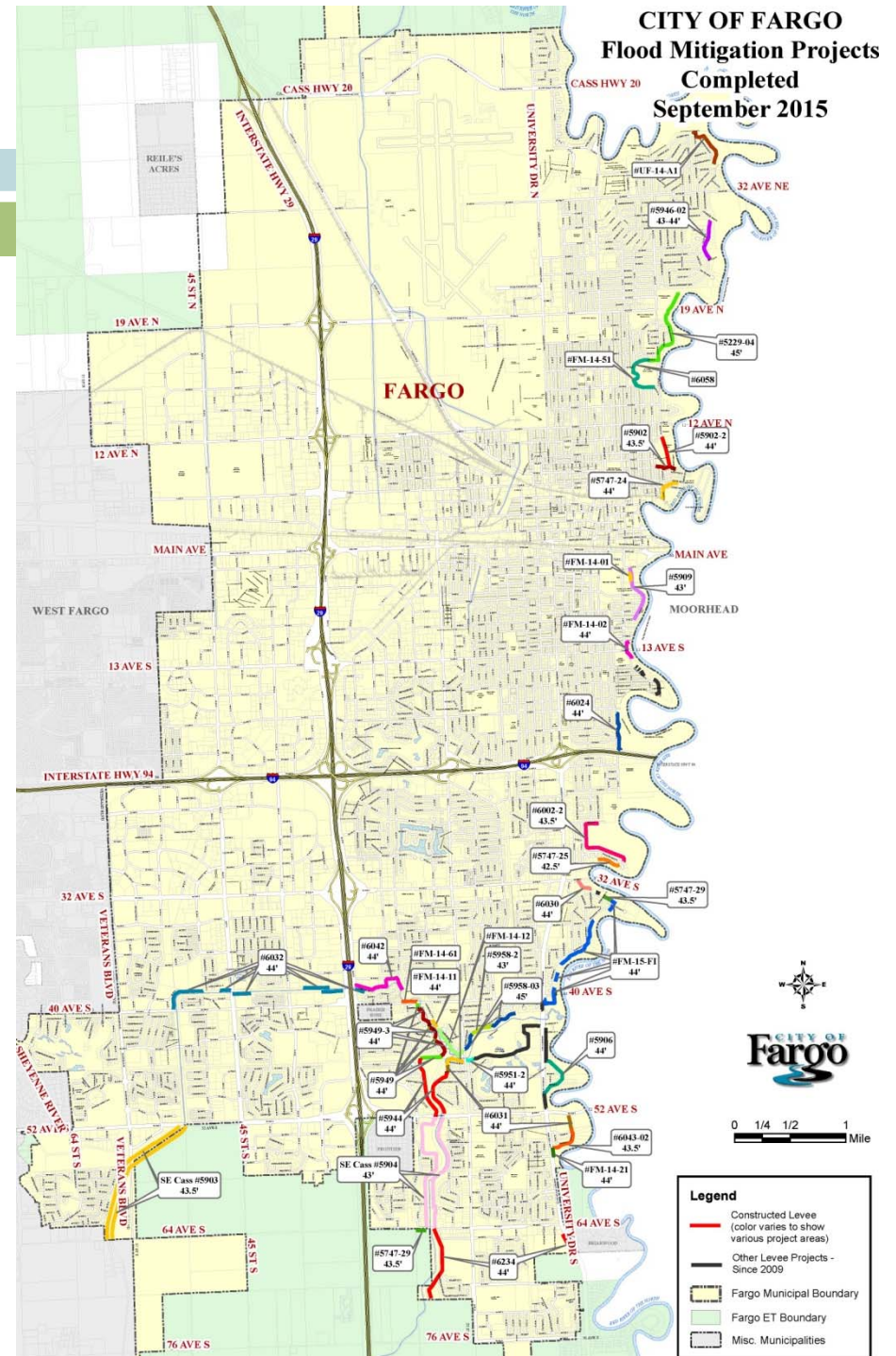


PROJECT NO. MS-14-20

SOUTHWEST AREA STORM SEWER MASTER PLAN


COMPLETED PROJECTS (SINCE 2009)

- Over 18 miles constructed
 - *47 miles of emergency levees constructed by the City in 2009
- Project Cost ≈ \$120 million
- Reduces required sandbags by approximately 4.5 million
- 50% of the Comprehensive Plan Completed



ND LEVEE CONSTRUCTION PERMIT

- A Flowage Easement is required if a Project impounds water on land not owned by applicant.
- Impacts greater than 0.1 foot requires a property right.

 **APPLICATION/NOTIFICATION TO CONSTRUCT OR MODIFY A DAM, DIKE, RING DIKE OR OTHER WATER RESOURCE FACILITY**
OFFICE OF THE STATE ENGINEER
REGULATORY DIVISION
SPN 51695 (2/15)

STATE WATER COMMISSION
USE ONLY

No. _____
(SPWC USE ONLY)

I, the undersigned, do hereby submit the following information to the Office of the State Engineer for determination and use as a filing of information required under North Dakota Century Code §61-04-02 or as an application to construct or modify a facility under North Dakota Century Code §61-16.1-38.

A. General Information
This Application/Notification Must Include A Map From An Actual Survey, Aerial Photo Or Topographic Map. The Size Of The Map Shall Be 8 1/2 By 11 Inches. The Map Shall Have A North Arrow And Approximate Scale. If, In The Opinion Of The State Engineer, The Map Does Not Contain Information To Properly Evaluate The Project, It Will Be Returned.

The Proposed Facility Is A

| | |
|--|---|
| <input type="checkbox"/> Dam (Complete Sections A, C & F) | <input type="checkbox"/> Pond, Lagoon, or Dugout (Complete Sections A, B & F) |
| <input type="checkbox"/> Dike (Complete Sections A, D & F) | <input type="checkbox"/> Diversion Ditch (Complete Sections A, B & F) |
| <input type="checkbox"/> Ring Dike (Complete Sections A, D & F) | <input type="checkbox"/> Other (Complete Sections A, B & F) |
| <input type="checkbox"/> Wetland Restoration (Complete Sections A, C, E & F) | |

Is This Application/Notification For Modification Of An Existing Structure? ☐ Yes ☐ No

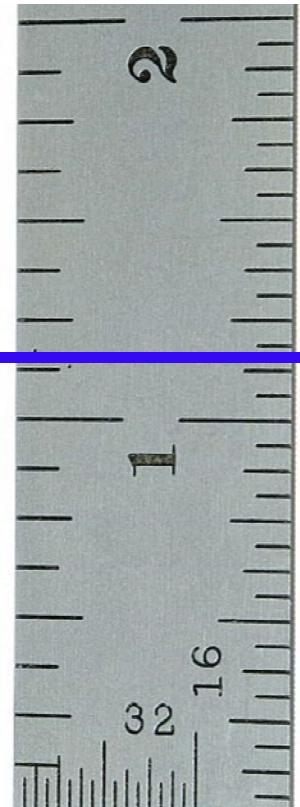
If So, What Year Was Existing Structure Constructed? _____ By Whom? _____

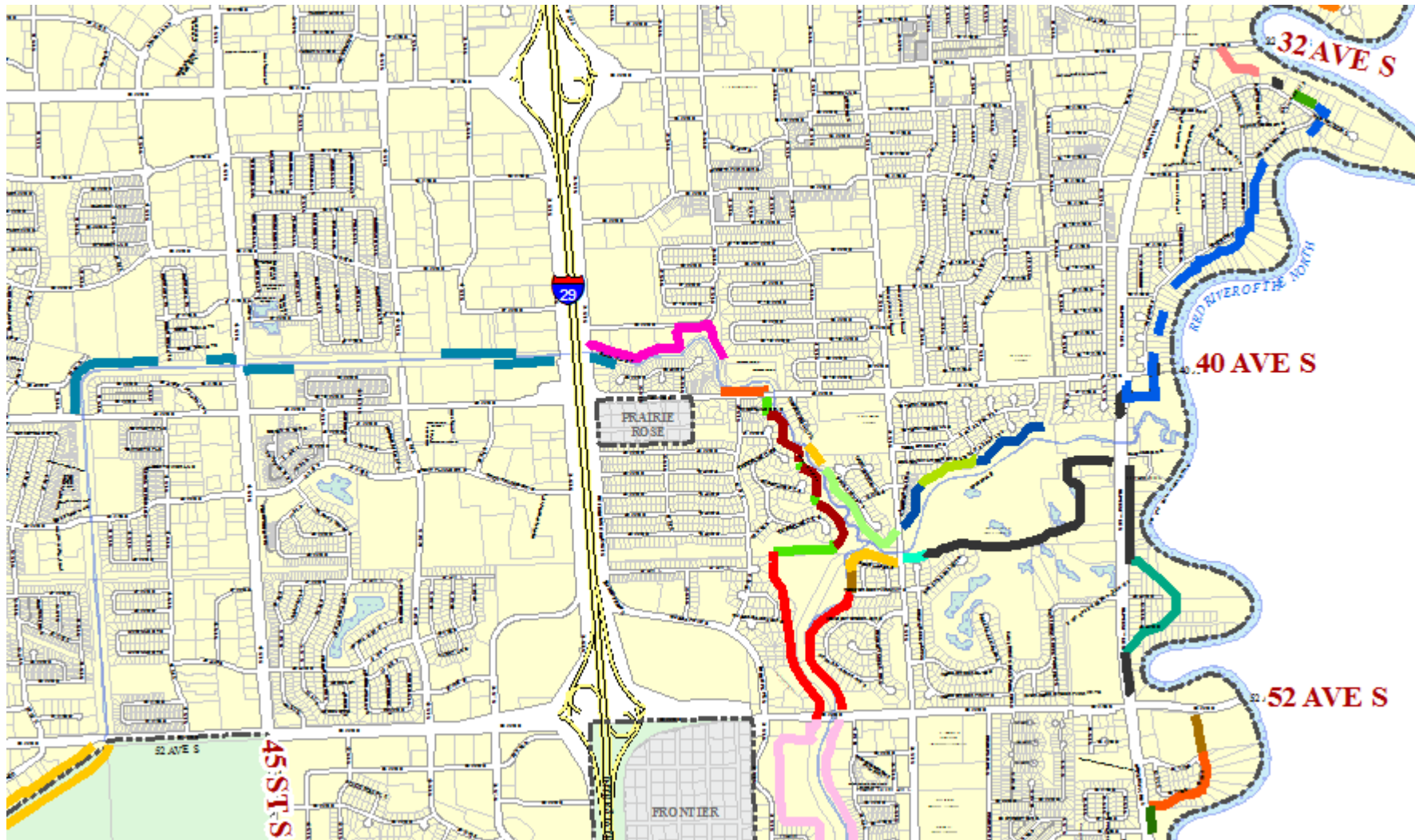
Project Will Be Located In Which Water Resource District _____

| | | | | |
|---------------------|-----------|-------------|----------|-------|
| Legal Description | 1/4 | 1/4 Section | Township | Range |
| (Optional) Latitude | Longitude | | | |

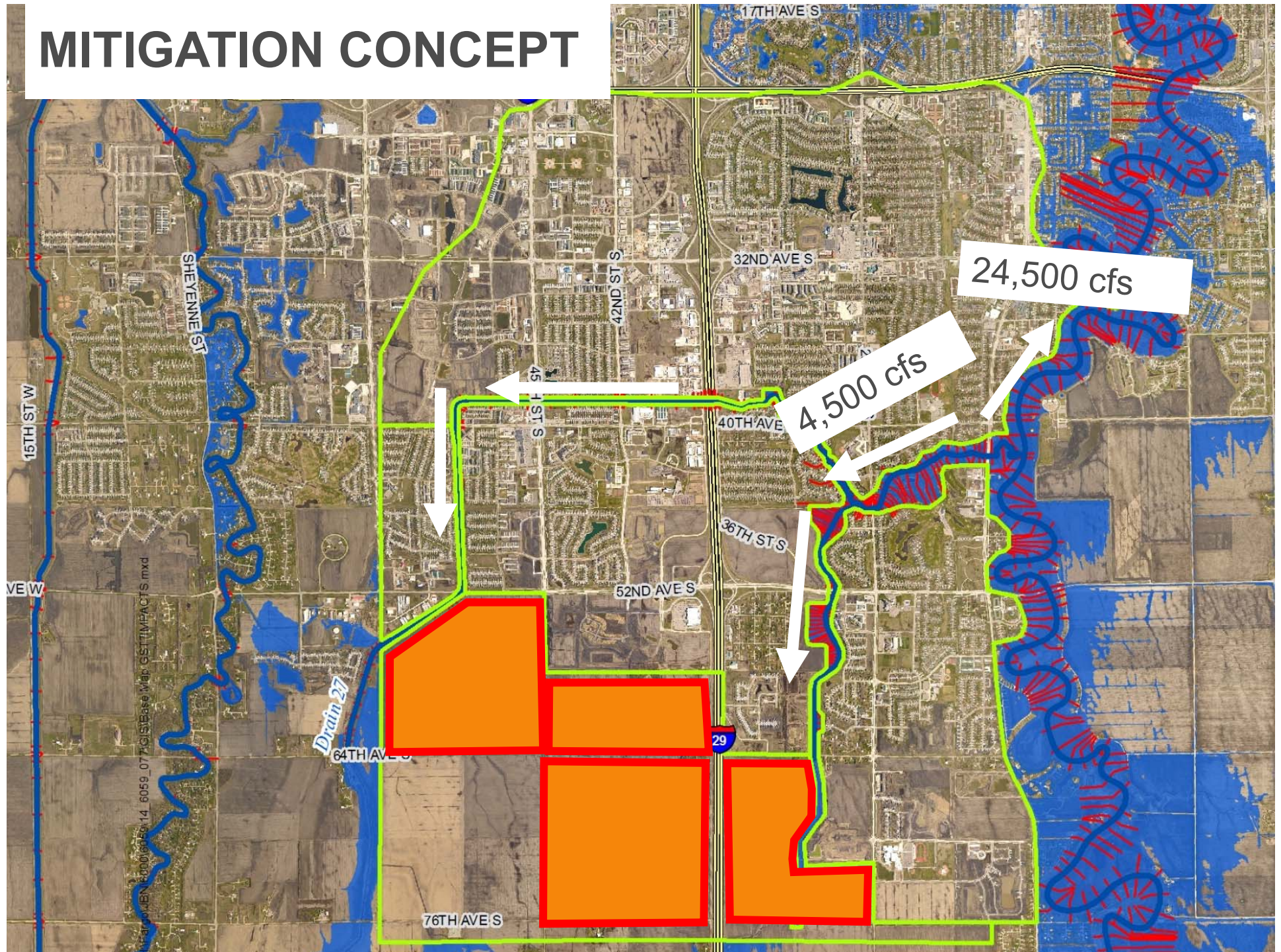
Watermark: For Which District Will Be 1 unit

0.1 ft = 1.2 inches





MITIGATION CONCEPT



OVERVIEW



- Study Area
- FEMA Floodplain
- Flood Protection to Date
- Hydraulic Modeling
- Impacts from Flood Protection
- Mitigation and Costs

STUDY AREA

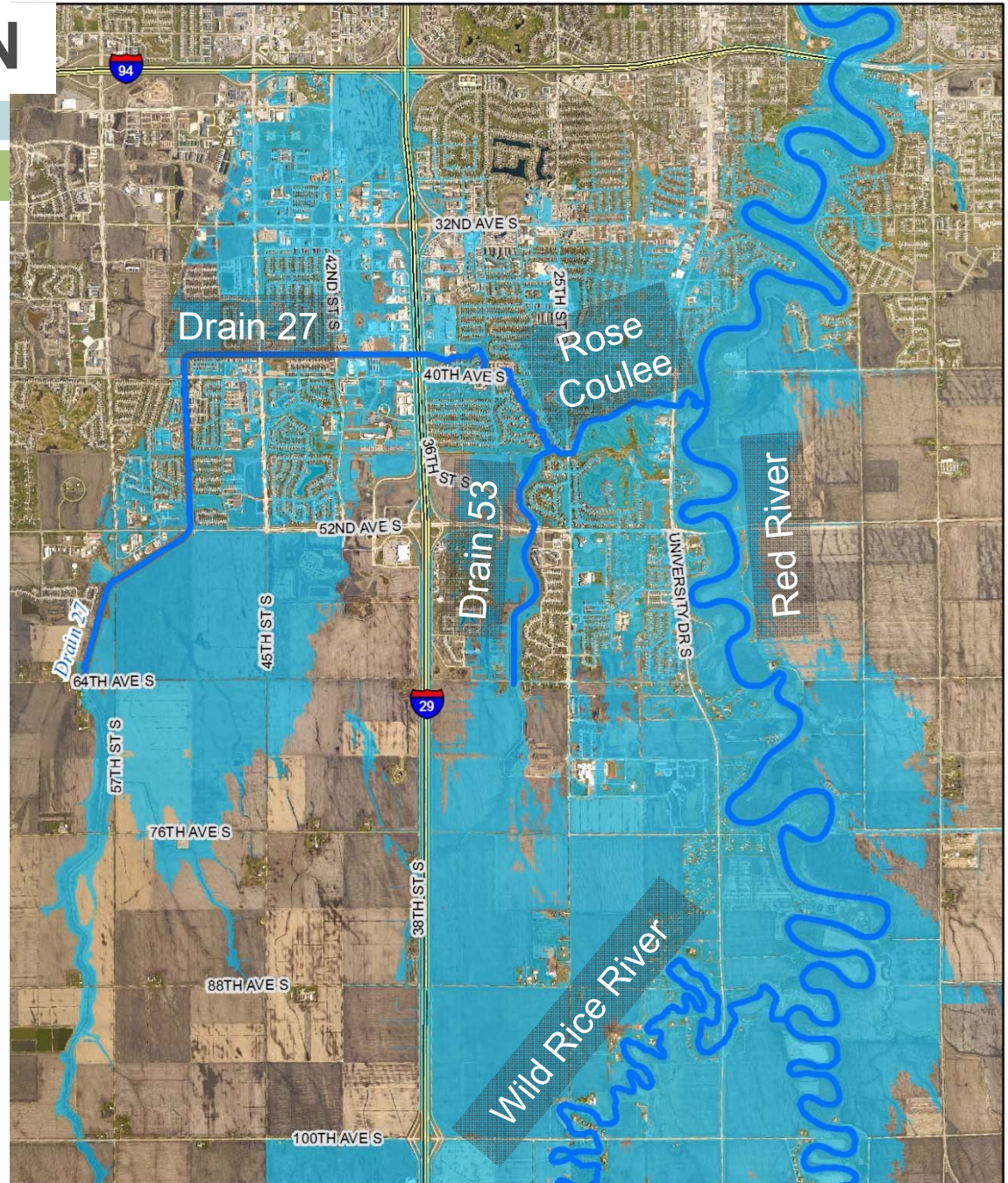
- Red River
- Wild Rice River
- Drain 27
- Drain 53
- Rose Coulee



