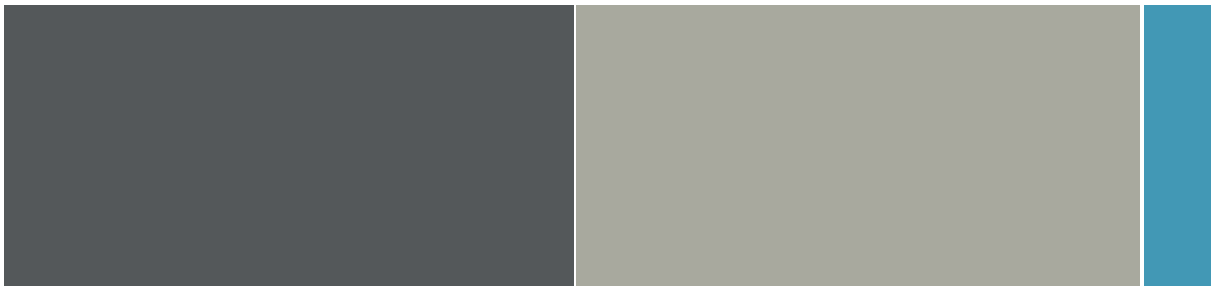




02 APPROACH

MODELING APPROACH

- 2 Steps of Model Development
  - Step 1: Macro-scale Modeling
    - Less detail
    - Large sewers and open channels
    - Entire city
  - Step 2: Critical Basin Scale Modeling
    - More detail
    - Smaller sewers
    - Critical basin

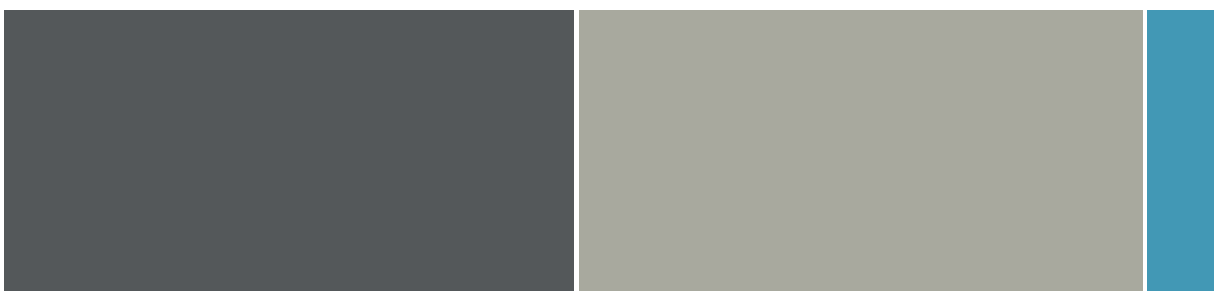


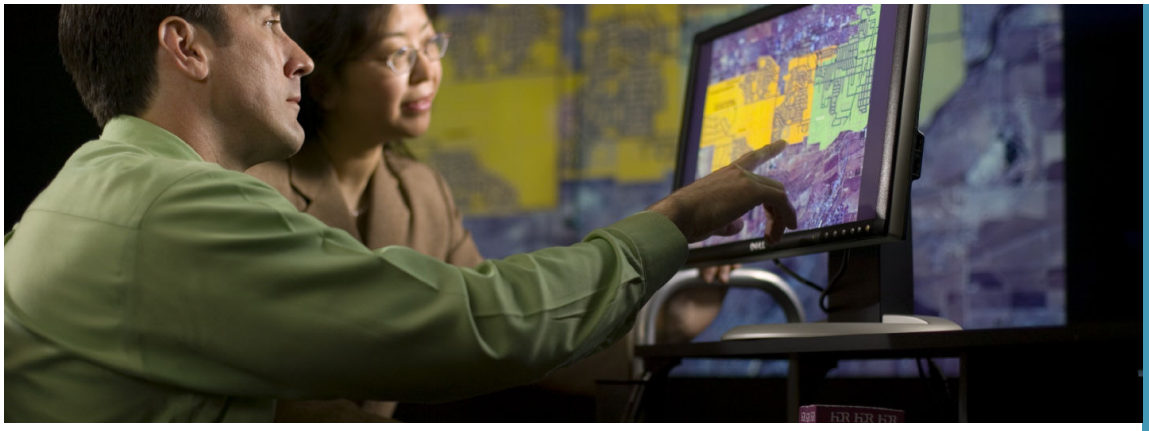
Macro-Scale Model

- Large pipes (greater than 48”)
- Open Channels
- Major Detention Facilities
- Broad-scale city overview
- Aggregate benefits of improvements and interaction between basins, creeks and Cedar River
- Major conveyance routes
- Provides foundation for basin-scale models

Basin-Scale Models

- More-detailed pipe network (greater than 12”)
- Overland flow
- Ponding and detention
- Project-scale evaluation
- Individual conveyance bottlenecks
- Tool for evaluating mitigation alternatives