FEMA FLOODPLAIN

- Red River
 - Wild Rice River
 - Drain 27
 - Drain 53
 - Rose Coulee
-
- no human intervention
 - no flood protection
 - state of nature

Cass County FIS – Jan 2015
Clay County FIS – April 2012



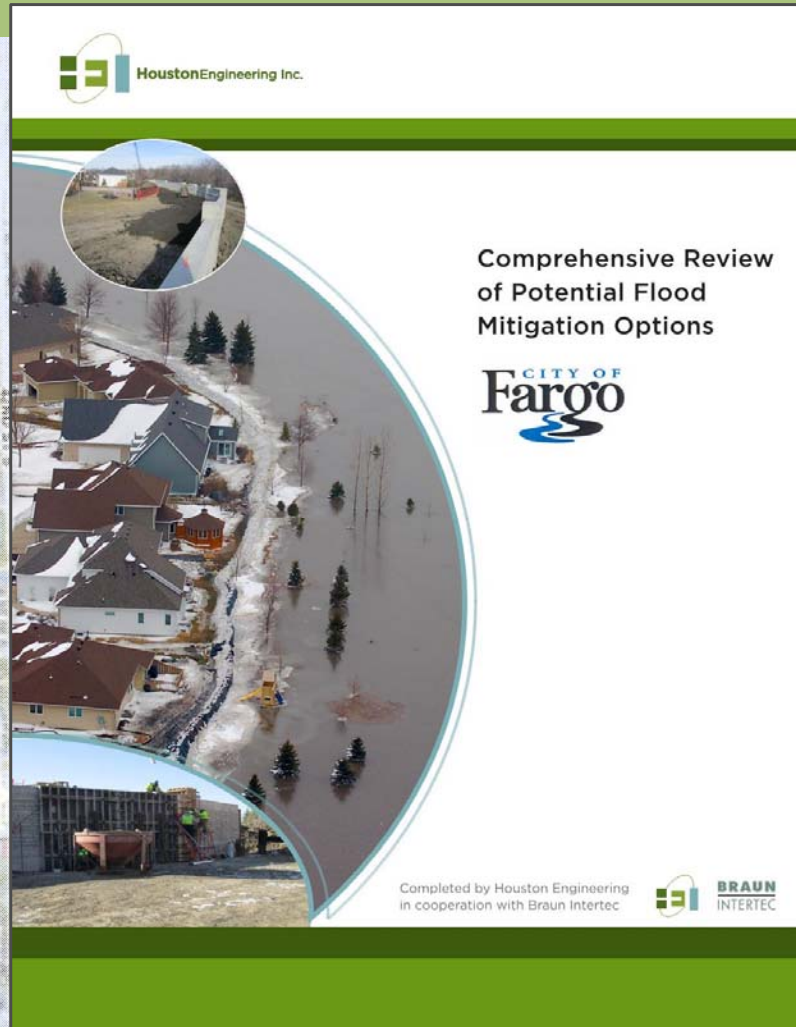
TEMPORARY FLOOD PROTECTION



TEMPORARY FLOOD PROTECTION



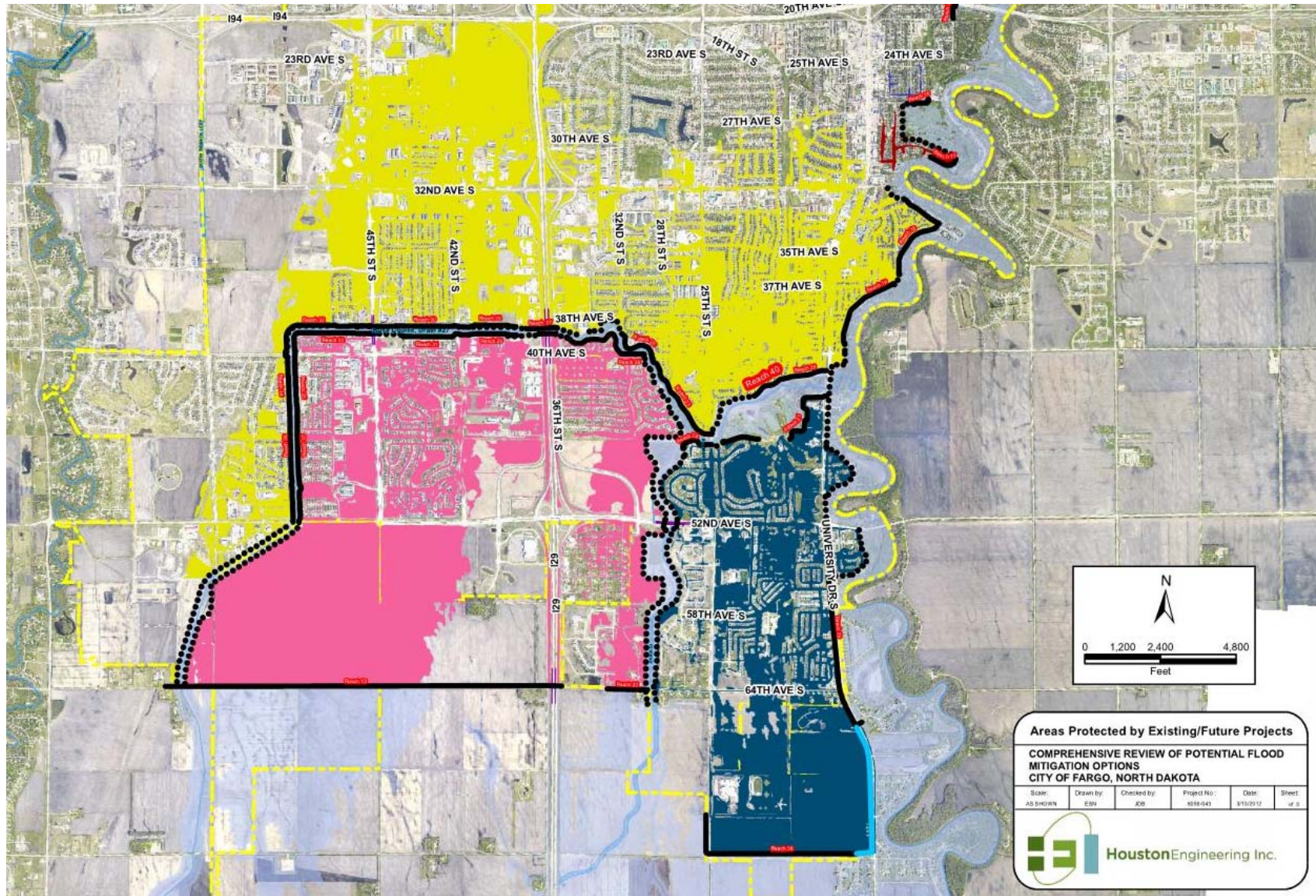
COMPREHENSIVE FLOOD MITIGATION PLAN



MARCH 2012

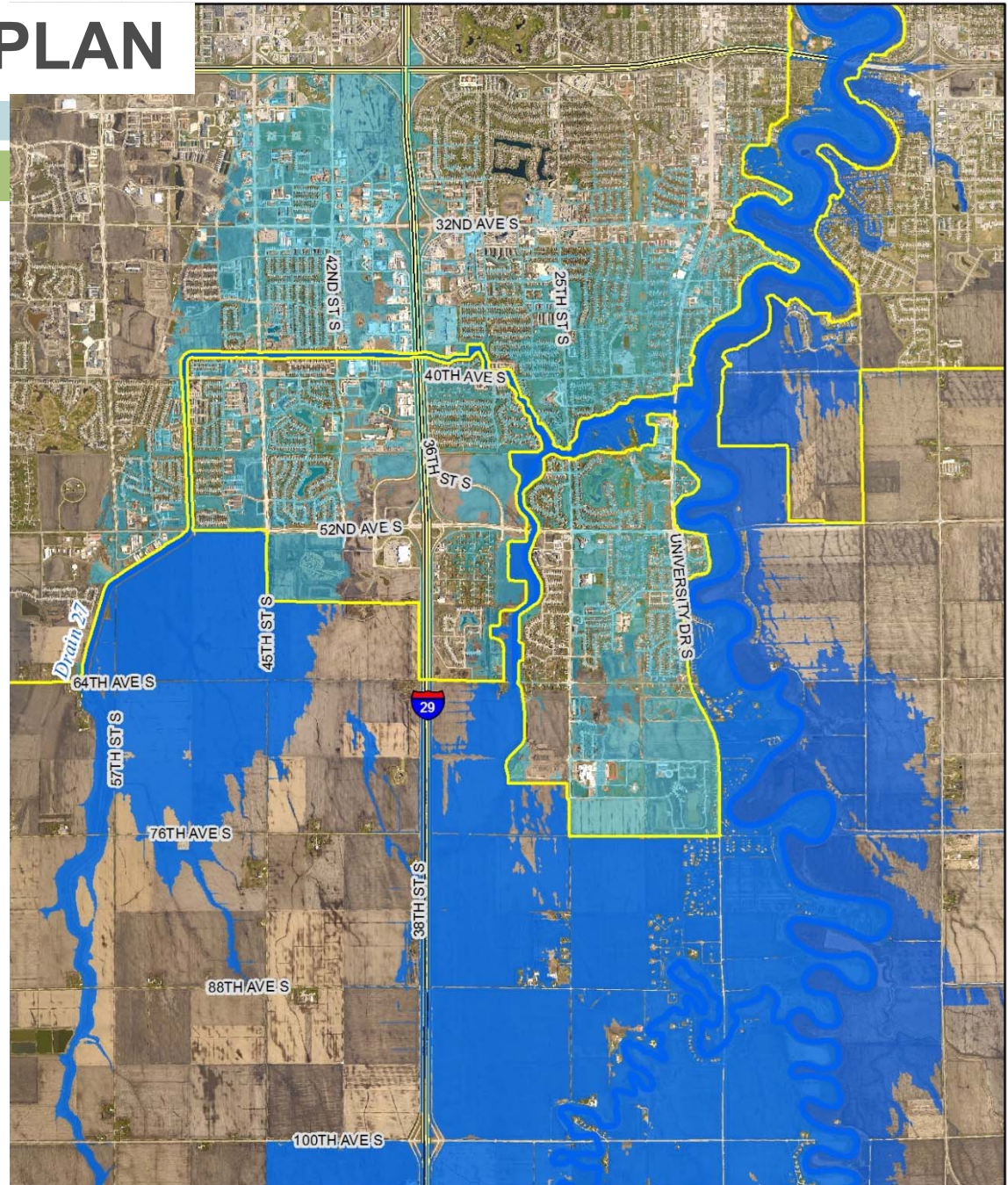


COMPREHENSIVE FLOOD MITIGATION PLAN



COMPREHENSIVE PLAN

- Conceptual Design
 - Levees
 - Floodwalls
 - Property Acquisitions
- Geotechnical Analysis
- ~50,000 foot plan
- Modeling Approach (Steady State)

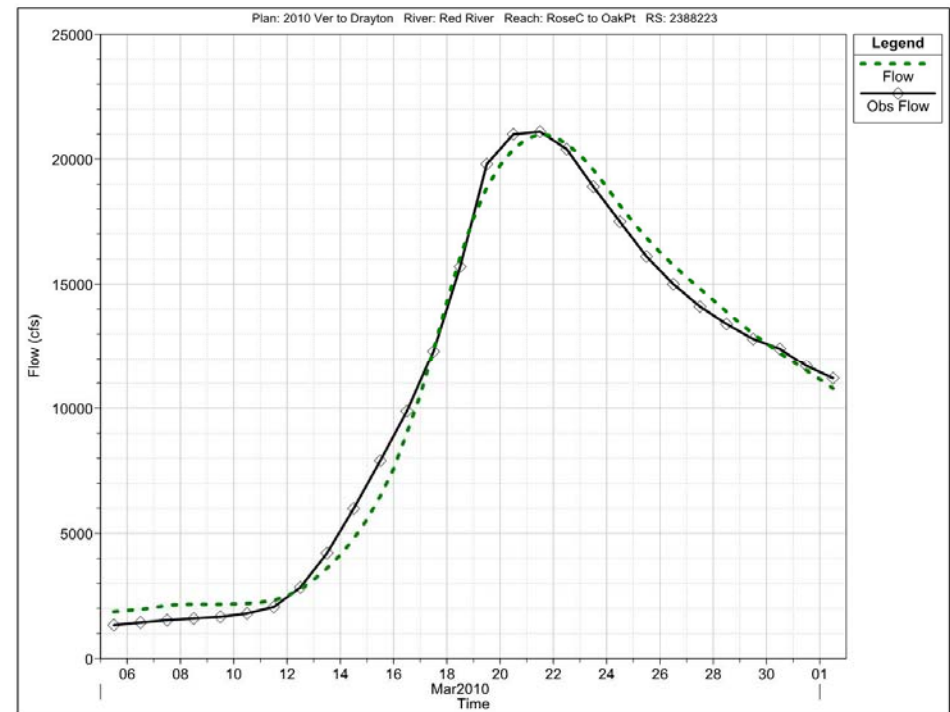
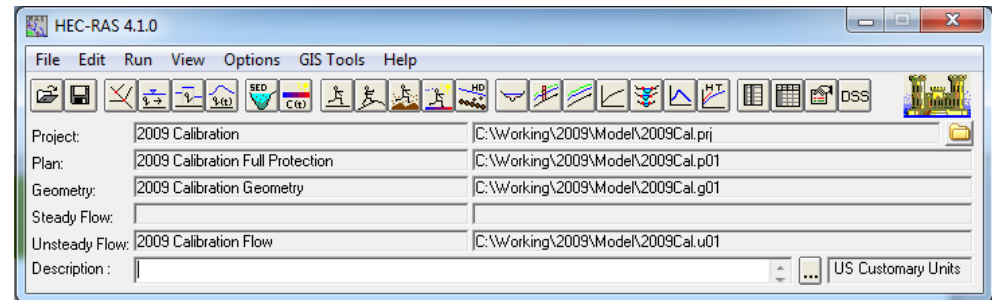
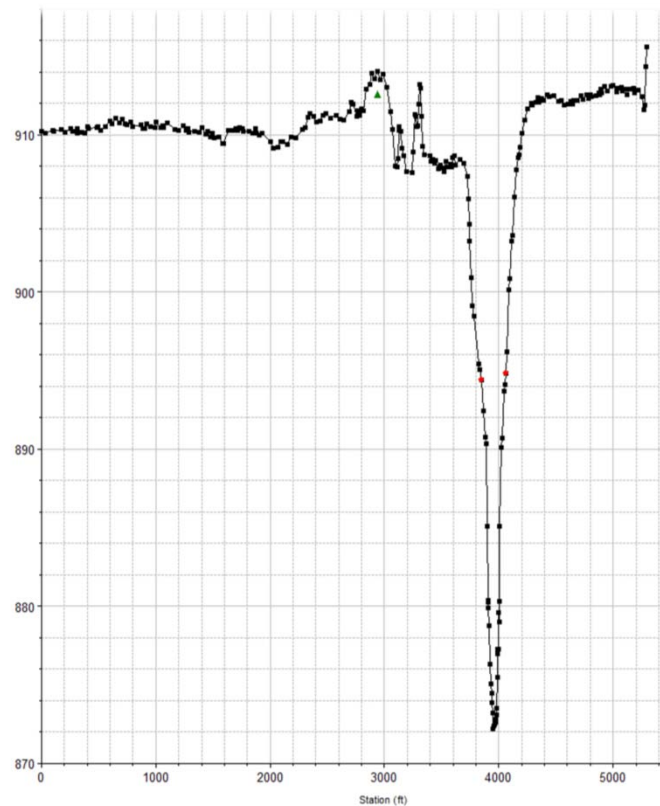


ANALYZING HYDRAULICS IMPACTS



■ HEC-RAS

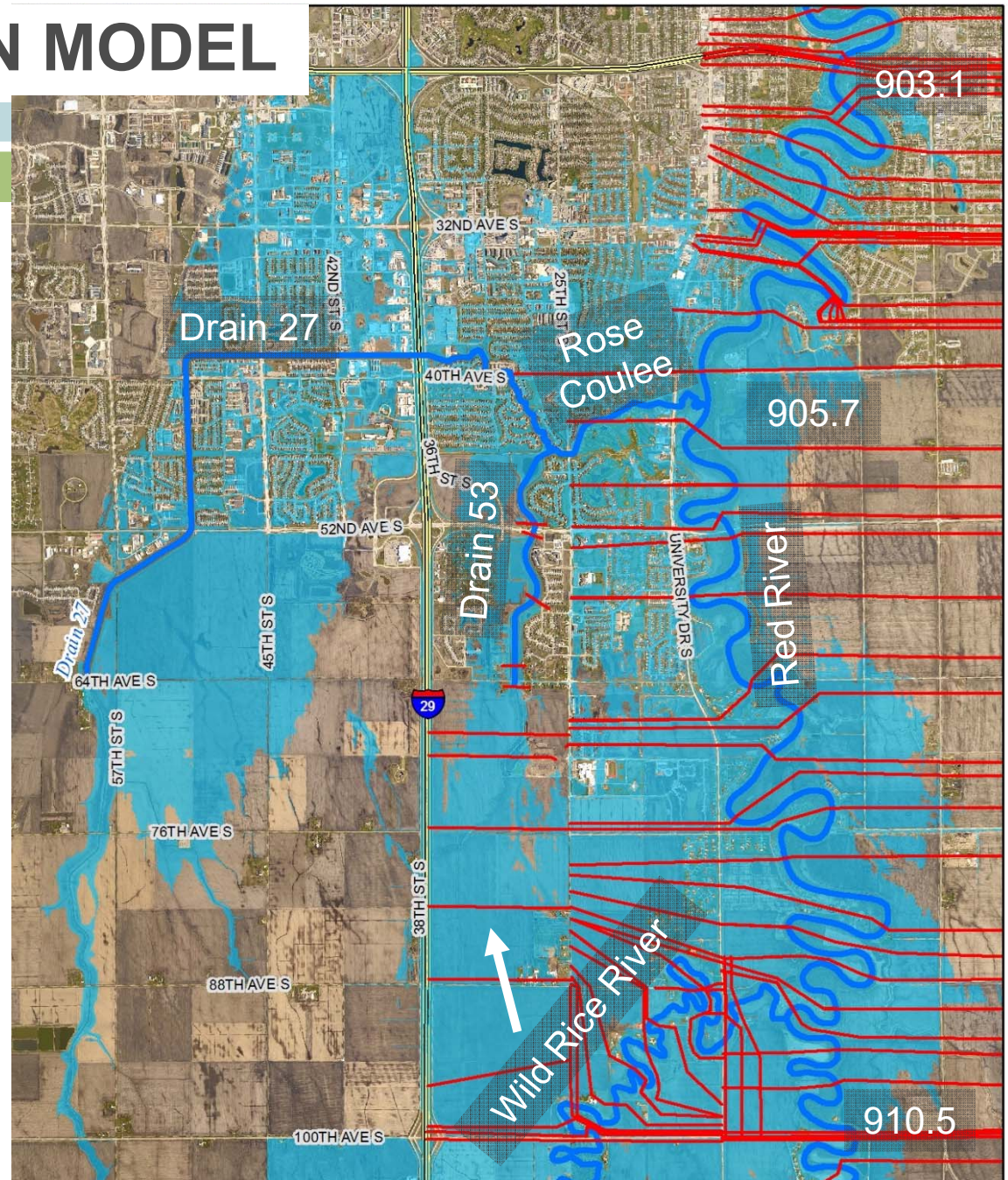
- Steady State (FEMA FIS)
- Unsteady State (FM Diversion)



FEMA FLOODPLAIN MODEL

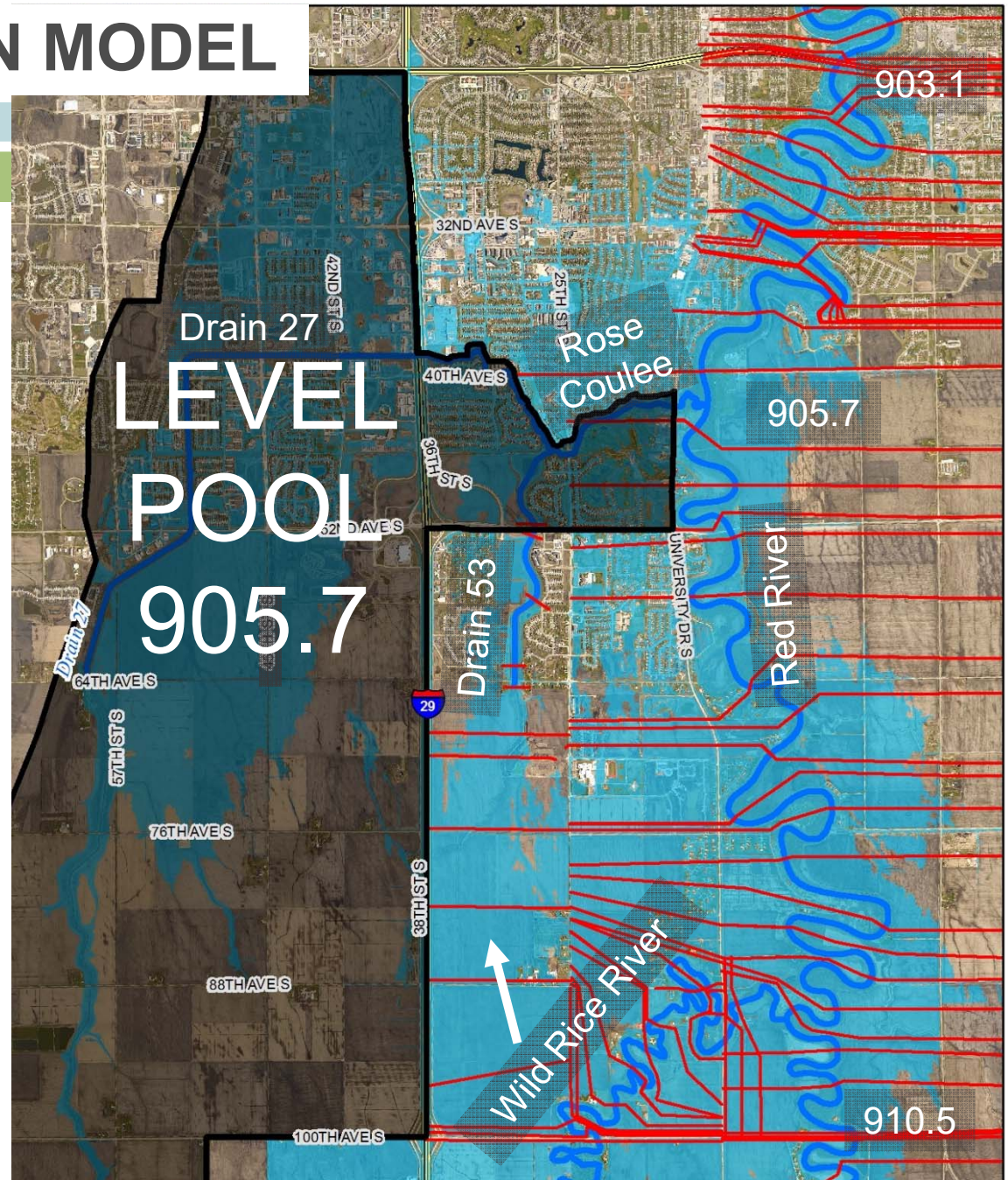
- Simple Approach
- Steady State
- Many Unknowns
- Many Assumptions
- Does not reflect reality
- Outdated Hydrology

Cass County FIS – Jan 2015
Clay County FIS – April 2012



FEMA FLOODPLAIN MODEL

- Simple Approach
- Steady State
- Many Unknowns
- Many Assumptions
- Does not reflect reality
- Outdated Hydrology

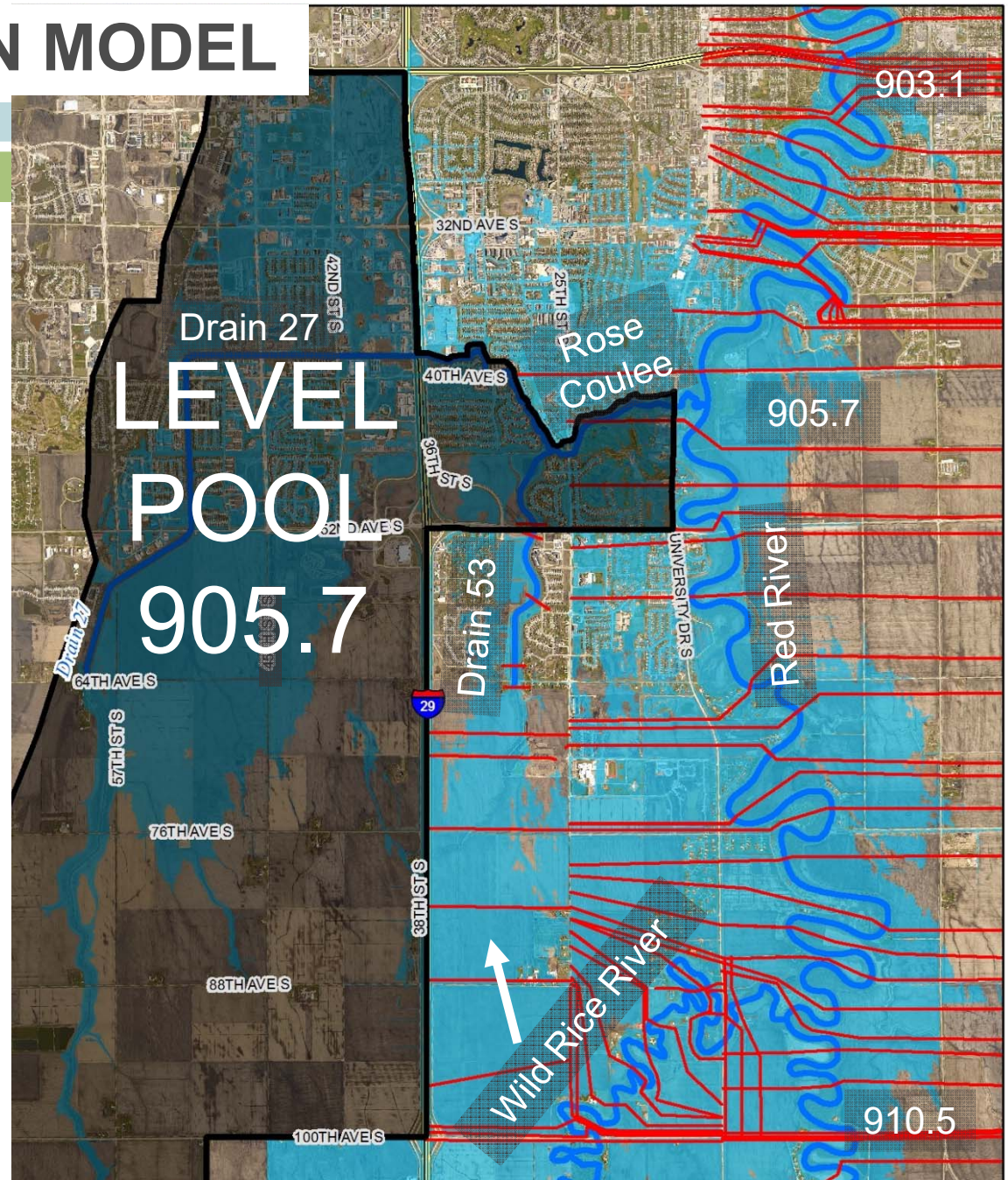


Cass County FIS – Jan 2015
Clay County FIS – April 2012

FEMA FLOODPLAIN MODEL

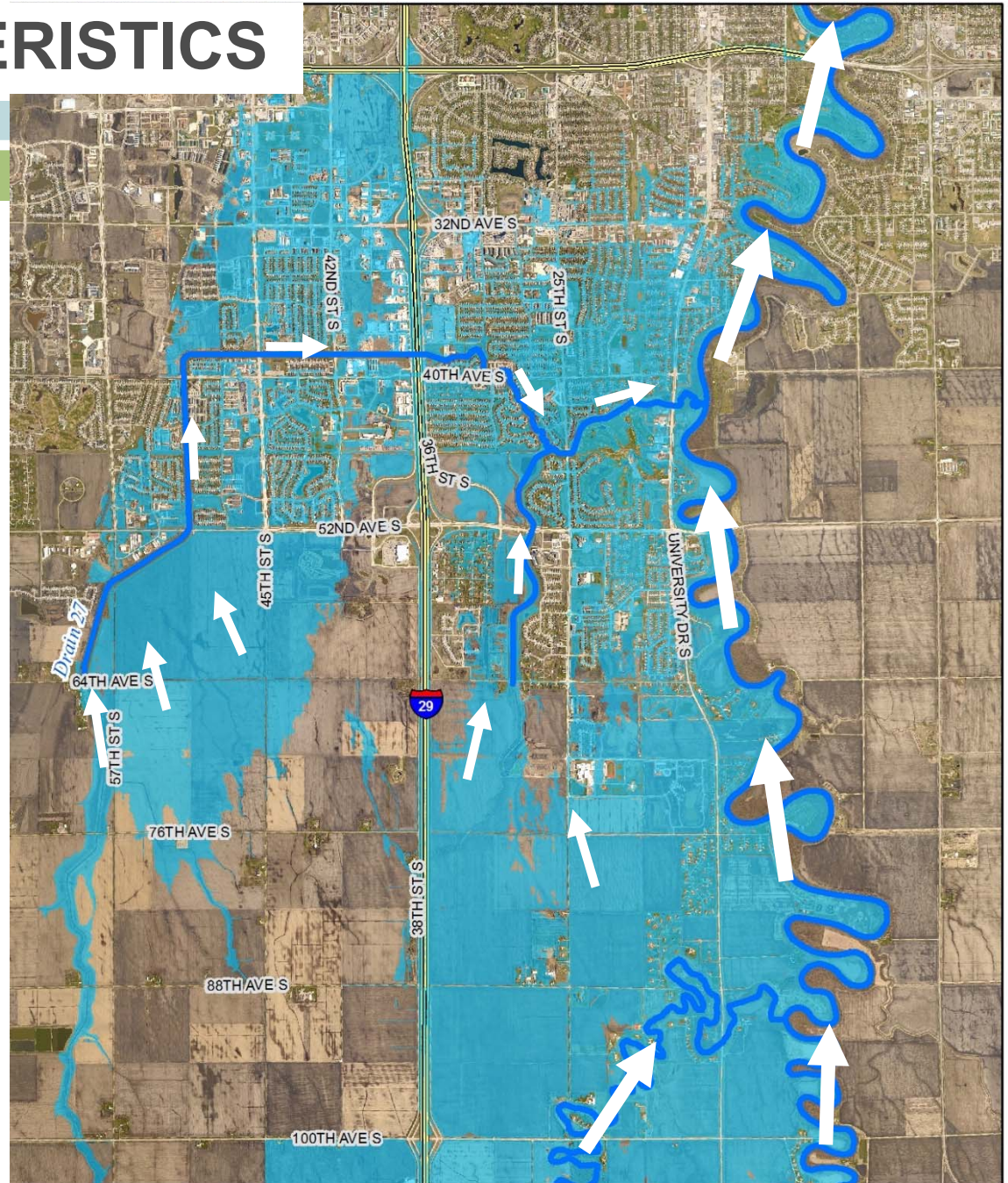
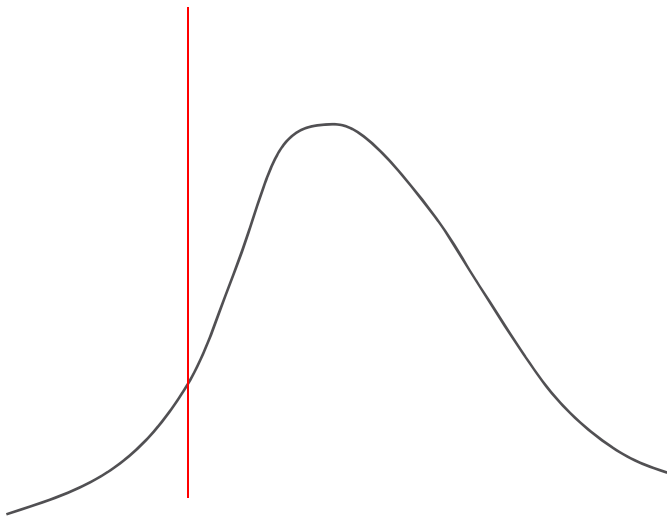
- Simple Approach
- Steady State
- Many Unknowns
- Many Assumptions
- Does not reflect reality
- Outdated Hydrology
 - H&H
 - 1979
 - FM Diversion
 - FEMA Future
 - Flood Risk

Cass County FIS – Jan 2015
Clay County FIS – April 2012



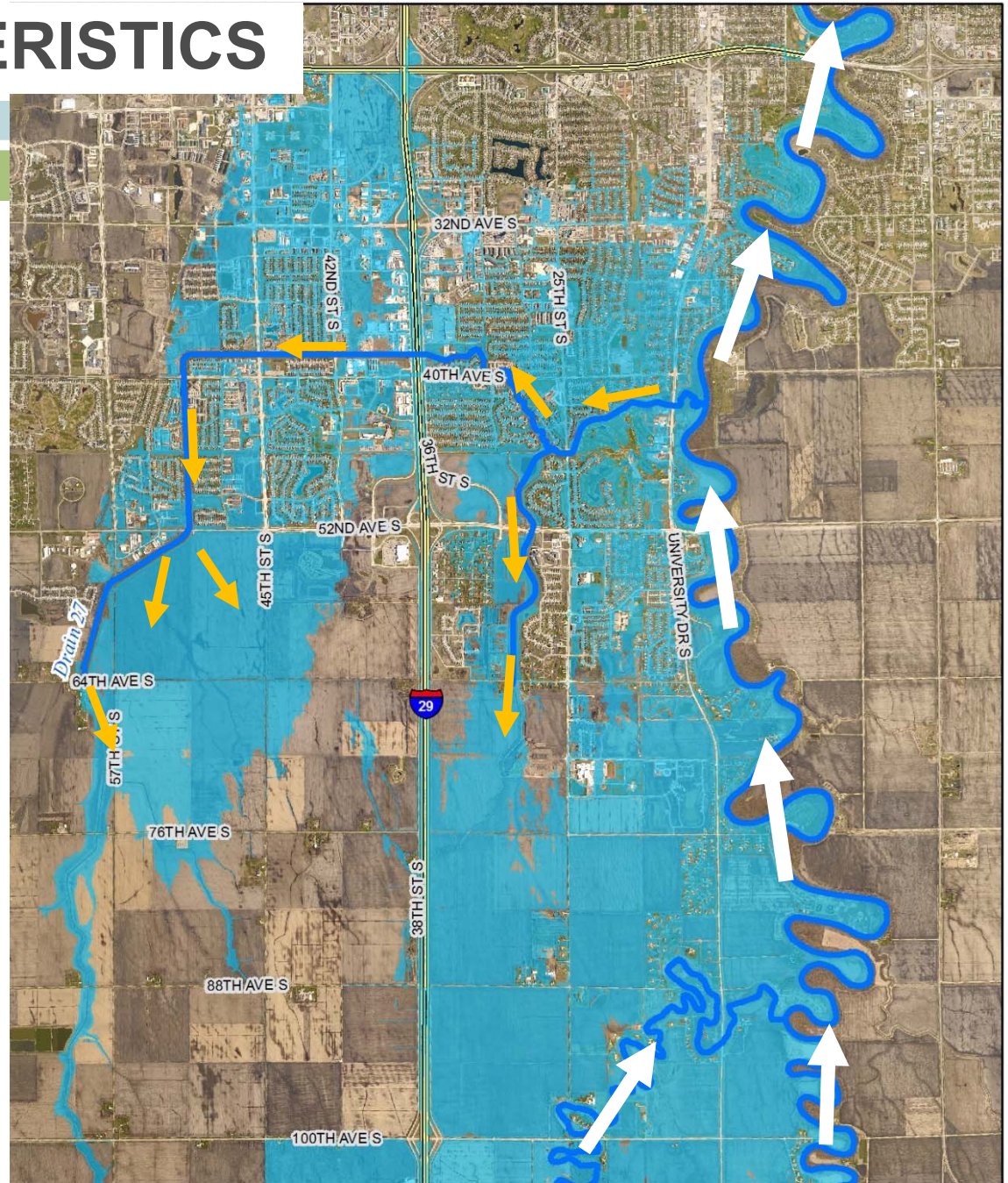
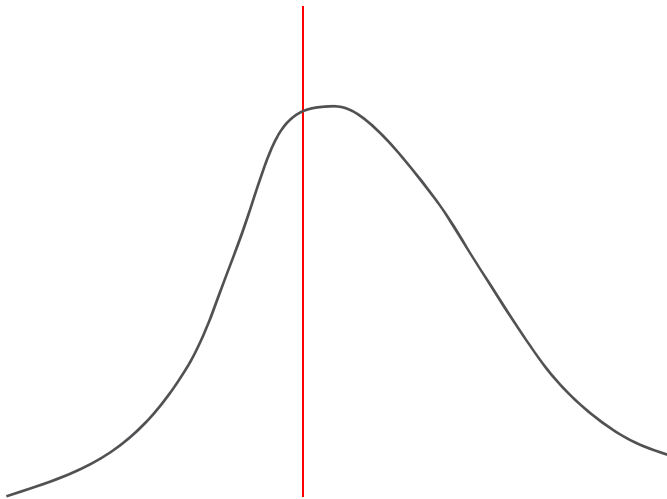
FLOOD CHARACTERISTICS