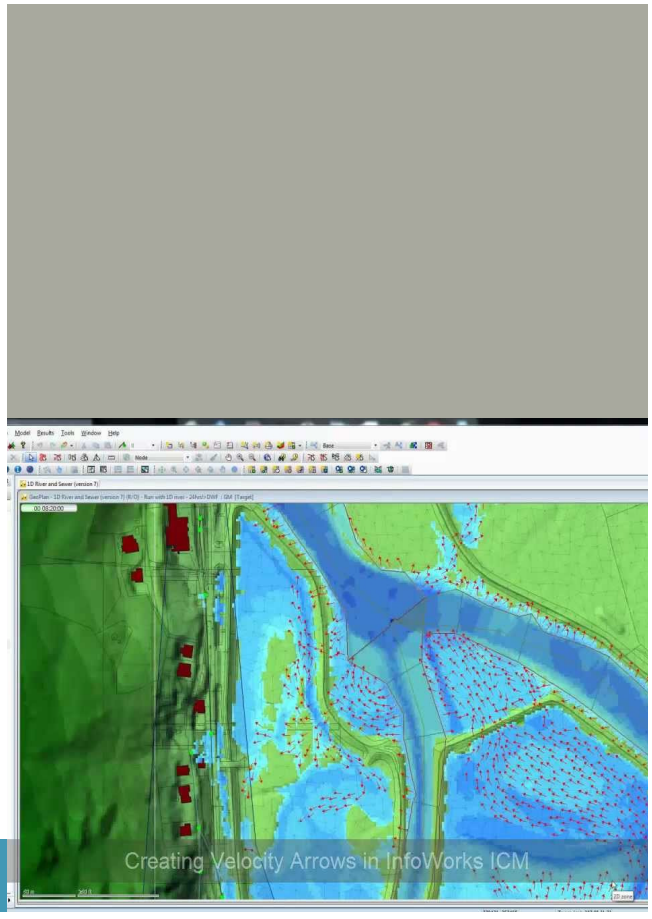


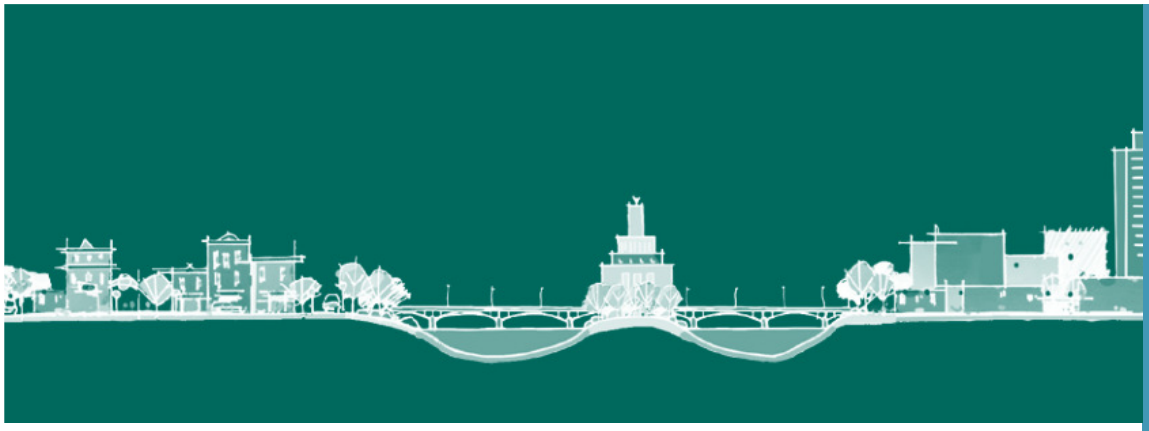


03 SOFTWARE SELECTION

Innovyze InfoWorks ICM

- Efficient computational engine (GPU)
- Multi-user support
- Run simulations in parallel
- Flexible for stormwater and sanitary sewers
- Flexible mesh for 2D analysis
- Numerically stable
- Data-tracking and flagging
- Analysis tools

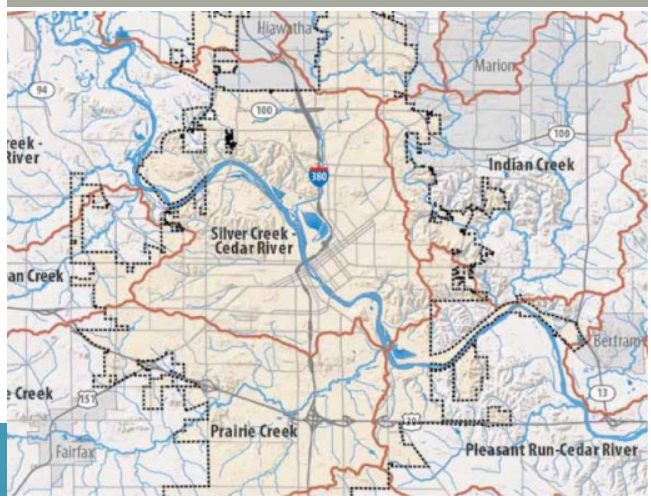


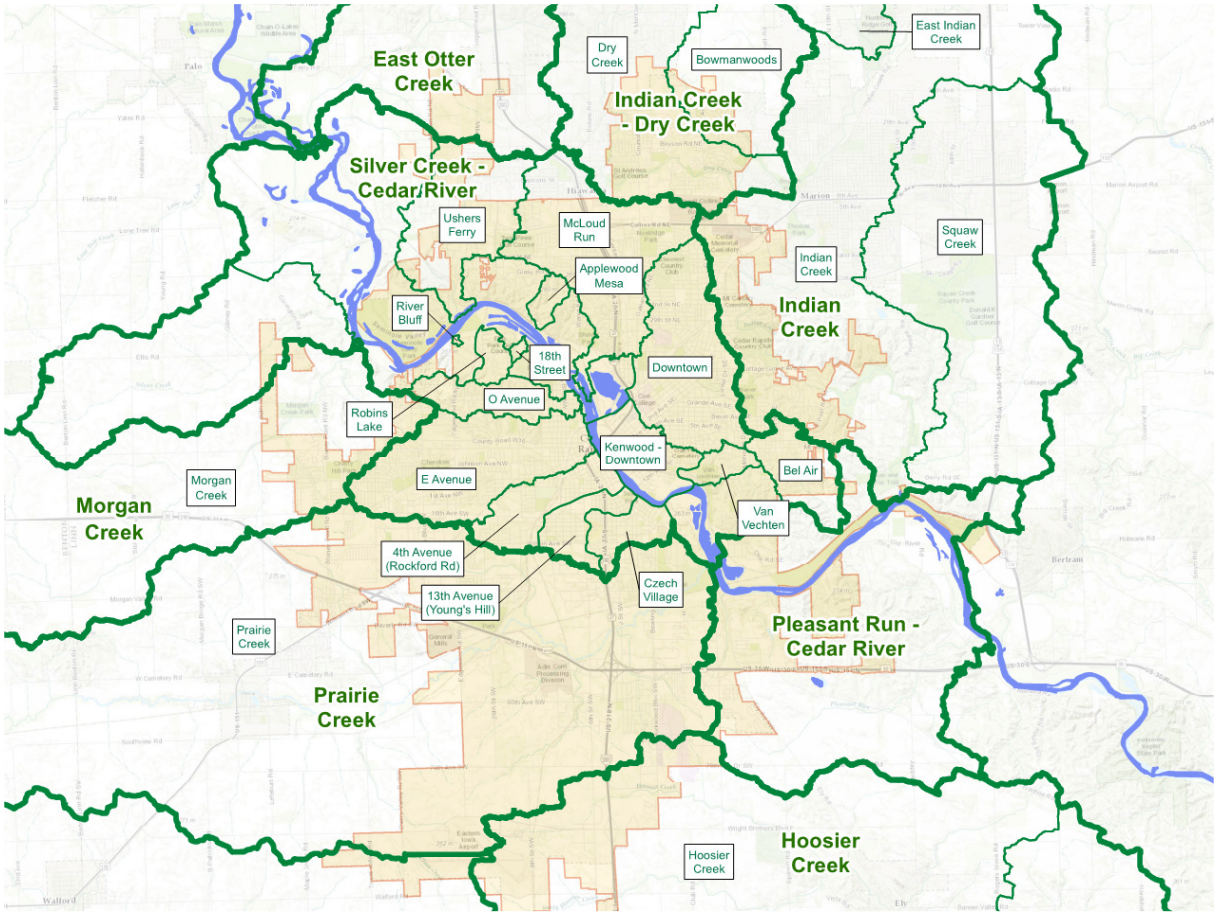


04 BASIN CHARACTERISTICS

SUMMARY OF BASINS

- **Watersheds – 7 within planning area**
  - Subwatersheds – 24 (12 east, 12 west) developed within watersheds
    - Catchments – 223 developed within watersheds and subwatersheds around stormsewer network
  - Average Catchment Size = 84 acres




East Otter Creek
Dry Creek
Bowmanwoods
East Indian Creek
Indian Creek - Dry Creek
Silver Creek - Cedar River
Ushers Ferry
McLoud Run
Squaw Creek
Applewood Mesa
Indian Creek
Indian Creek
River Bluff
18th Street
Downtown
O Avenue
Robins Lake
Kenwood - Downtown
Bel Air
Morgan Creek
E Avenue
Morgan Creek
Van Vechten
4th Avenue (Rockford Rd)
Czech Village
13th Avenue (Young's Hill)
Pleasant Run - Cedar River
Prairie Creek
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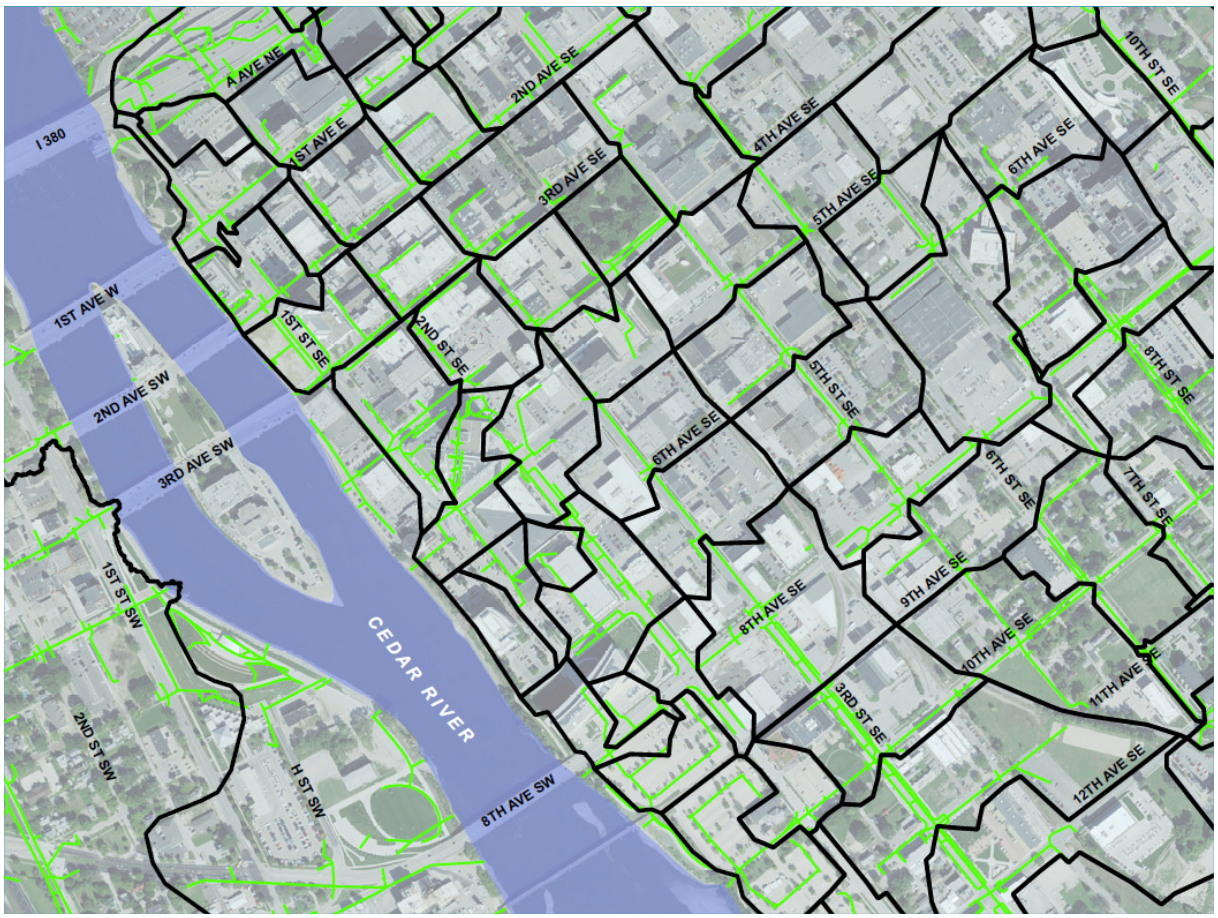
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INPUT DATA

- GIS Watersheds
- Topography (LiDAR)
- Soil Type (Hydraulic Soil Group)
- Cover Type (Imperviousness/Land Use)
- Rivers, Creeks, and Channels (Open Channel Flow)

DATA CLEAN UP AND ASSUMPTIONS

- Watersheds and Subwatersheds
  - Resolved with previous boundaries and LiDAR dataset, pipe network
- Catchments based on resolved watersheds, subwatersheds, and storm network
  - Time of concentration and time of travel developed using catchment slopes and flow path lengths
- Curve numbers based on Soil Type and Cover Type
  - Existing land use (GIS database)
  - Confirmed/Modified based on aerial photography
    - Agricultural/industrial
    - Civic – parks vs buildings
    - Overlapping layers
  - Complete soils coverage for the planning area

BASIN HYDROLOGY – RUNOFF AND ROUTING

- Rainfall Runoff
  - Initial Abstraction
  - Land Use and Soil Type (Curve Number)
  - Time of Concentration
  - Time of Travel

RUNOFF METHOD

- SCS Runoff Curve Number Method (NRCS TR-55)
- Consistent with previous work, Iowa DNR guidance
- Based on NRCS soils data, planimetrics and land use

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad \text{[eq. 2-1]} \qquad I_a = 0.2S \qquad S = \frac{1000}{CN} - 10$$

where

Q = runoff (in)
P = rainfall (in)
S = potential maximum retention after runoff begins (in) and
I_a = initial abstraction (in)

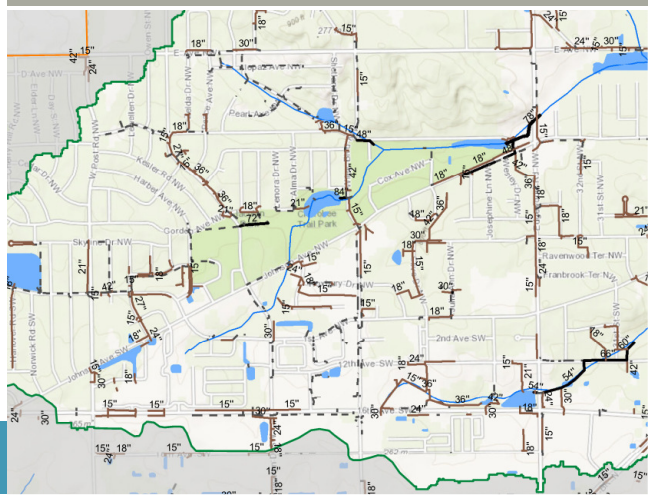
05 1D FLOW NETWORK

1D FLOW NETWORK SUMMARY

- Runoff gets routed from catchments to 1D system in the model
  - 46 miles of pipe 48-inches and greater

INPUT DATA

- GIS Stormsewer Layers (Sewer Network)
- Survey Data from City and Anderson Bogert
- HR Green XPSWMM Model for Westside Flood Protection Area
- Rivers, Creeks, and Channels (Open Channel Flow)
- Lakes and Large Pond Facilities (Detention)



DATA CLEAN UP AND ASSUMPTIONS

- GIS Data Gap Analysis
  - To find missing data points (diameters and inverts mostly)
- Input Survey Data into GIS Network
  - To fill in gaps with field data collected points
- Validate Network
  - To fill in remaining gaps with pipe diameters and inverts
    - Inferred missing gaps not surveyed from upstream/downstream pipes
  - To maintain positive slopes
    - Resolved data issues (datum, etc.) by interpolating from upstream/downstream pipes
  - To rectify connectivity and pipe direction
    - Sometimes added pipes for connectivity