- Red River
- Wild Rice River
- Drain 27
- Drain 53
- Rose Coulee



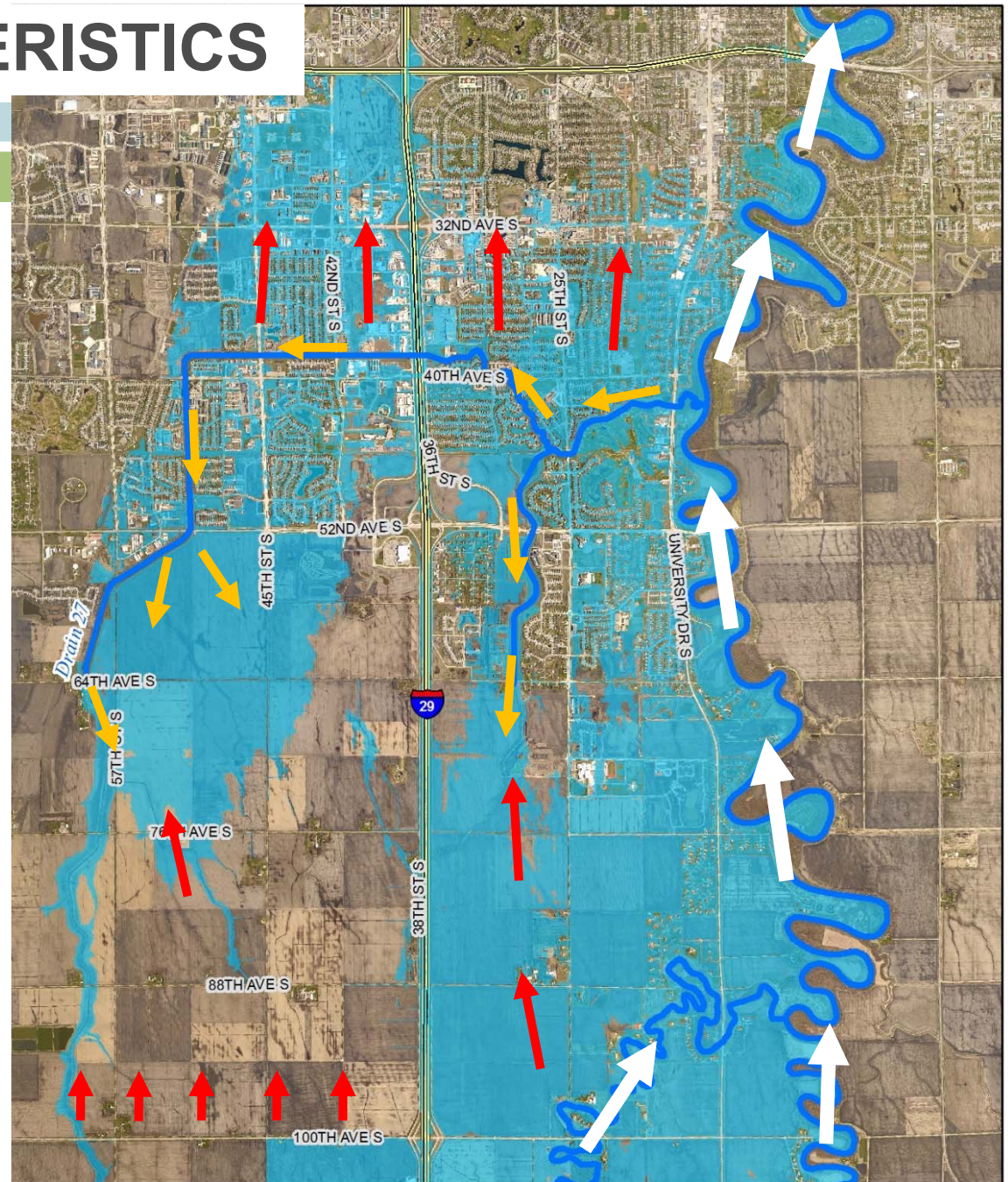
FLOOD CHARACTERISTICS

- Reverse Flow:
Rose Coulee
Drain 27
Drain 53



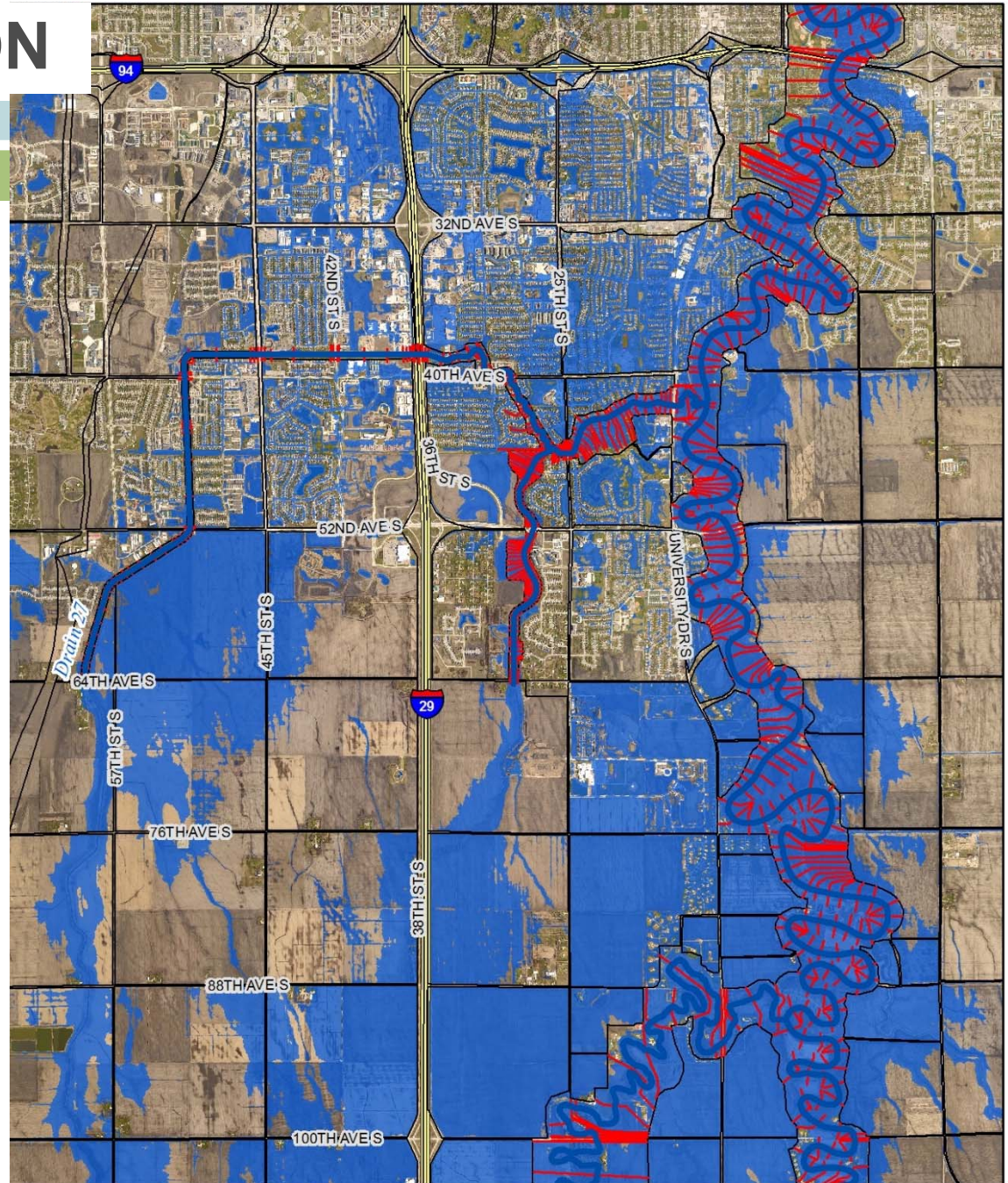
FLOOD CHARACTERISTICS

- Large Events
- Breakout Flows
 - Overland Flow
 - Wild Rice River
 - County Road 16



MODEL SIMULATION

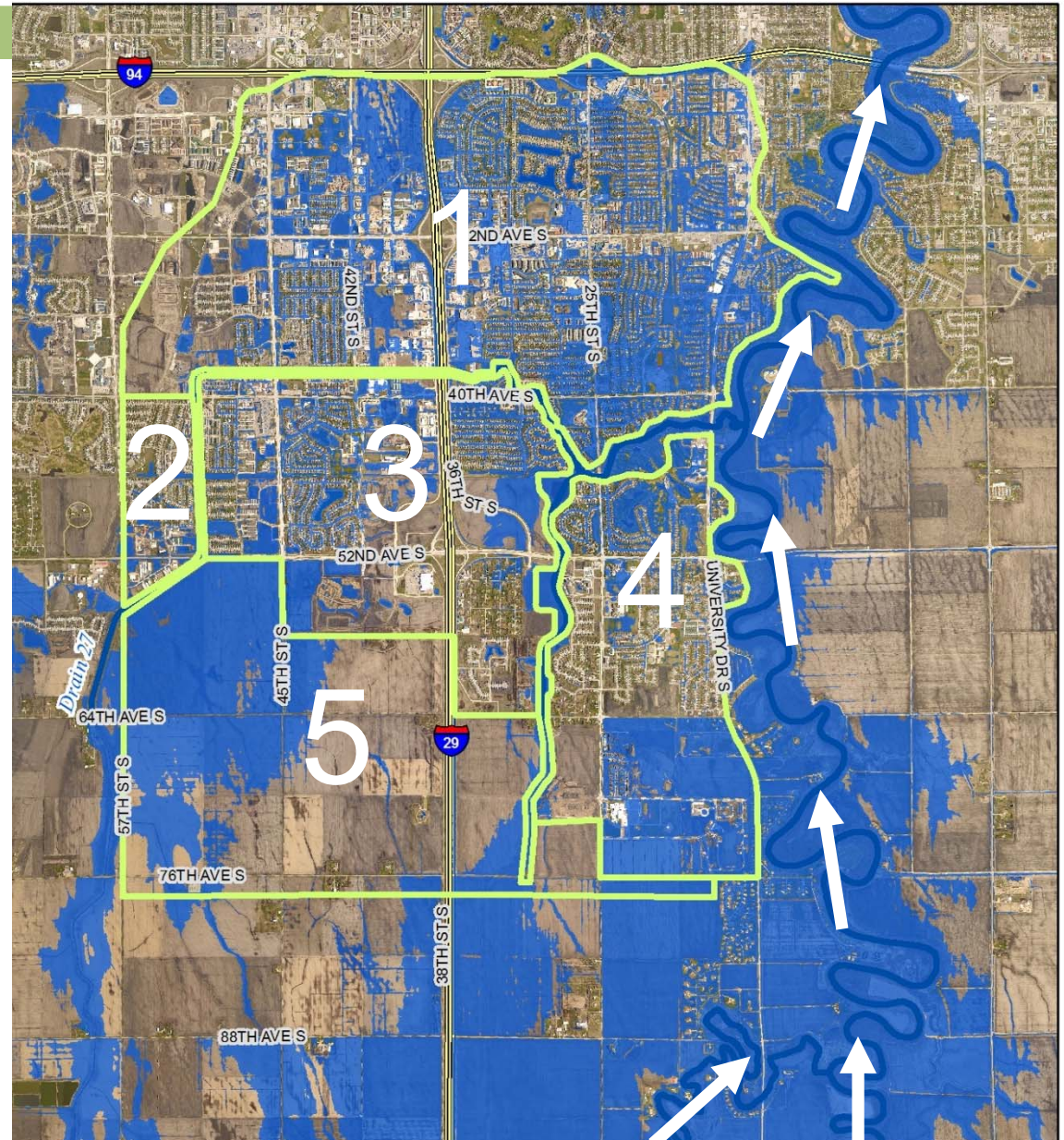
- New Model
- FM Diversion
 - Phase 8
 - Unsteady State
 - Full Hydrograph
 - Cross Sections
 - Storage Areas
- Complex
- More Realistic
- Flow Interaction
- Wild Rice River Breakout
- Reverse Flow