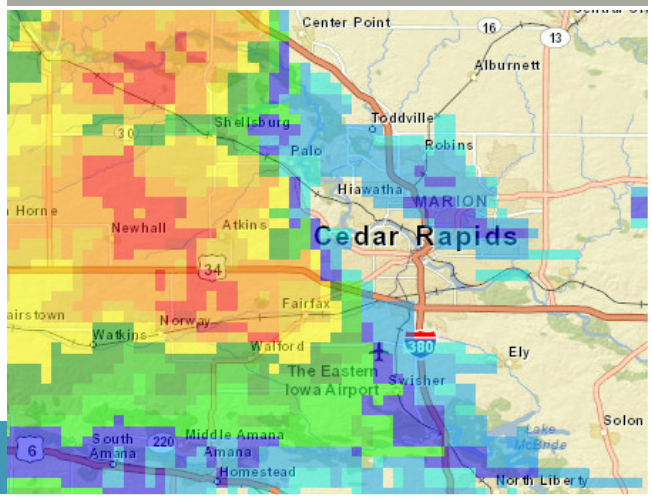
HYDRAULICS AND ASSUMPTIONS

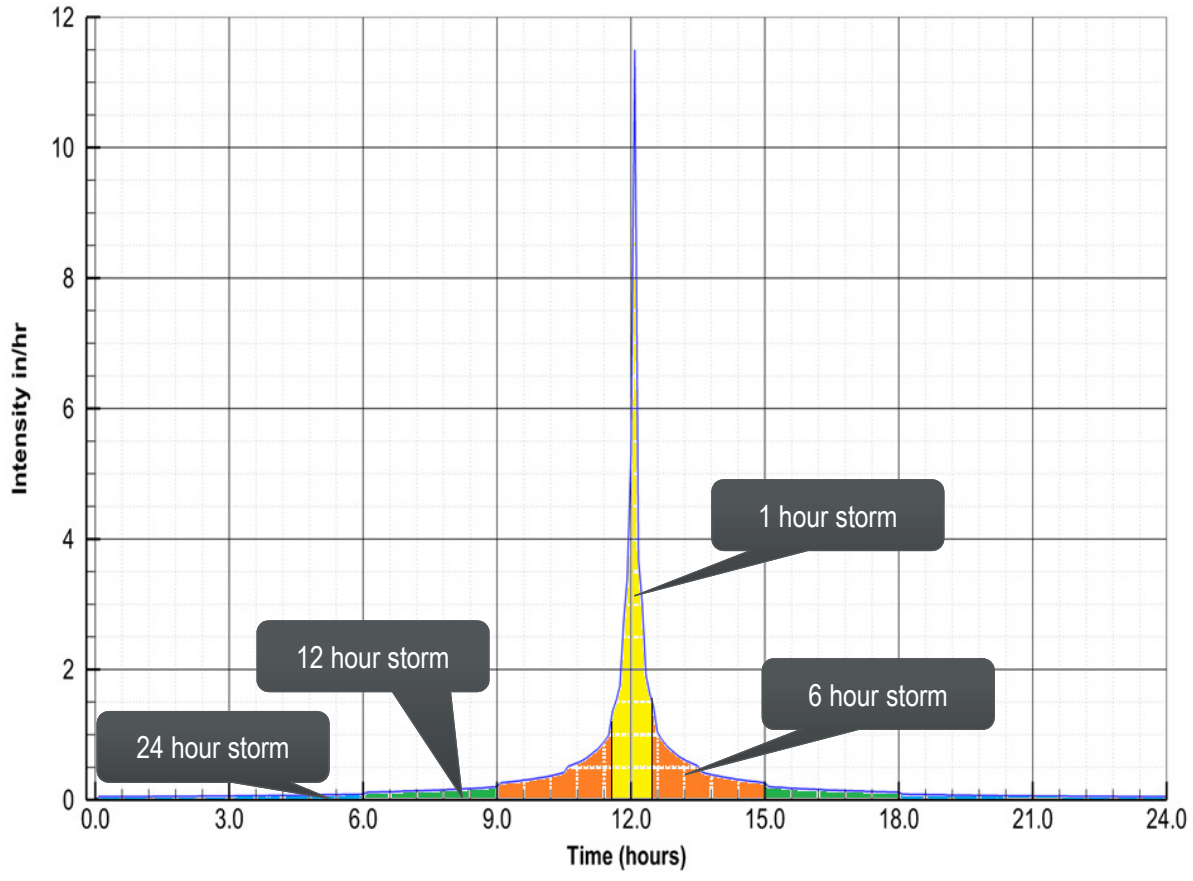
- Manning's Equation
  - Pipes - Manning's Roughness Coefficients
  - Channels – treed lined, grassy swale, etc.
- Boundary Conditions
  - 5-year, 100-year – free outfall
  - Can be modified to reflect stages from HEC-RAS models or historic elevations; e.g. Cedar River Stage Data
- Detention Facilities
  - Major, in-line detention facilities
  - Influence of smaller facilities not captured

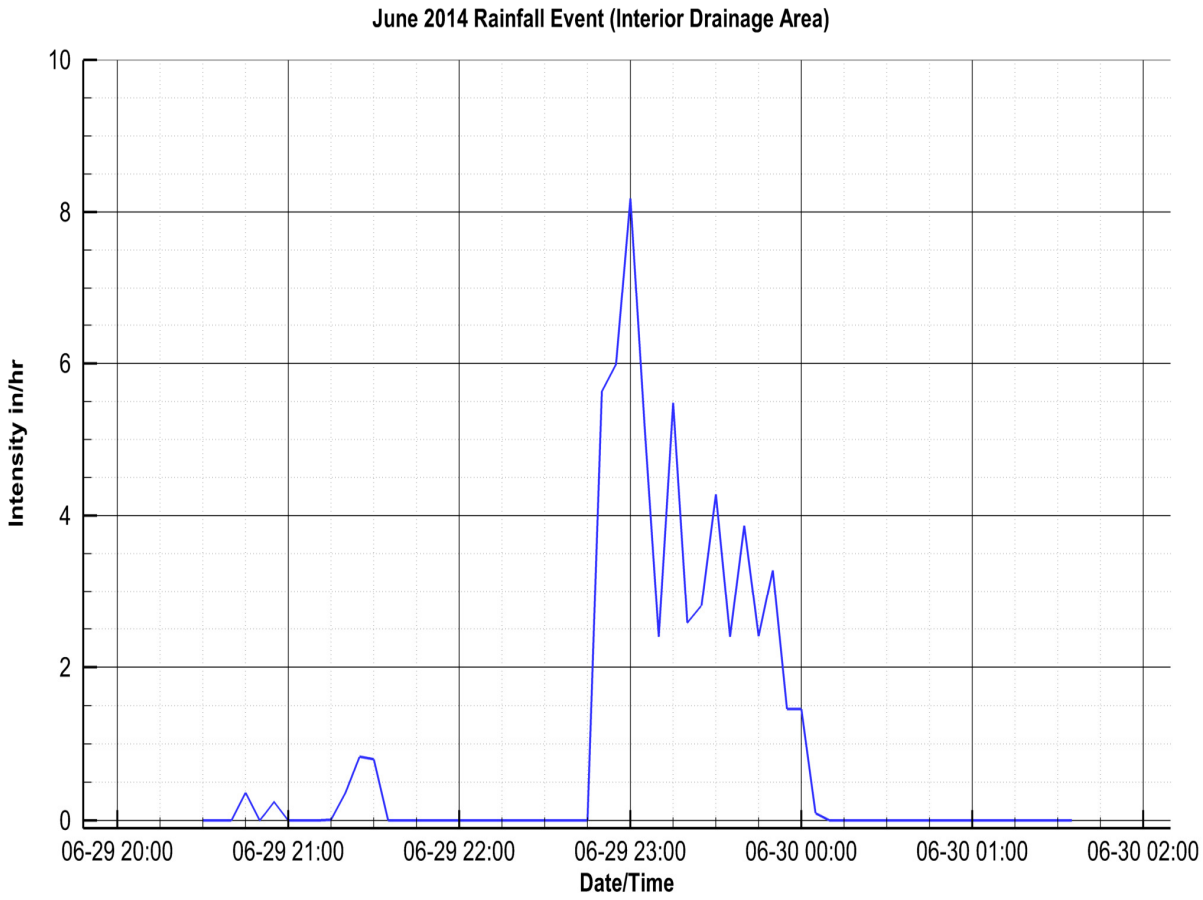
06 RAINFALL

EVENTS

- 5-year Nested Design Storm
  - 24 hour run
  - NOAA Atlas 14
- 100-year Nested Design Storm
  - 24 hour run
  - NOAA Atlas 14
- June 2014 Event (next step)
  - 500-year event
  - Approximately 1 hour – short duration
  - Radar reconstruction