STUDY AREA



Identify flood impacts
from floodplain
removal



FLOOD IMPACTS



Flood Impacts

1. Volume Loss
2. Conveyance Loss

Area 1 = 3,100 ac-ft

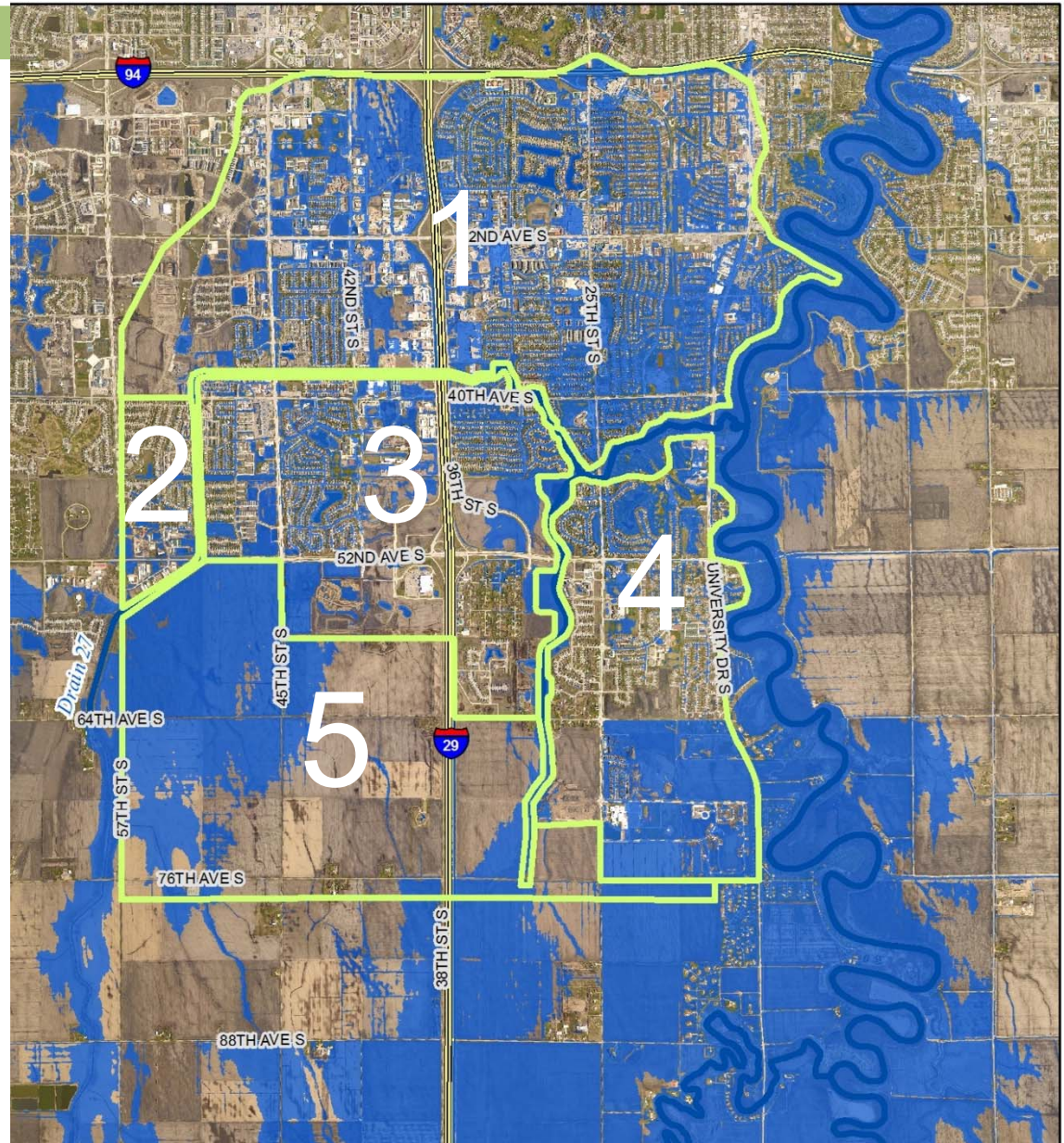
Area 2 = 100 ac-ft

Area 3 = 1,000 ac-ft

Area 4 = 100 ac-ft

Area 5 = 1,400 ac-ft

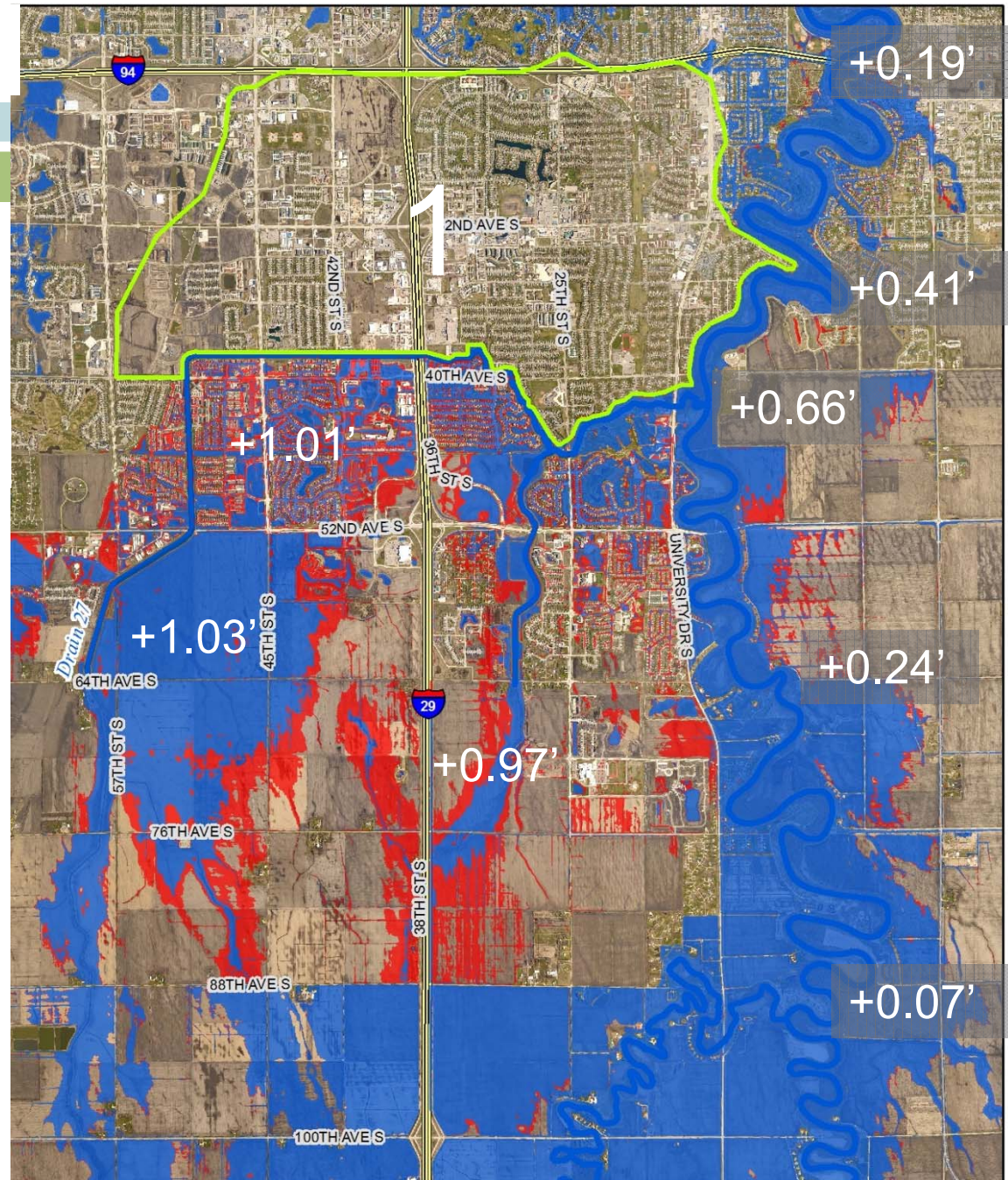
Total = 6,400 ac-ft



IMPACTS – AREA 1

Impacts from Current Flood Protection

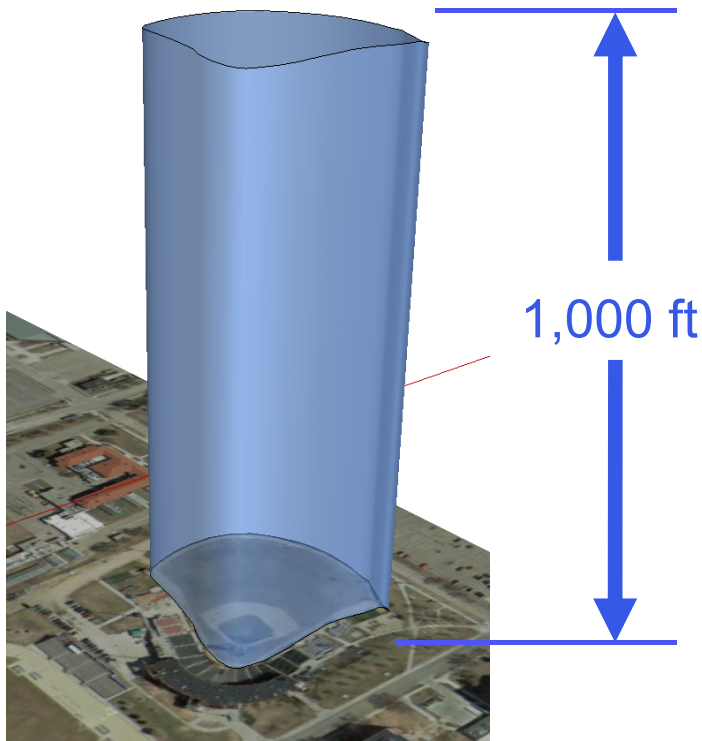
Area 1 = 3,100 ac-ft



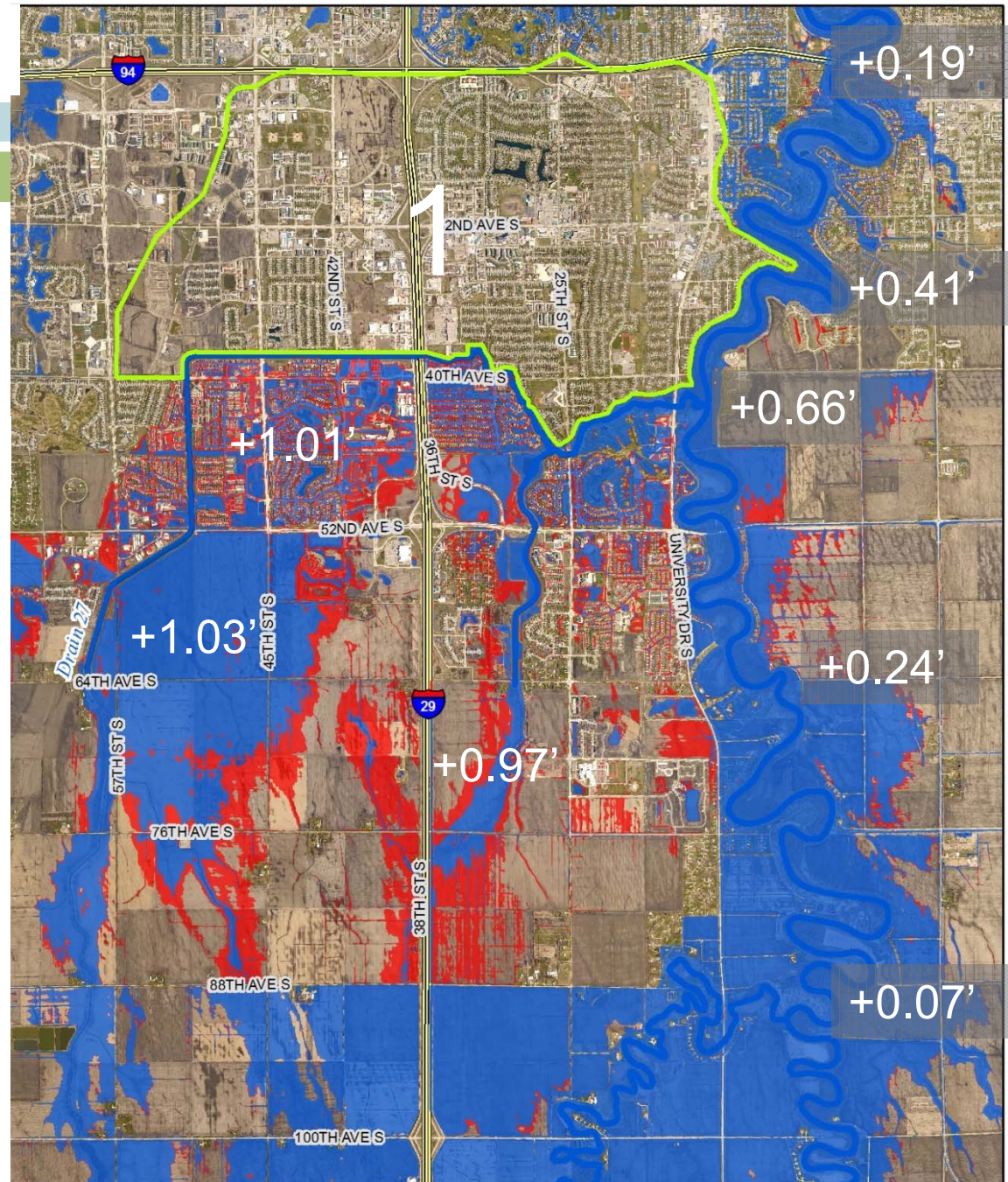
IMPACTS – AREA 1

Impacts from Current Flood Protection

Area 1 = 3,100 ac-ft



Newman Outdoor Field x 1000 ft high



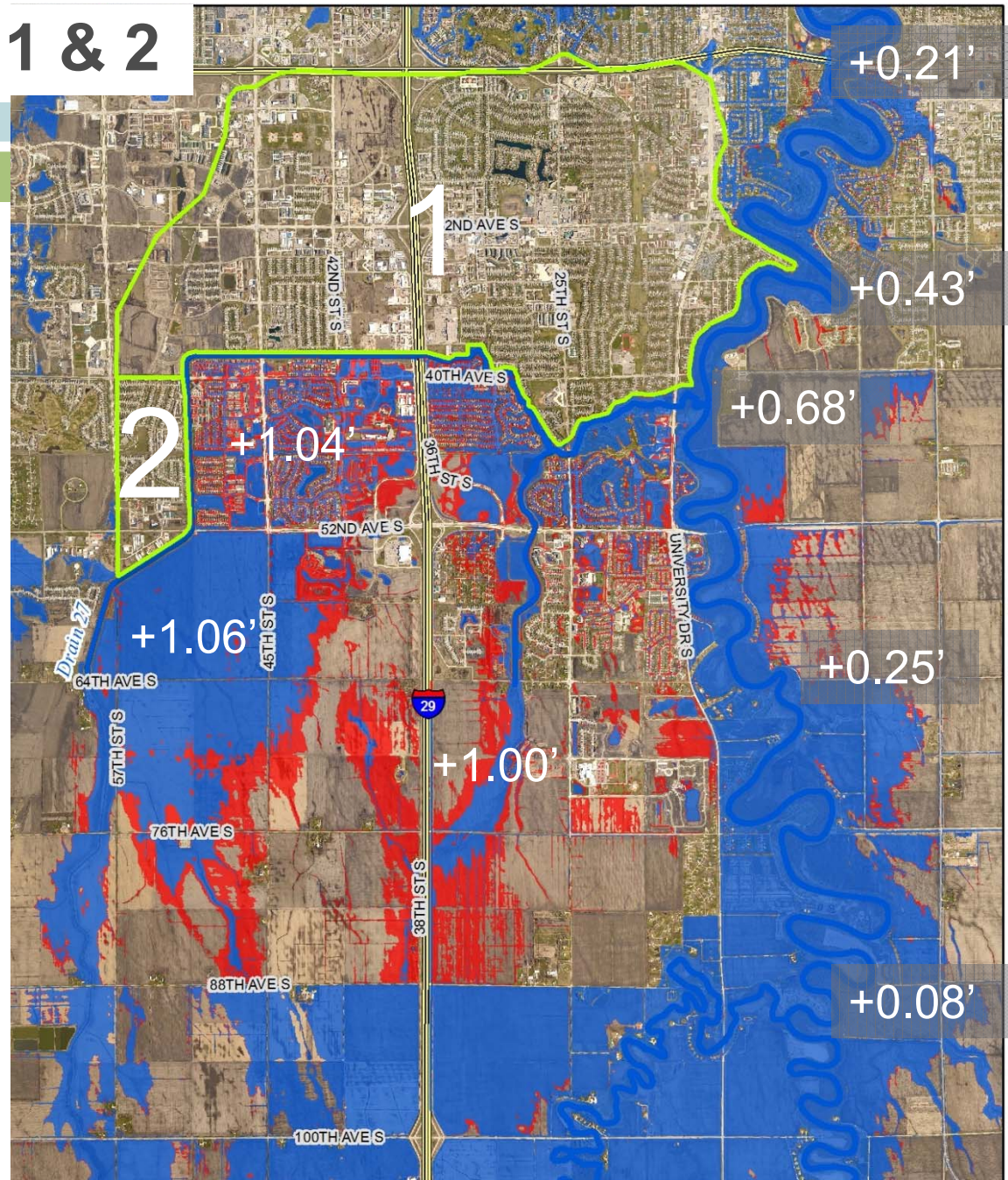
IMPACTS – AREAS 1 & 2

Impacts from Current Flood Protection

Area 1 = 3,100 ac-ft

Area 2 = 100 ac-ft

Total = 3,200 ac-ft



IMPACTS – AREAS 1 - 3

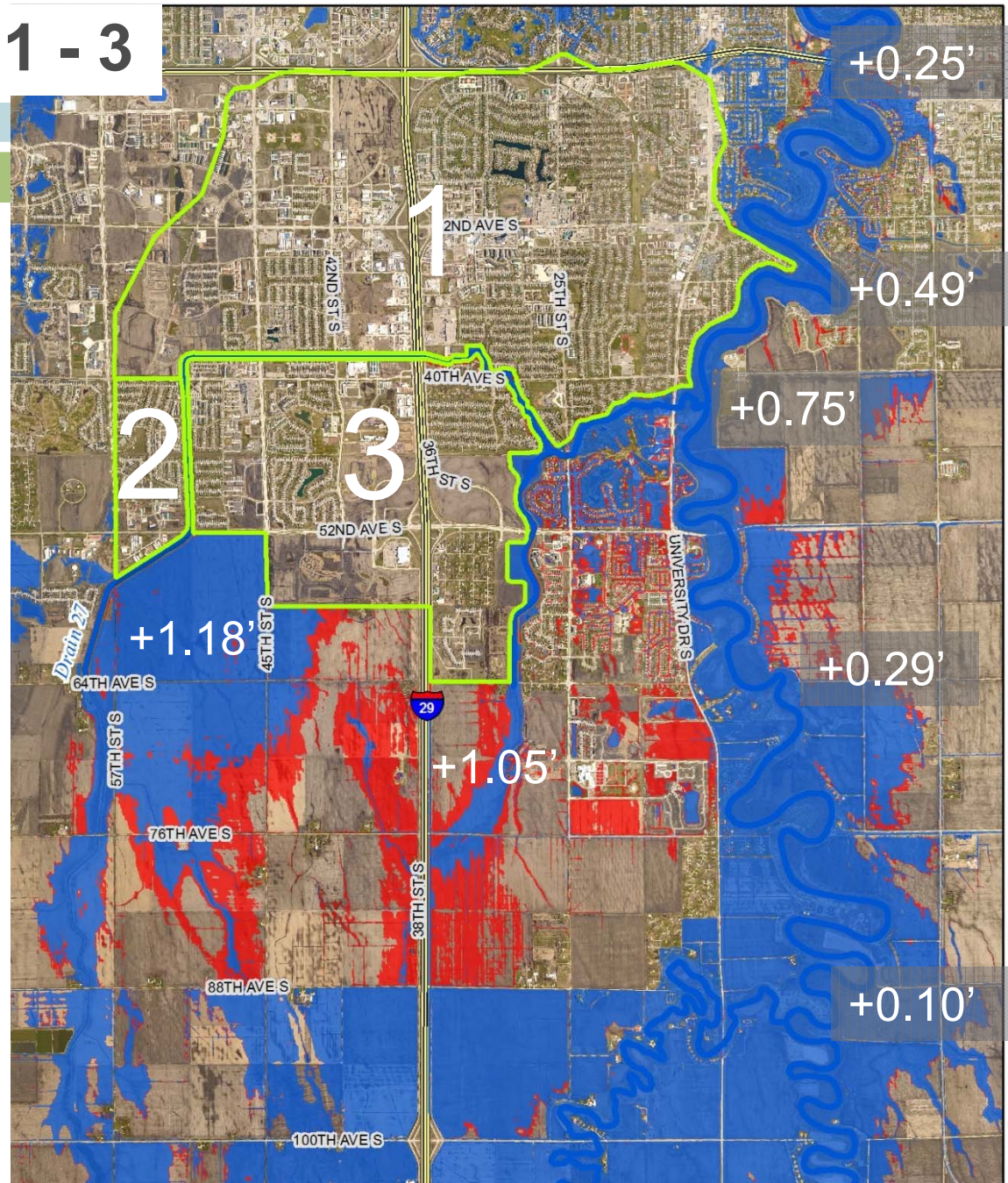
Impacts from Current Flood Protection