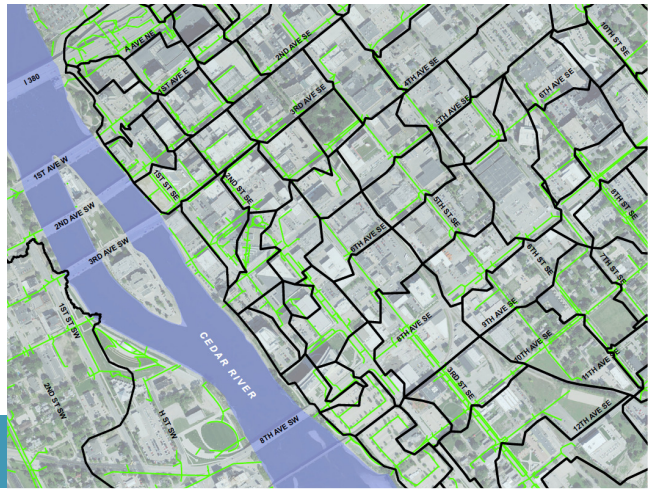


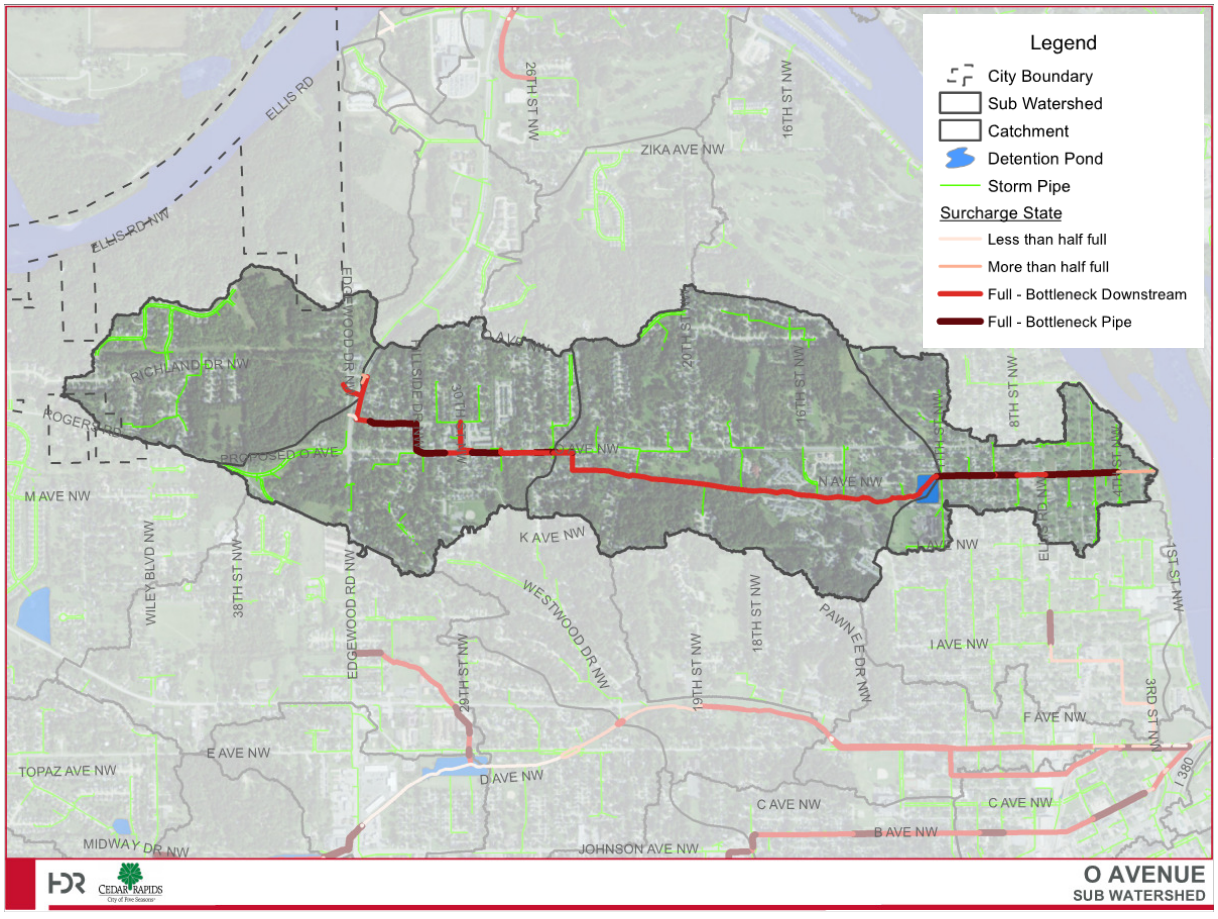


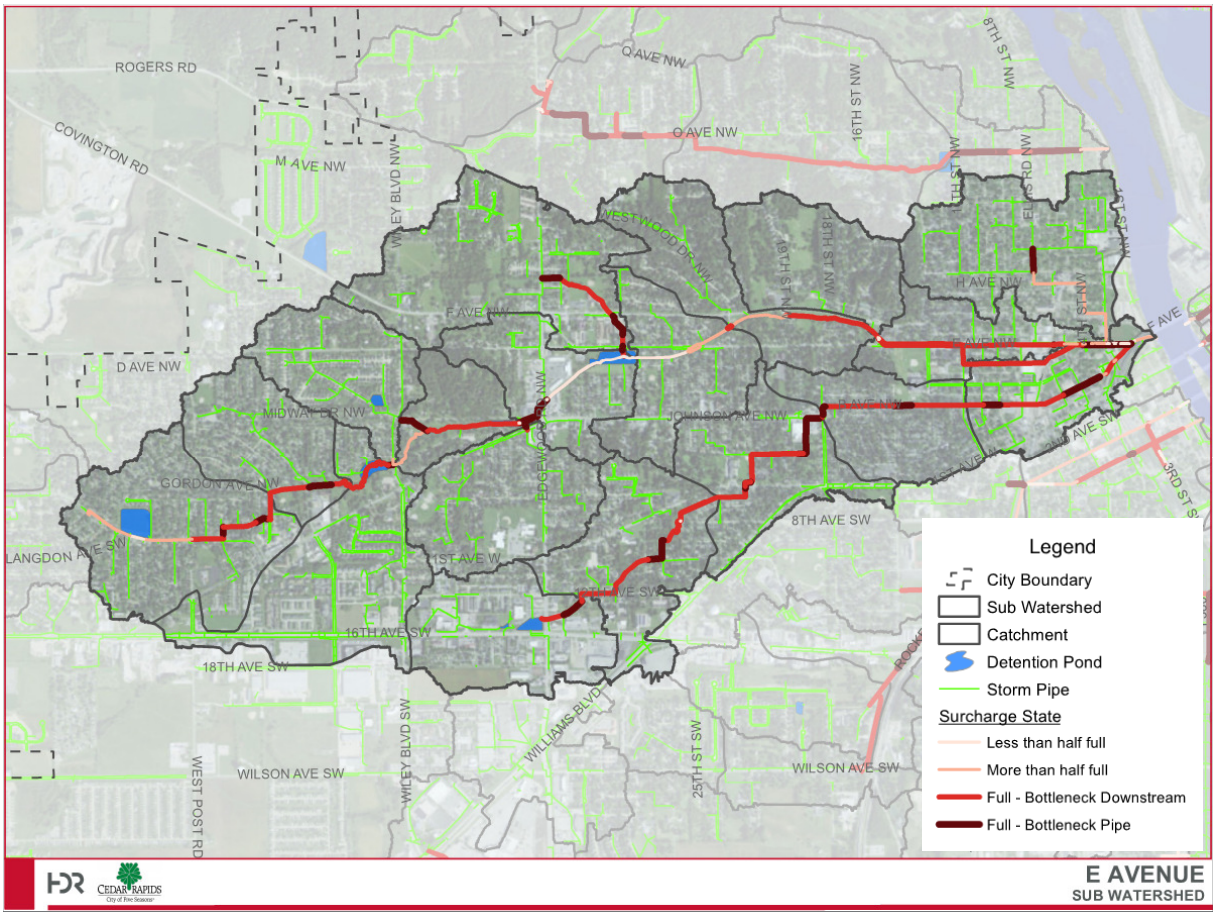
07 PRELIMINARY RESULTS