Area 1 = 3,100 ac-ft

Area 2 = 100 ac-ft

Area 3 = 1,000 ac-ft

Total = 4,200 ac-ft



IMPACTS – AREAS 1 - 3

Impacts from Current Flood Protection

Area 1 = 3,100 ac-ft

Area 2 = 100 ac-ft

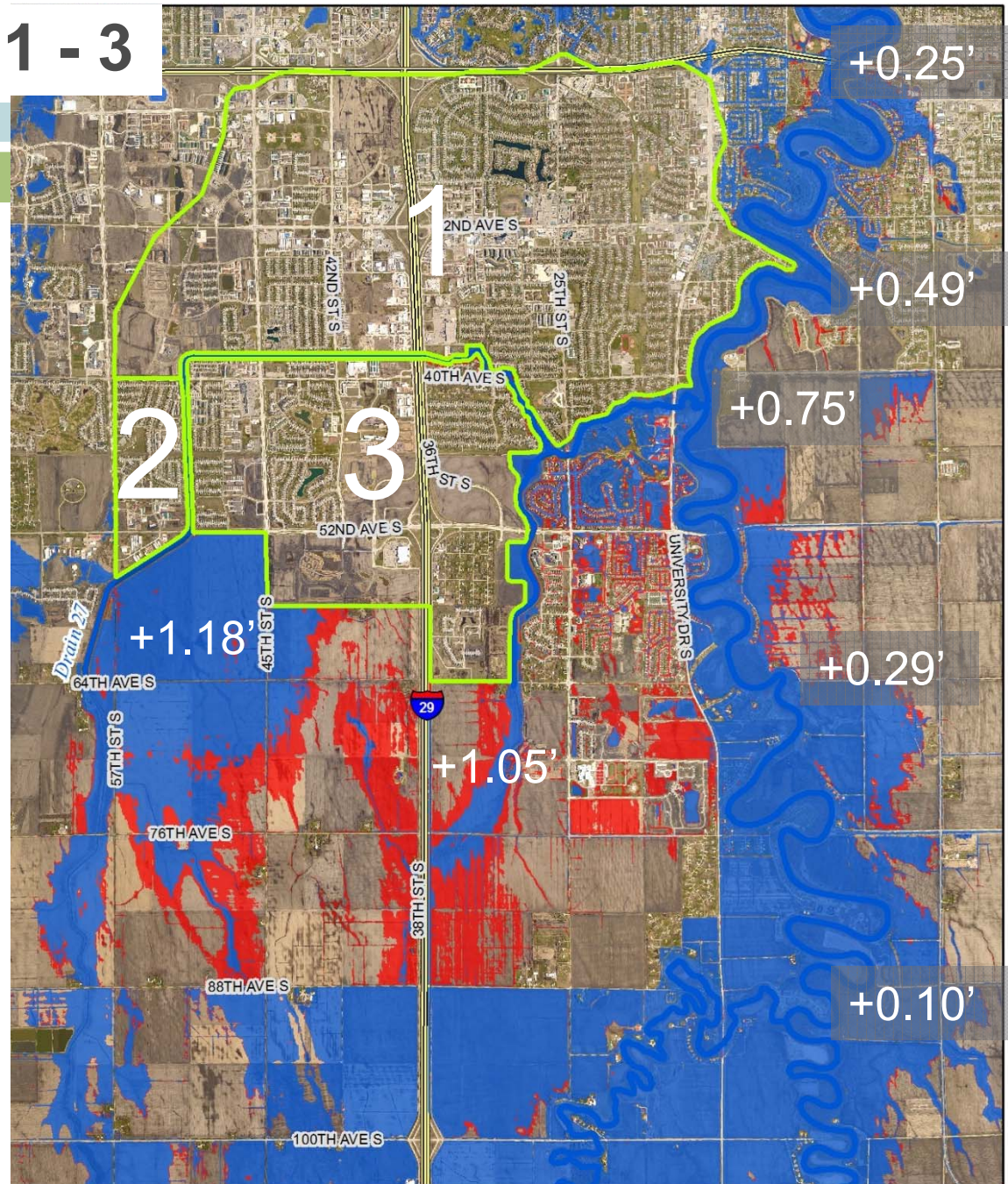
Area 3 = 1,000 ac-ft

Total = 4,200 ac-ft



Photo by championshipsdivision.com

25,500,000 cu.ft. = 585 ac-ft



IMPACTS – AREAS 1 - 4

Impacts from Current Flood Protection

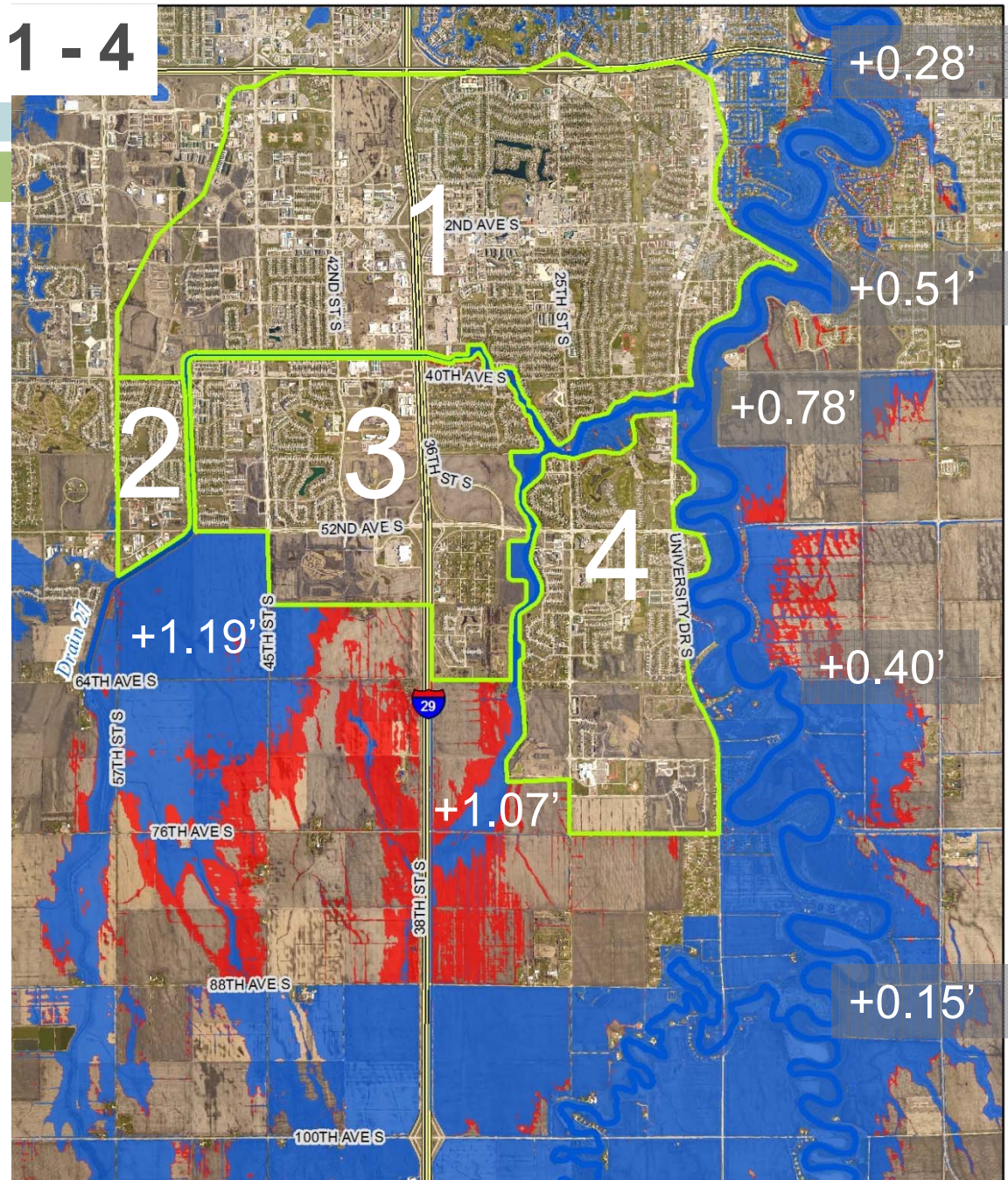
Area 1 = 3,100 ac-ft

Area 2 = 100 ac-ft

Area 3 = 1,000 ac-ft

Area 4 = 800 ac-ft

Total = 5,000 ac-ft



IMPACTS – ALL AREAS (1 – 5)

Impacts from Current
and
Future Flood Protection

Area 1 = 3,100 ac-ft

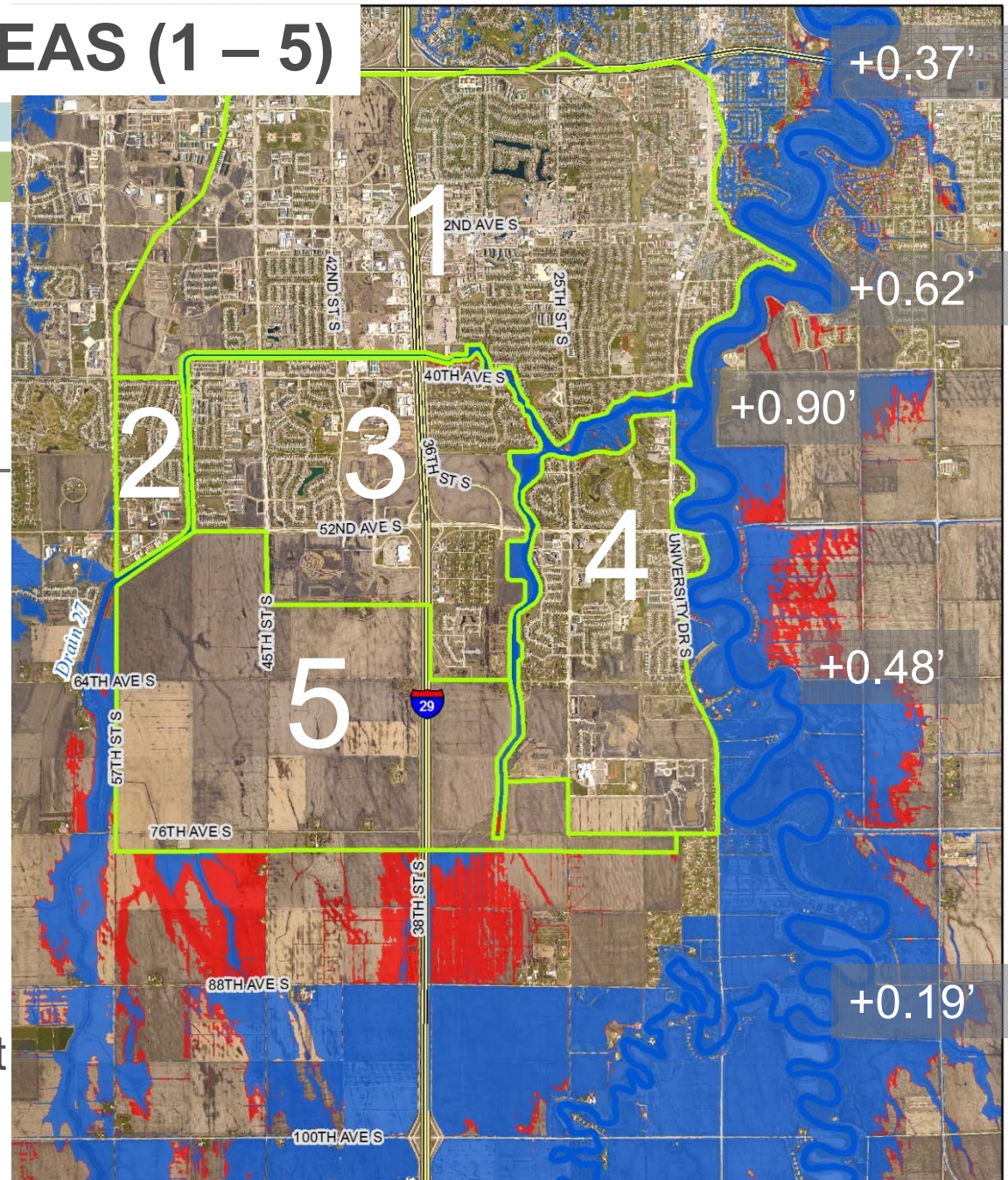
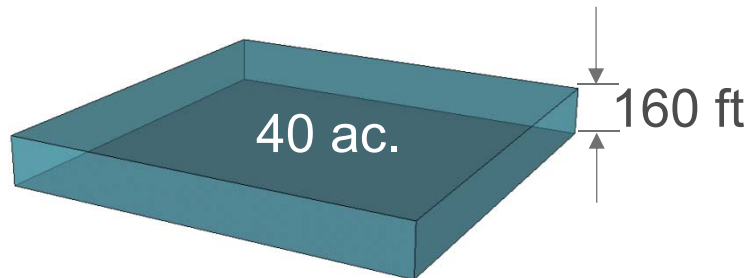
Area 2 = 100 ac-ft

Area 3 = 1,000 ac-ft

Area 4 = 800 ac-ft

Area 5 = 1,400 ac-ft

Total = 6,400 ac-ft



IMPACTS – ALL AREAS (1 – 5)

Impacts from Current and Future Flood Protection

Area 1 = 3,100 ac-ft

Area 2 = 100 ac-ft

Area 3 = 1,000 ac-ft

Area 4 = 800 ac-ft

Area 5 = 1,400 ac-ft

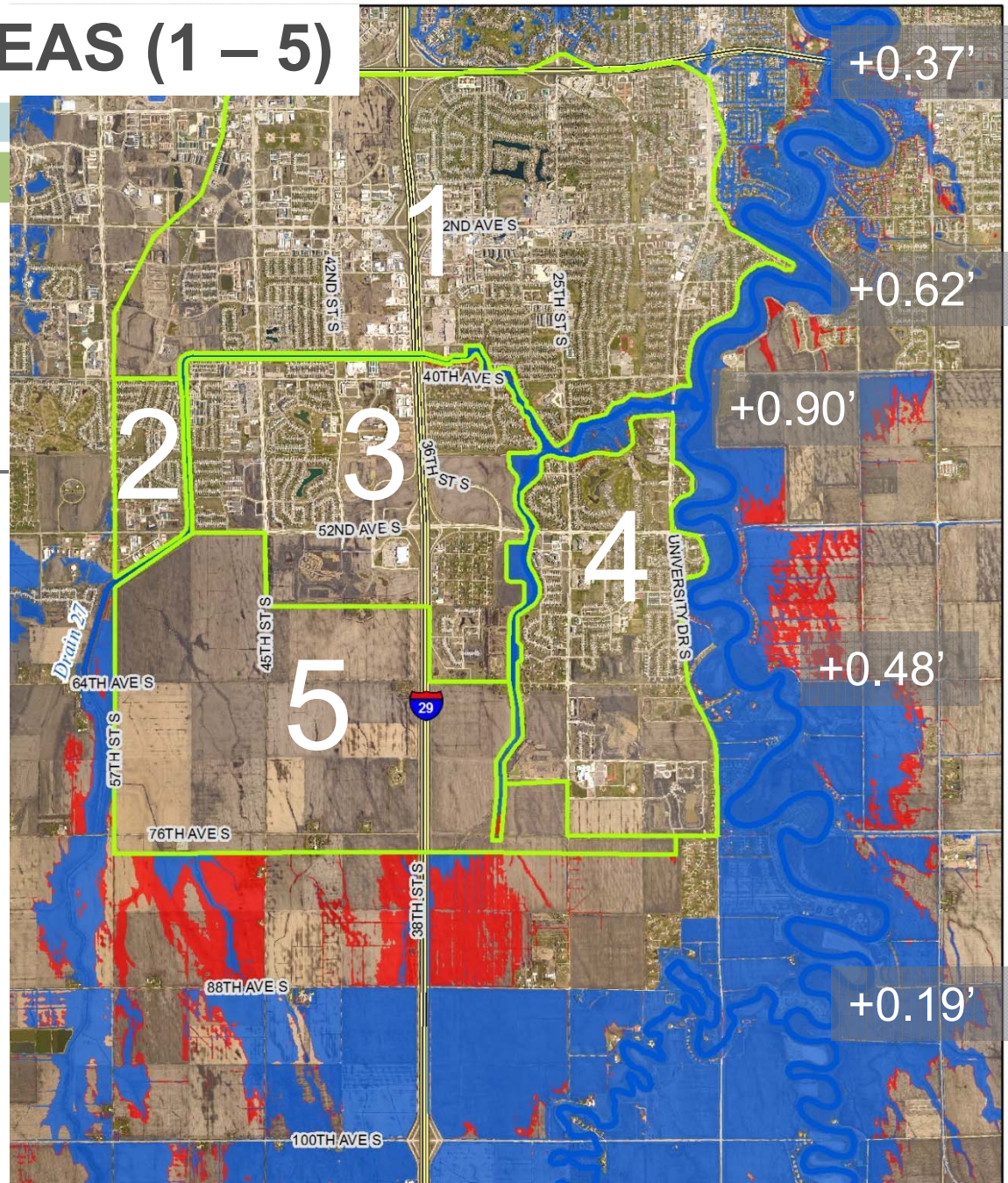
Total = 6,400 ac-ft



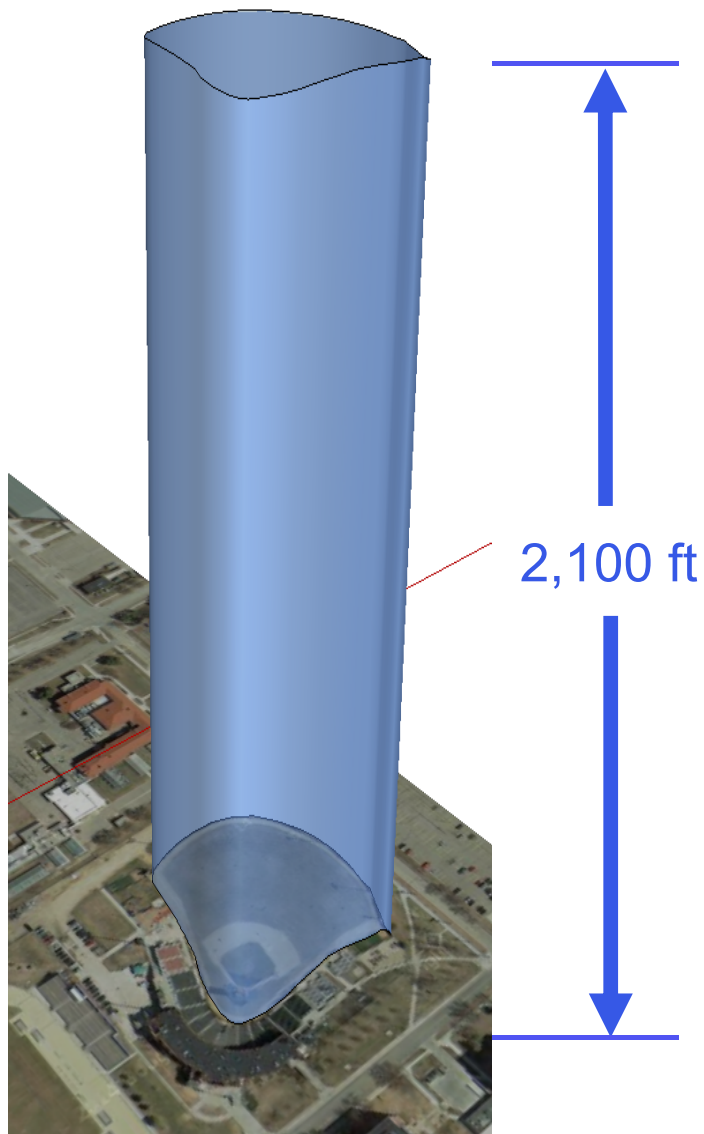
x 11

Photo by championshipsubdivision.com

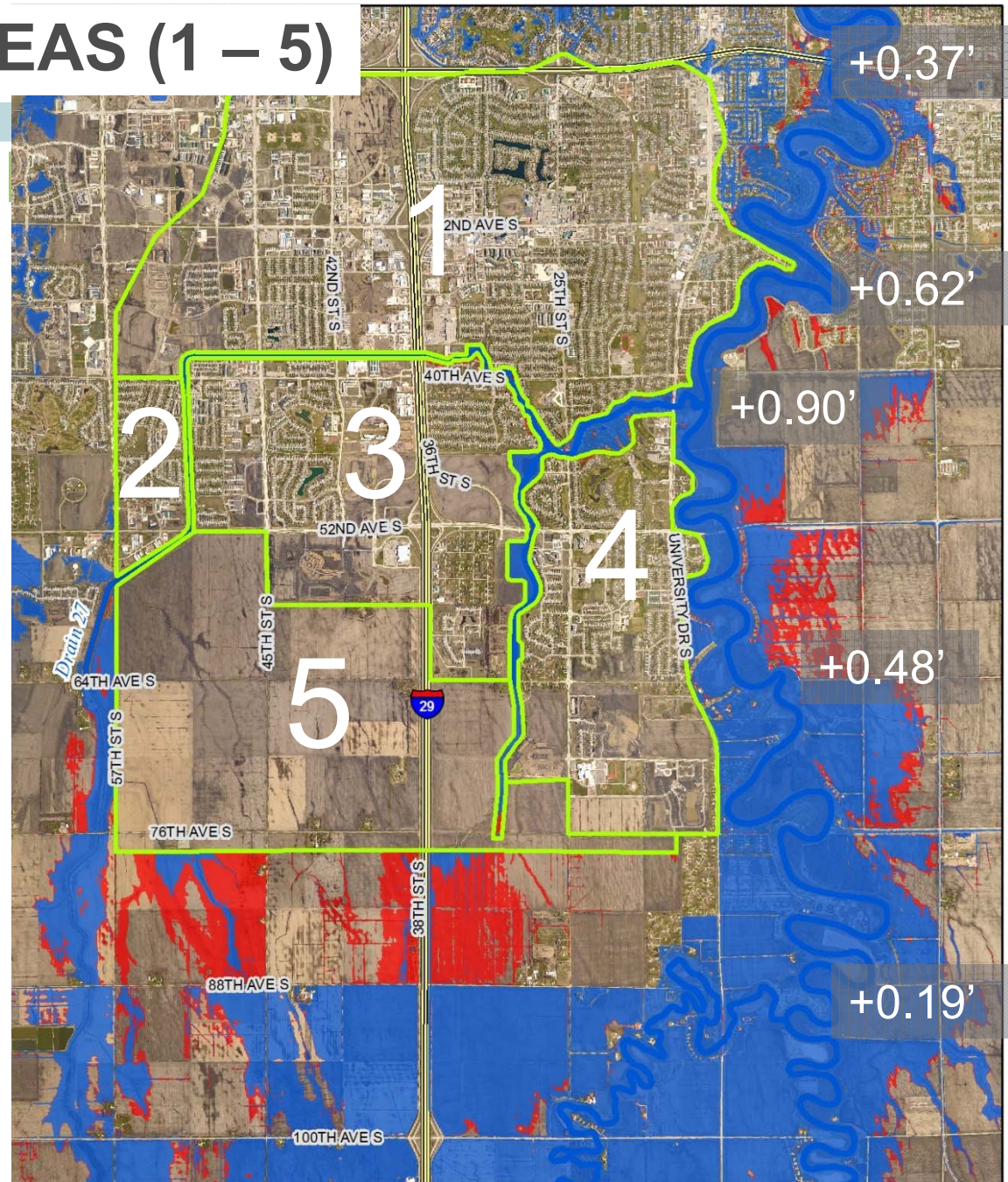
25,500,000 cu.ft. = 585 ac-ft



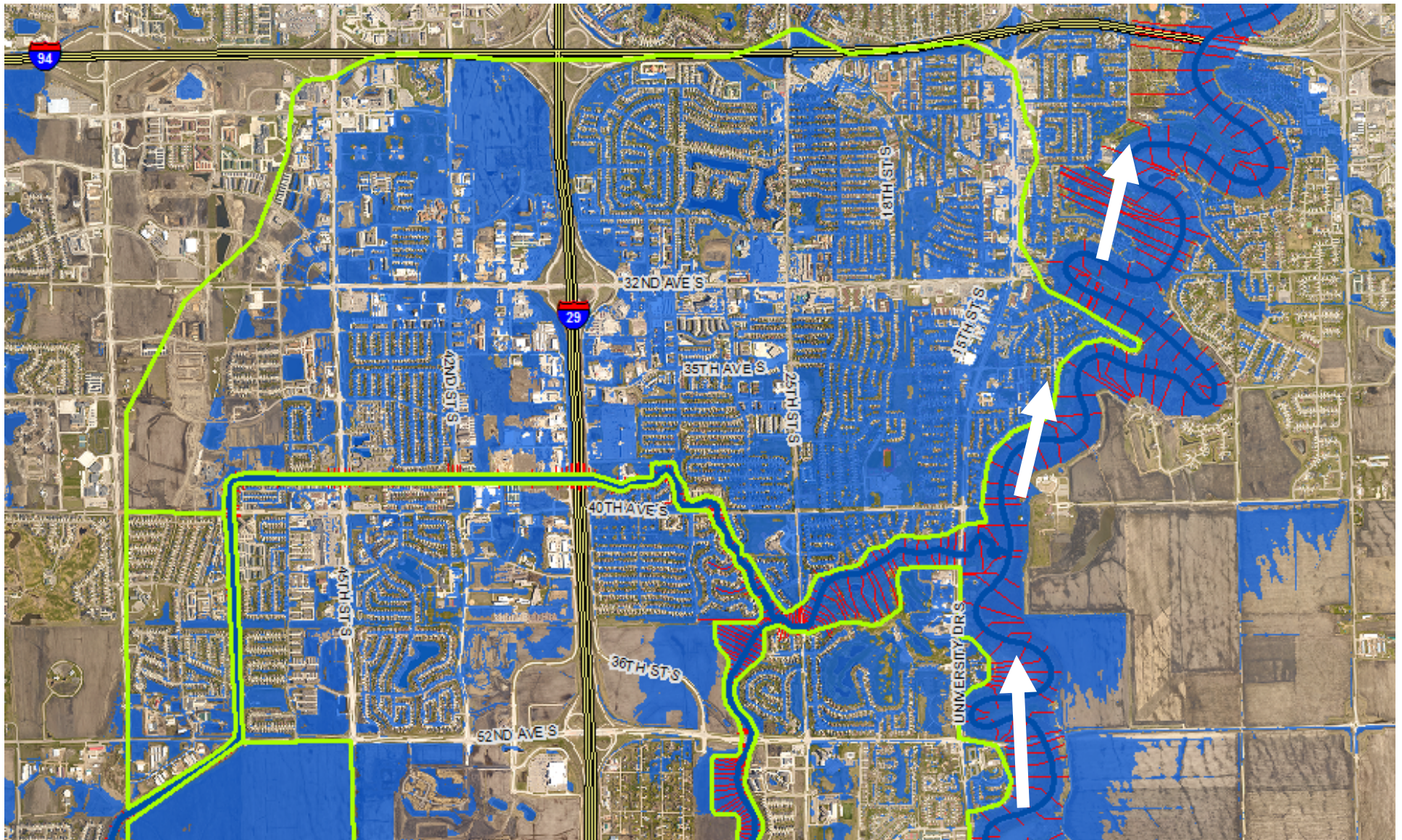
IMPACTS – ALL AREAS (1 – 5)