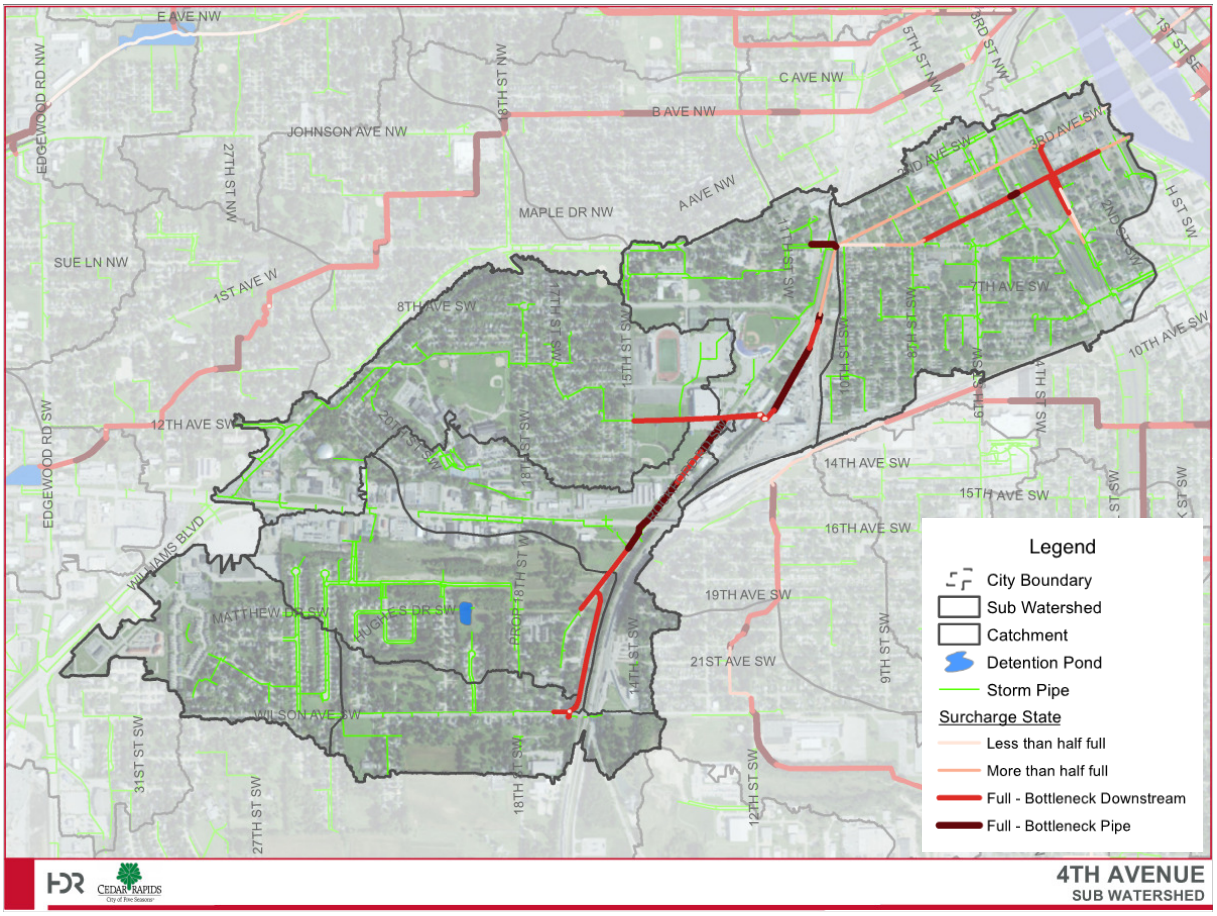
Scenarios Run to Date

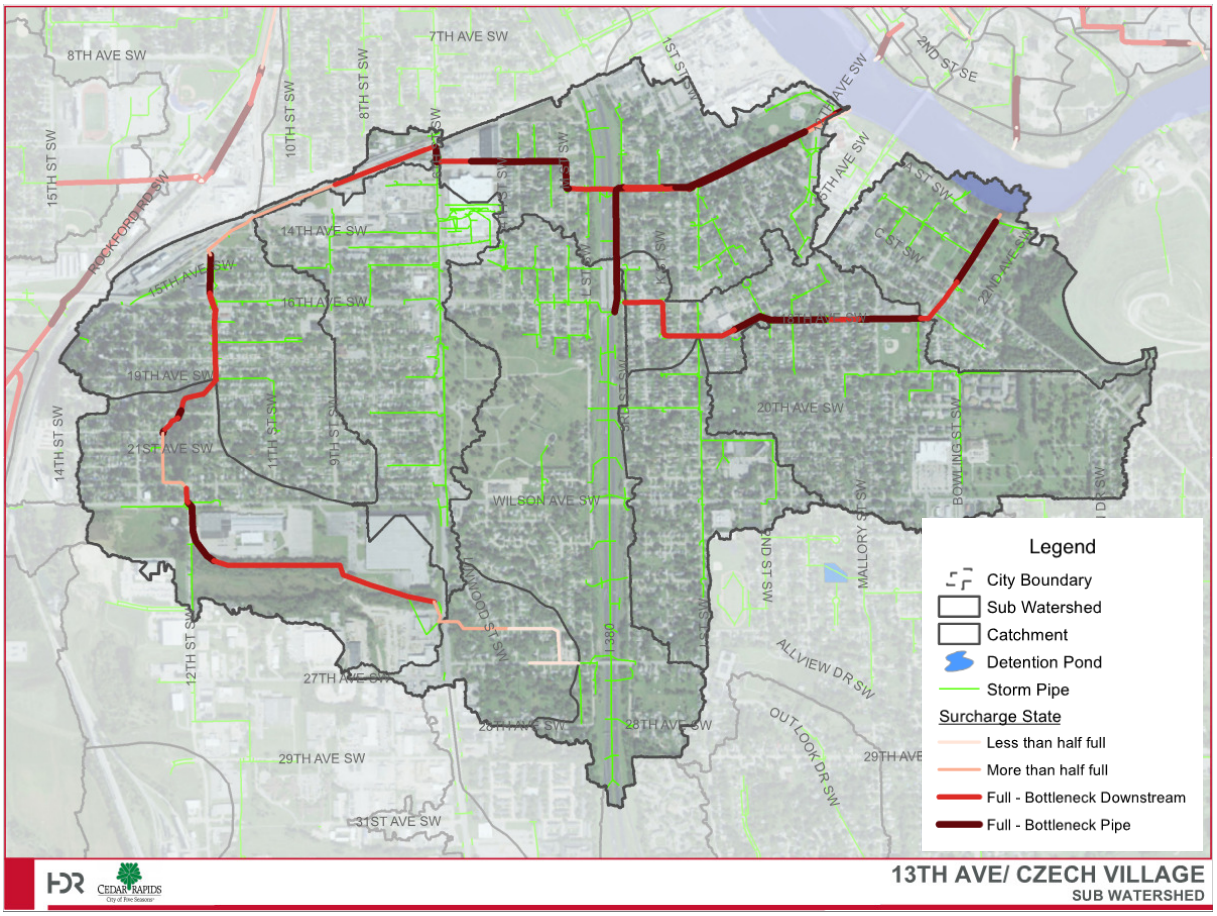
- **5 Year Design Rainfall Event**
- 100 Year Design Rainfall Event

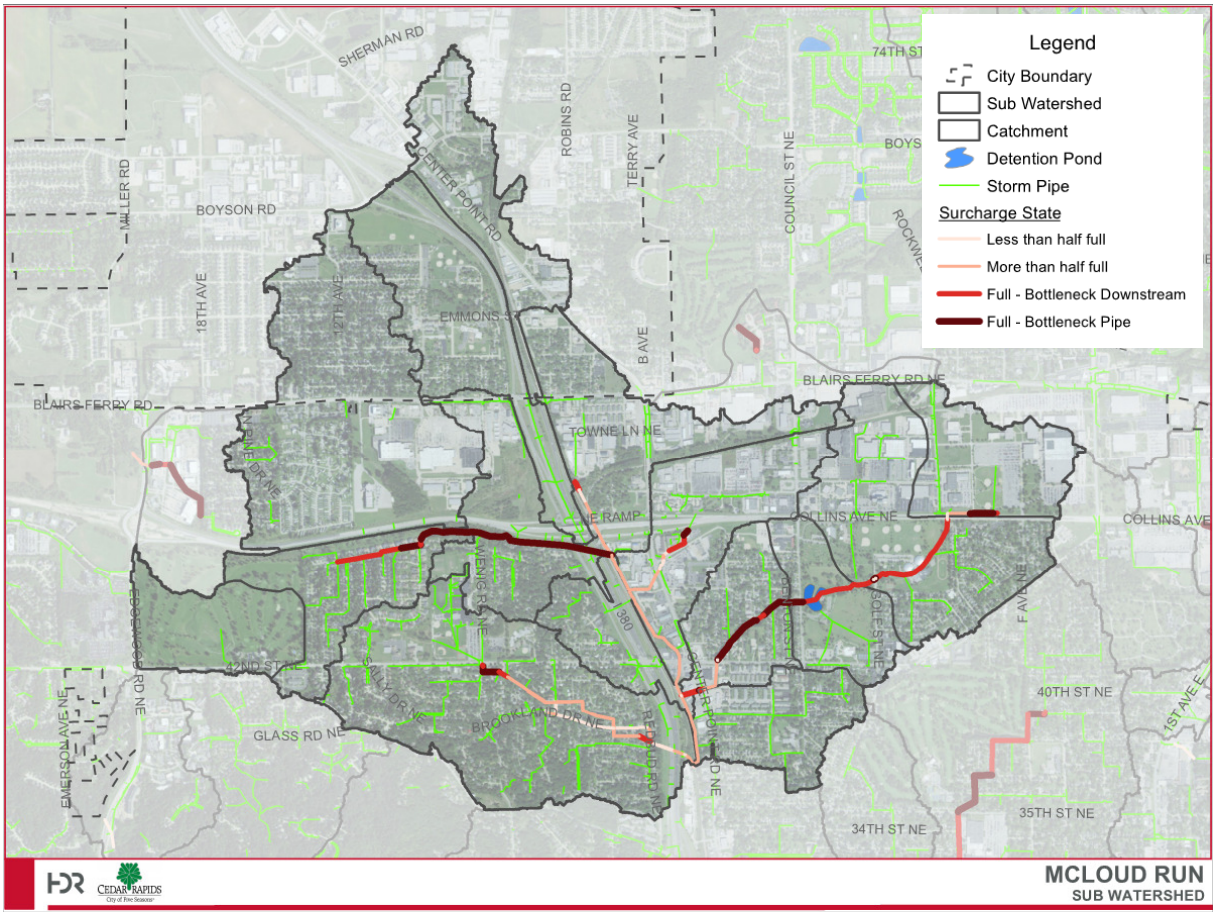


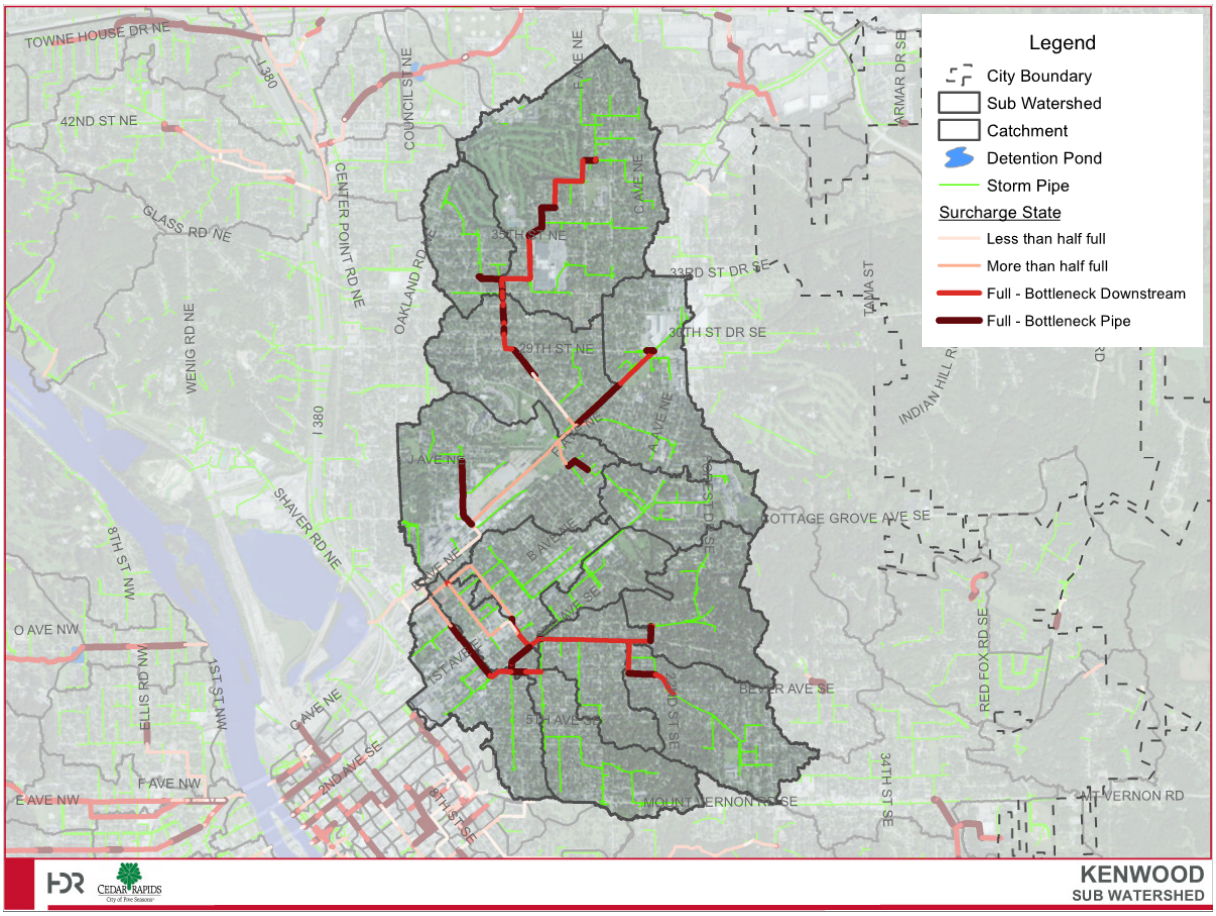



ROGERS RD
COVINGTON RD
M AVE NW
Q AVE NW
O AVE NW
16TH ST NW
8TH ST NW
WILEY BLVD NW
WESTWOOD DR NW
15TH ST NW
18TH ST NW
H AVE NW
F AVE NW
D AVE NW
MIDWAY DR NW
EDGEWOOD RD NW
JOHNSON AVE NW
GORDON AVE NW
LANGDON AVE SW
1ST AVE W
16TH AVE SW
18TH AVE SW
8TH AVE SW
WILLIAMS BLVD
25TH ST SW
WILSON AVE SW
WEST POST RD
WILEY BLVD SW
Legend
City Boundary
Sub Watershed
Catchment
Detention Pond
Storm Pipe
Surcharge State
Less than half full
More than half full
Full - Bottleneck Downstream
Full - Bottleneck Pipe
E AVENUE
SUB WATERSHED


E AVE NW
EDGEWOOD RD NW
16TH ST NW
C AVE NW
B AVE NW
JOHNSON AVE NW
27TH ST NW
A AVE NW
MAPLE DR NW
SUE LN NW
1ST AVE W
8TH AVE SW
12TH AVE SW
EDGEWOOD RD SW
WILLIAMS BLVD
MATTHEW DR SW
HUGHES DR SW
WILSON AVE SW
31ST ST SW
27TH ST SW
18TH ST SW
12TH ST SW
14TH AVE SW
15TH AVE SW
16TH AVE SW
19TH AVE SW
21ST AVE SW
Legend
City Boundary
Sub Watershed
Catchment
Detention Pond
Storm Pipe
Surcharge State
Less than half full
More than half full
Full - Bottleneck Downstream
Full - Bottleneck Pipe
4TH AVENUE
SUB WATERSHED

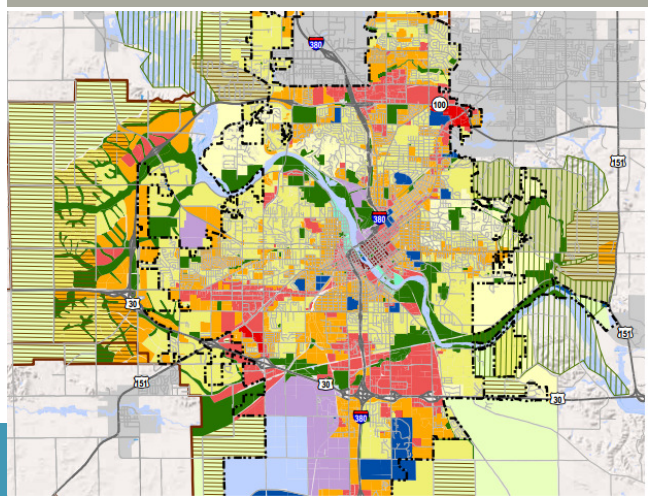

8TH AVE SW
7TH AVE SW
15TH ST SW
10TH ST SW
8TH ST SW
ROCKFORD RD SW
14TH AVE SW
15TH AVE SW
16TH AVE SW
19TH AVE SW
14TH ST SW
11TH ST SW
9TH ST SW
21ST AVE SW
WILSON AVE SW
20TH AVE SW
12TH ST SW
27TH AVE SW
28TH AVE SW
29TH AVE SW
31ST AVE SW
I-380
ALLVIEW DR SW
OUTLOOK DR SW
MALLORY ST SW
BOWLING ST SW
2ND ST SE
Legend
City Boundary
Sub Watershed
Catchment
Detention Pond
Storm Pipe
Surcharge State
Less than half full
More than half full
Full - Bottleneck Downstream
Full - Bottleneck Pipe
13TH AVE/ CZECH VILLAGE
SUB WATERSHED


SHERMAN RD
ROBINS RD
TERRY AVE
CENTER POINT RD
MILLER RD
BOYSON RD
18TH AVE
7TH AVE
EMMONS
B AVE
COUNCIL ST NE
BLAIRS FERRY RD
BLAIRS FERRY RD NE
TOWNE LN NE
COLLINS AVE NE
COLLINS AVE
I-380
42ND ST
GLASS RD NE
BROOKLAND DR NE
EMERSON AVE NE
40TH ST NE
35TH ST NE
34TH ST NE
Legend
City Boundary
Sub Watershed
Catchment
Detention Pond
Storm Pipe
Surcharge State
Less than half full
More than half full
Full - Bottleneck Downstream
Full - Bottleneck Pipe
MCLOUD RUN
SUB WATERSHED



Results Discussion

- Broad Overview
- Shell/ Foundational
- General observations
- Review of 5 priority project areas in the next 3-5 years



08 DISCUSSION

Critical Area Identification

- Locations of on-going major stormwater issues
- Discuss which stormwater basin to use as the priority for critical basin-scale model

Next Steps

- Incorporate future land use
- Major Detention facilities
- Update pipe and channel materials
- June 2014 storm model run and validation
- Identification of macro-model system deficiencies and alternative improvements
- Critical basin-scale model development, field investigation, validation, and alternatives analysis