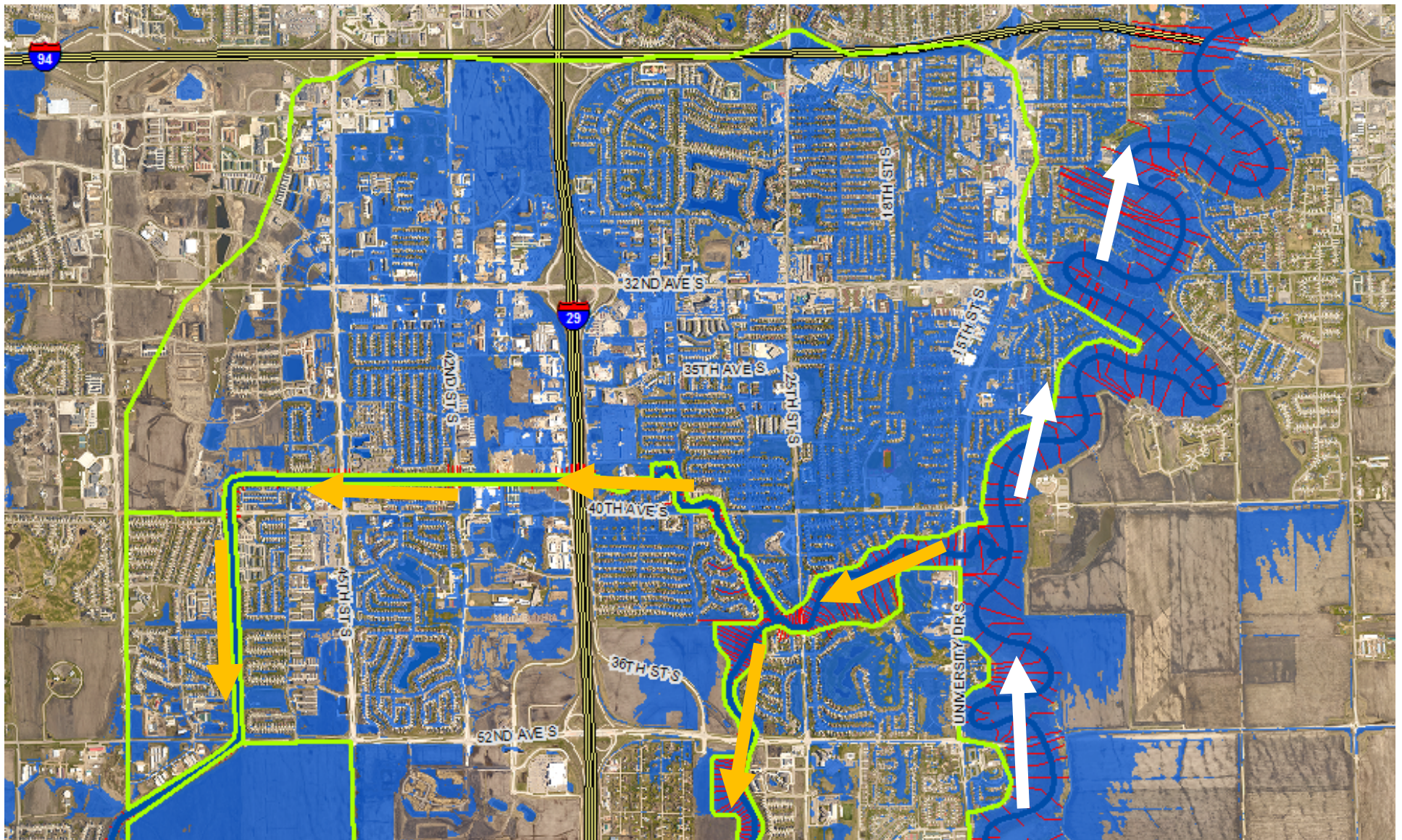
Newman Outdoor Field x 2100 ft high



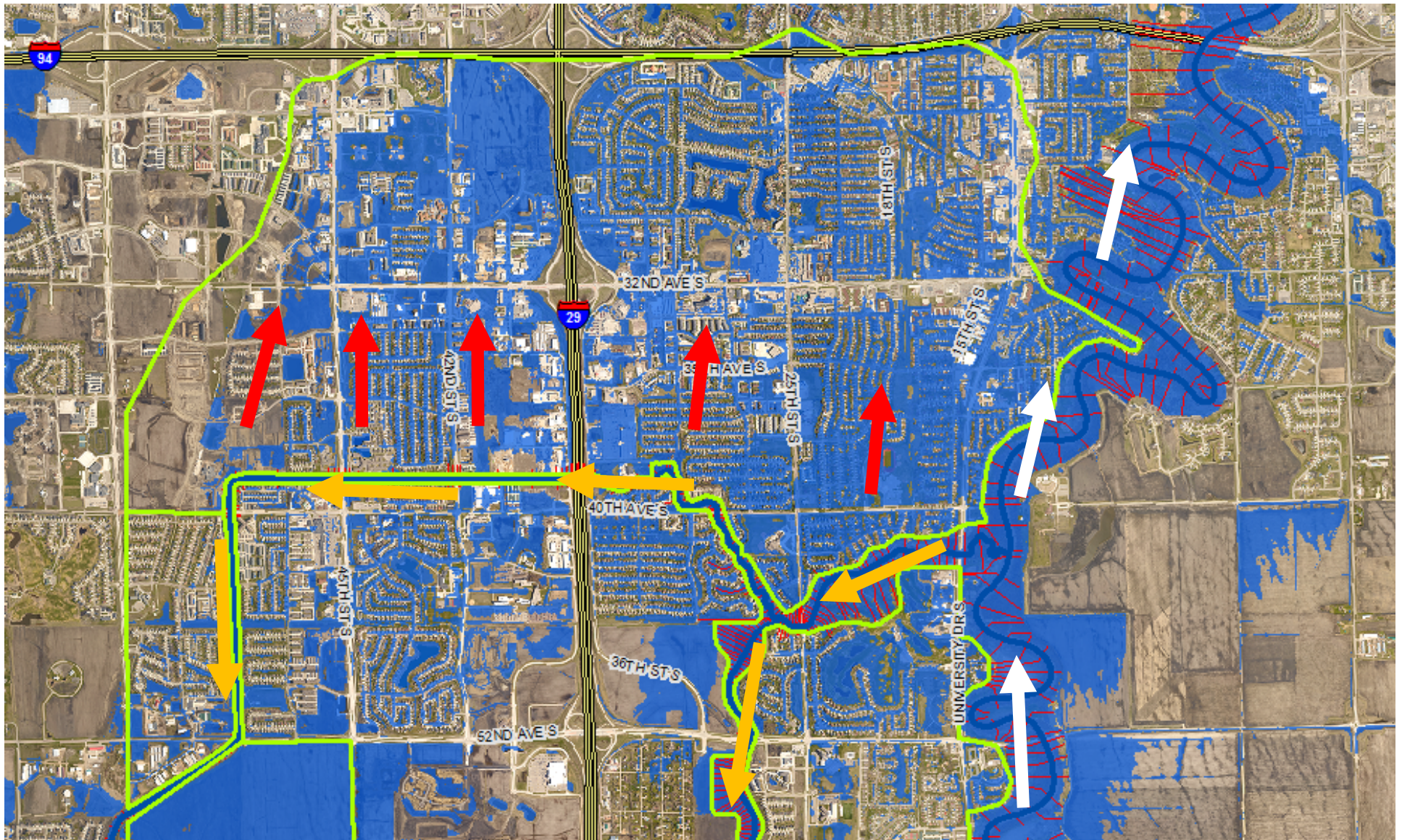
CONVEYANCE LOSS



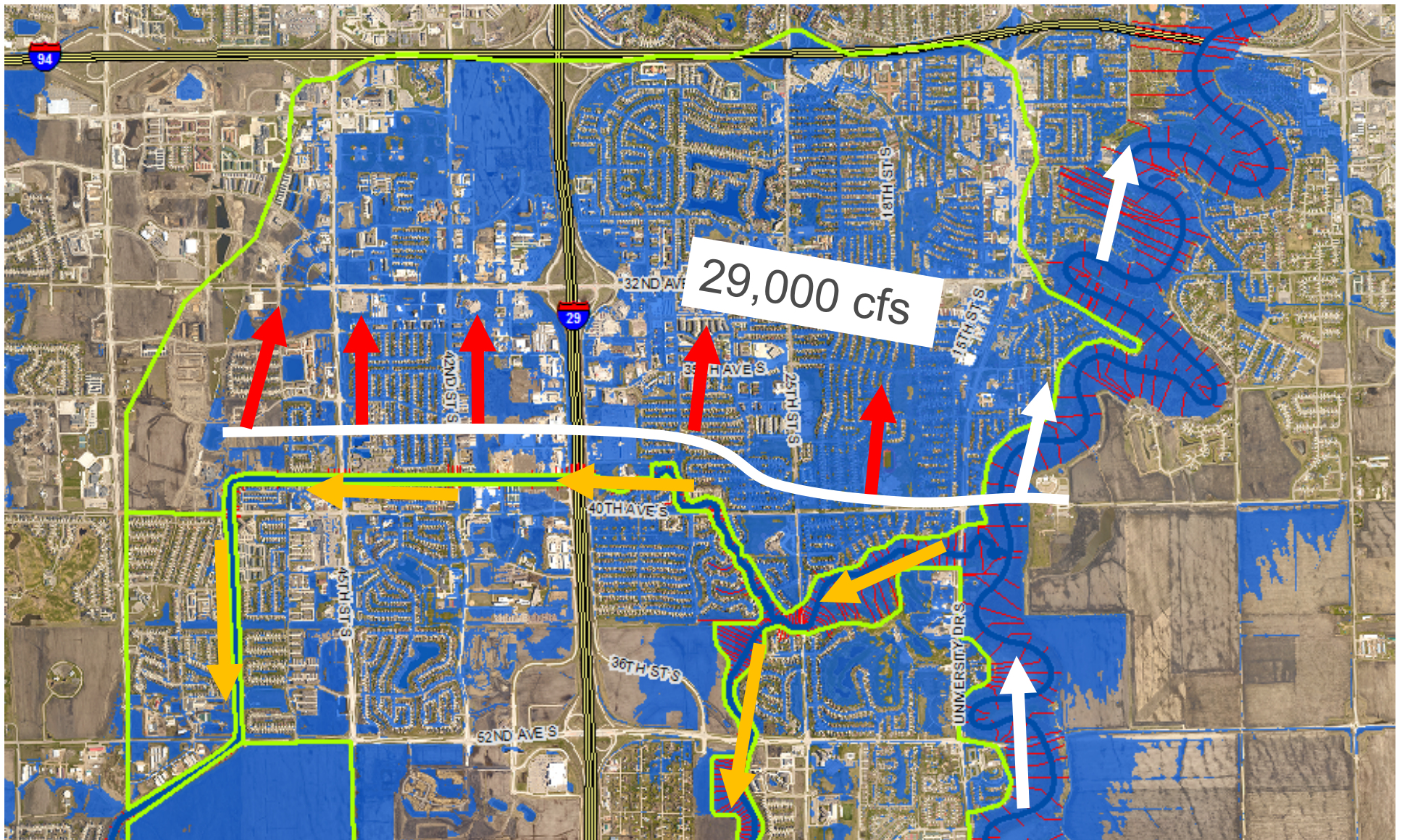
CONVEYANCE LOSS



CONVEYANCE LOSS



CONVEYANCE LOSS

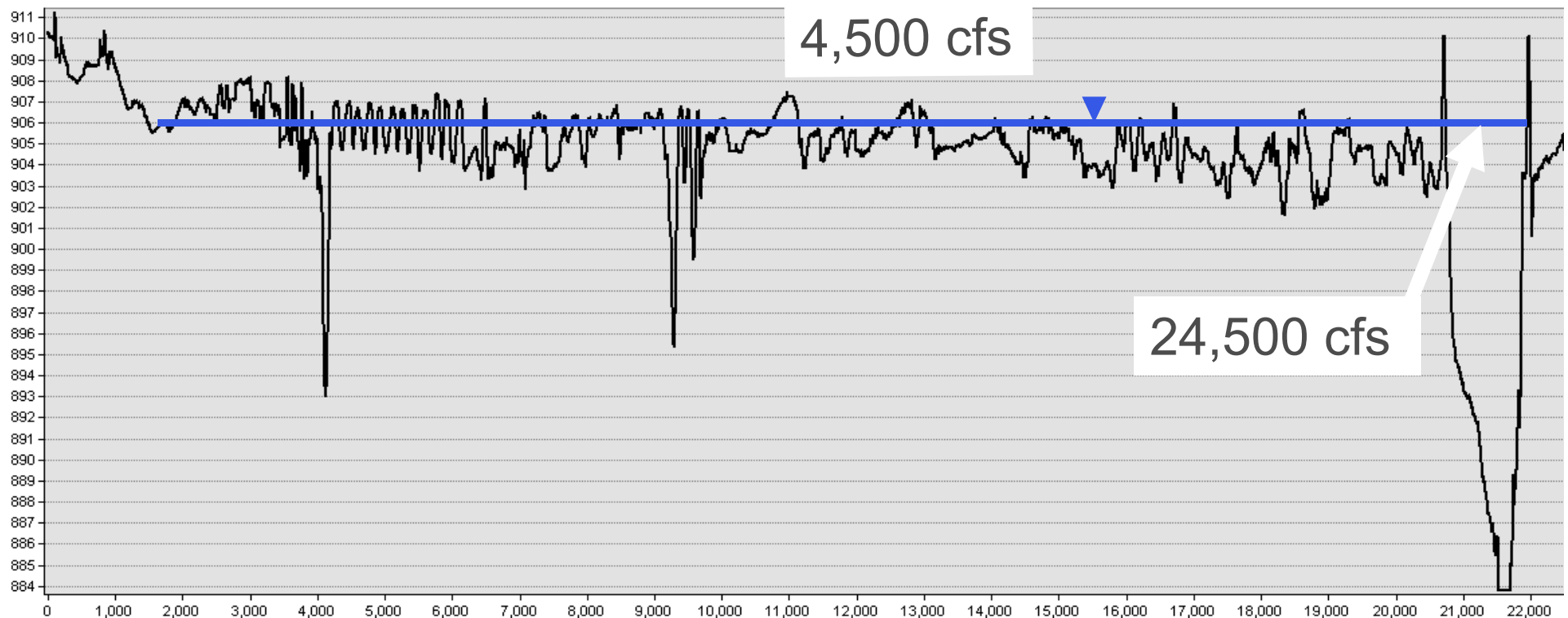


CONVEYANCE LOSS



Flow over entire width of floodplain

Total = 29,000 cfs

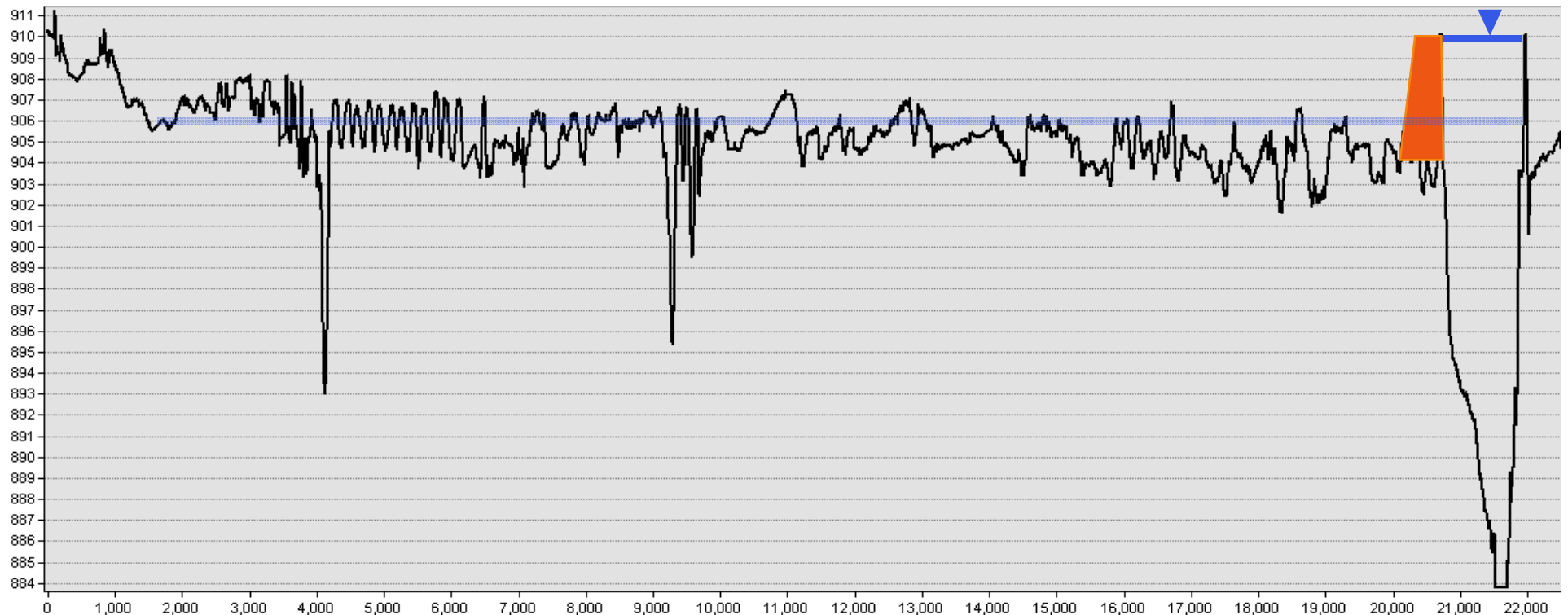


CONVEYANCE LOSS



Levee Construction
Forces flow between the levees
Results in a stage increase

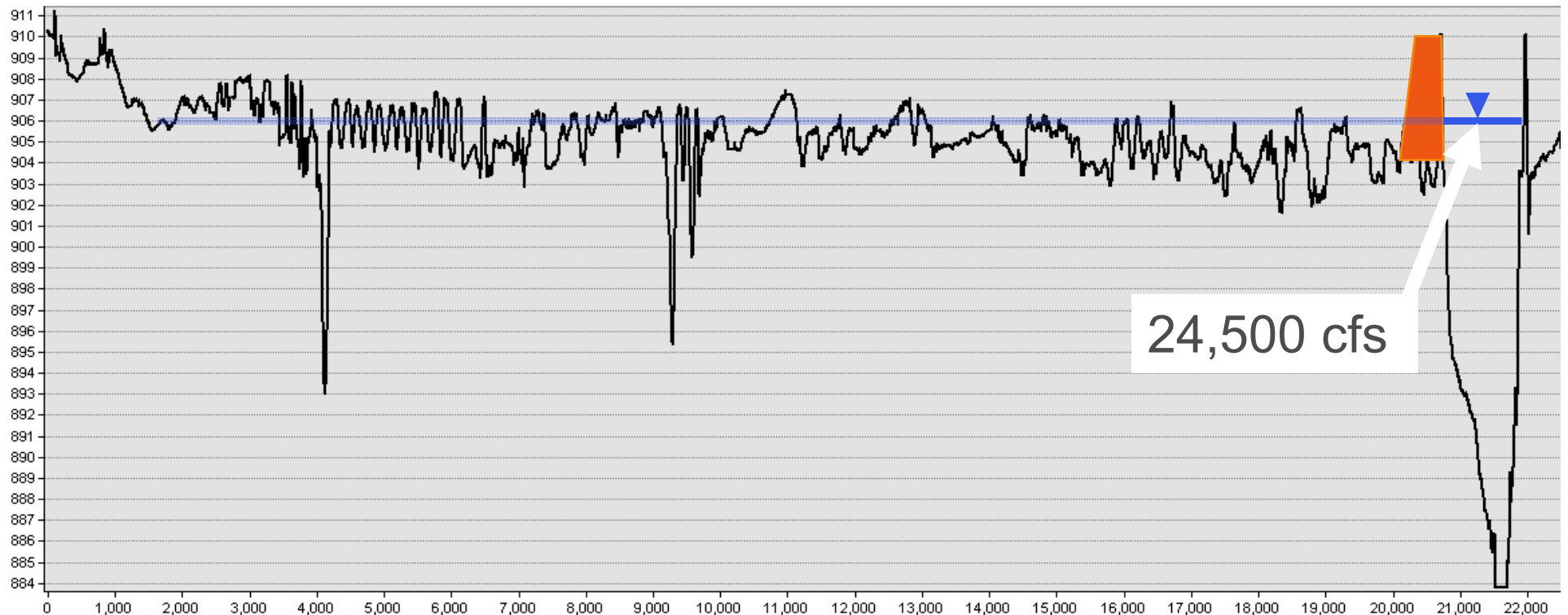
29,000 cfs



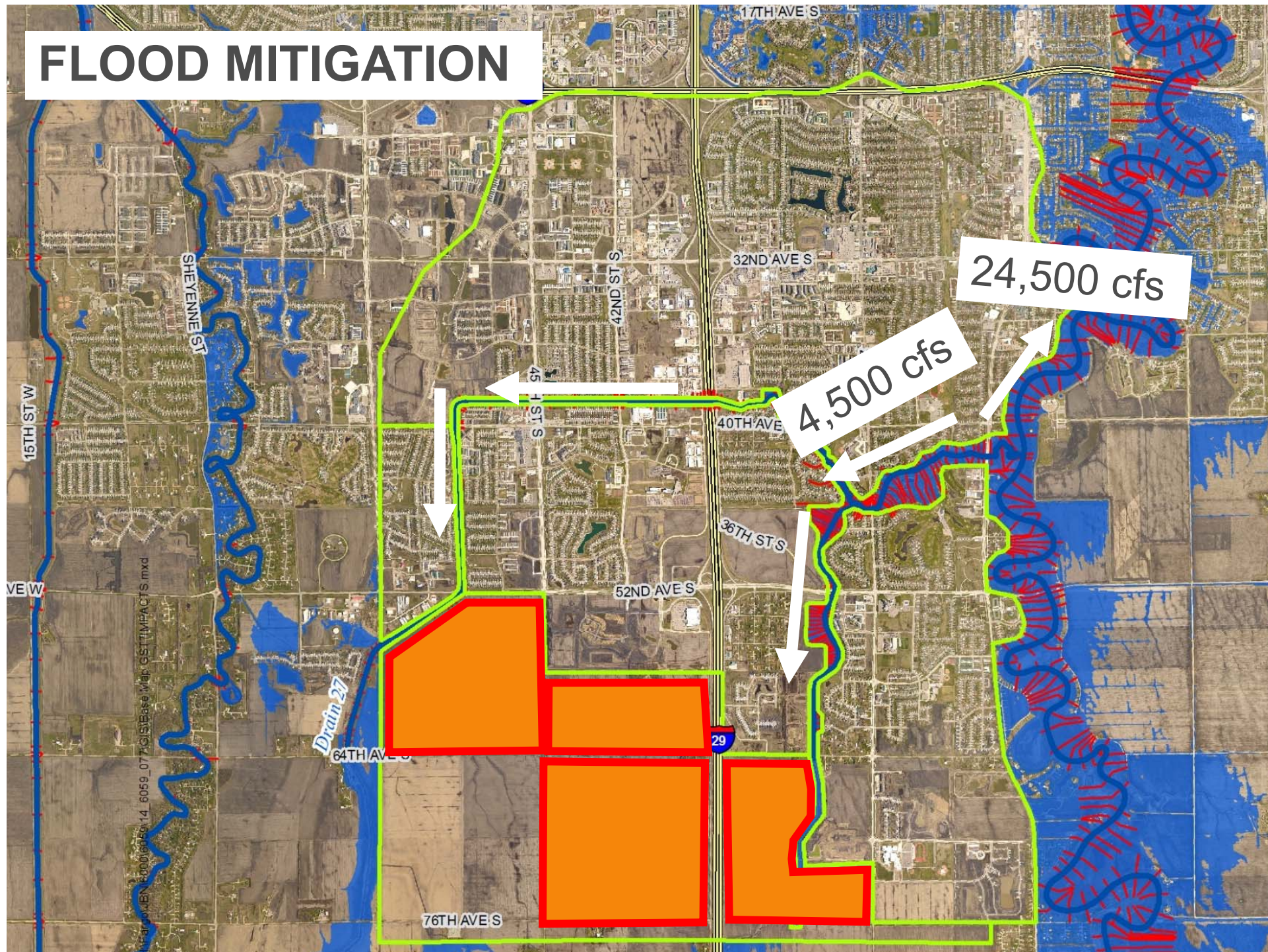
CONVEYANCE LOSS



Levee Construction
Forces flow between the levees
Results in a stage increase



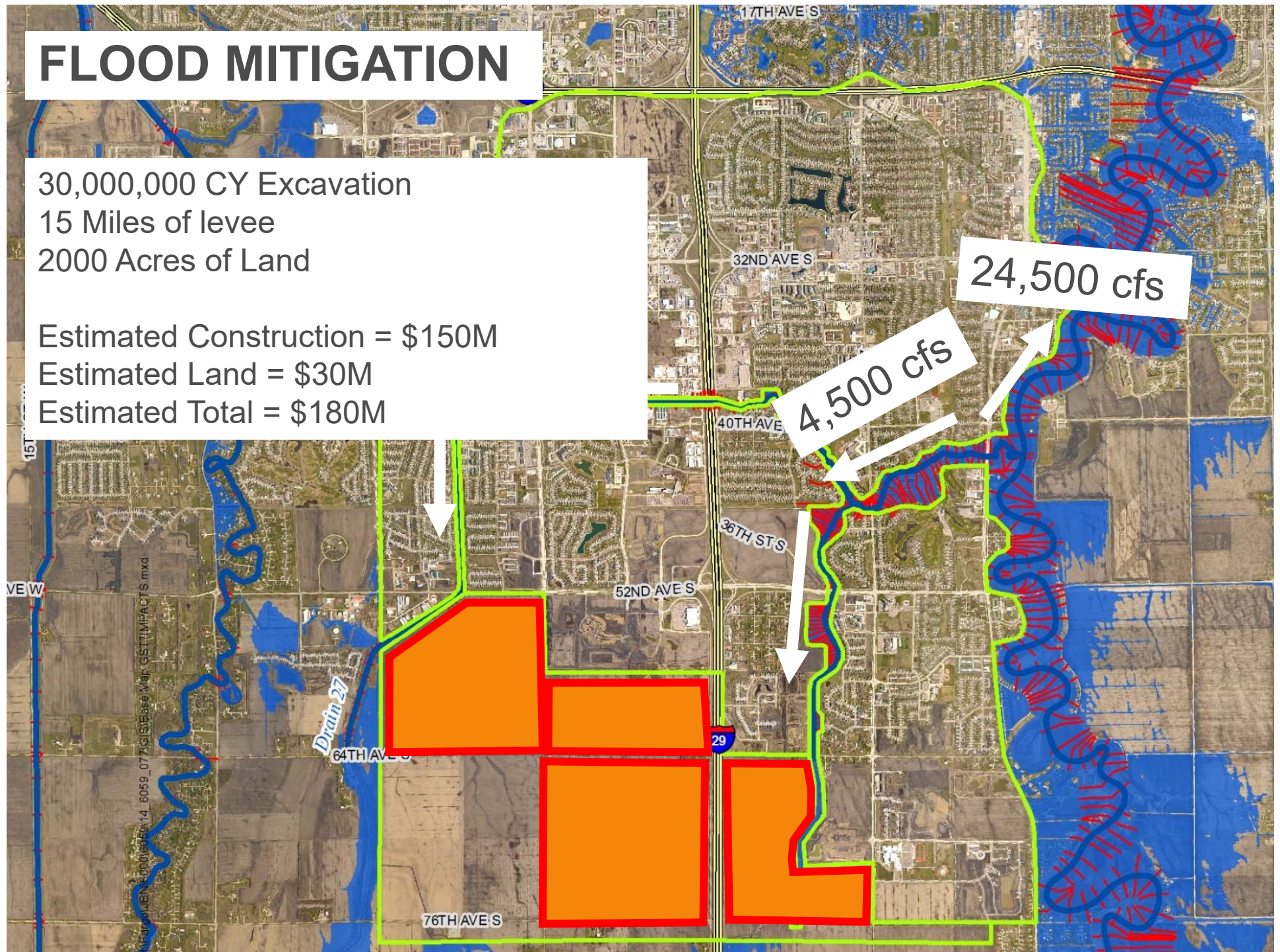
FLOOD MITIGATION



FLOOD MITIGATION

30,000,000 CY Excavation
15 Miles of levee
2000 Acres of Land

Estimated Construction = \$150M
Estimated Land = \$30M
Estimated Total = \$180M



ANALYSIS UPDATE

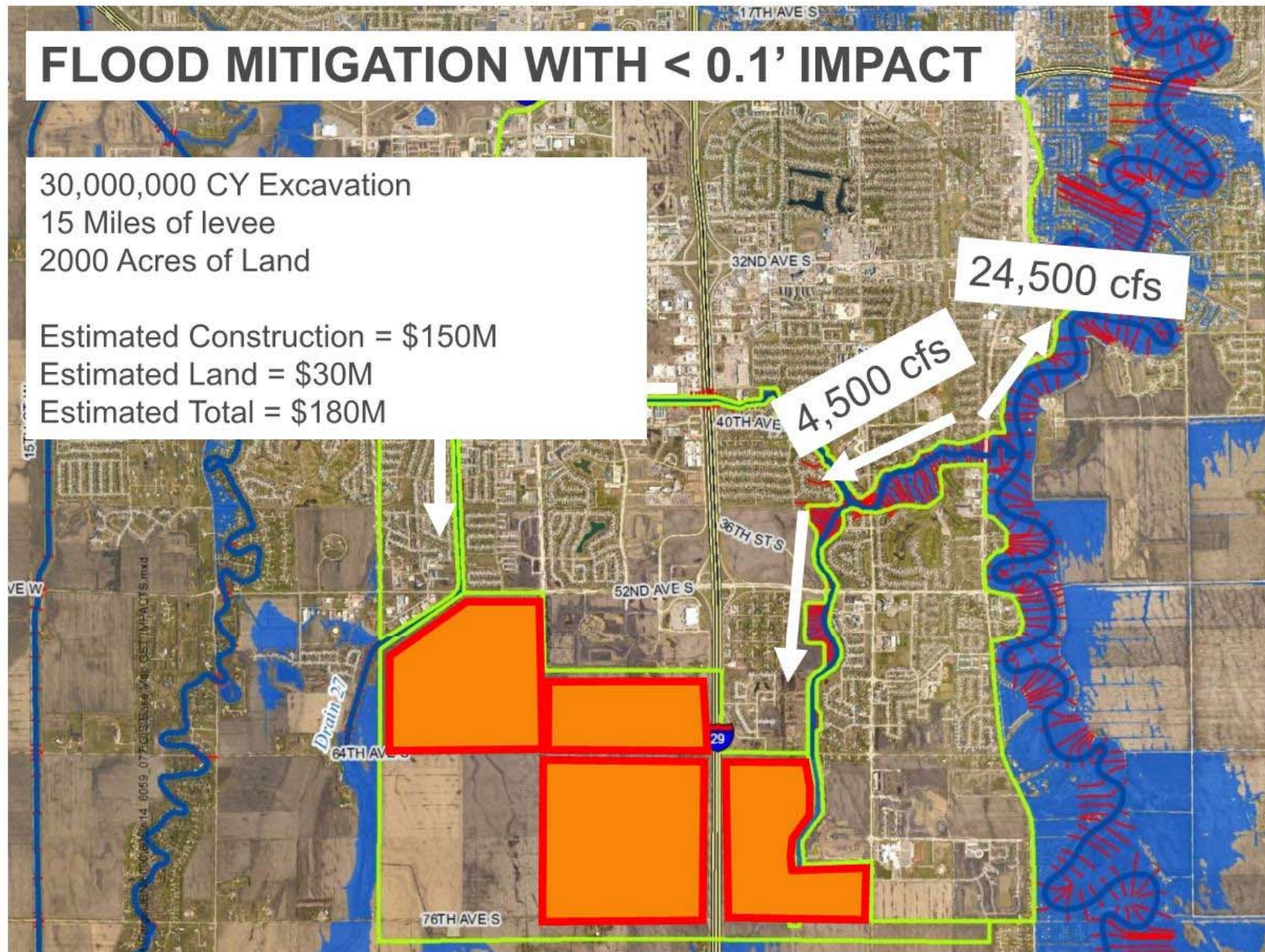
- Analysis to Date
- Uses latest FM Diversion model
 - Best Available
 - Model was developed for the larger scale project
 - Could be refined for this smaller scale project
- Plan to review model parameters
 - Detailed modeling to better reflect the isolated project area
 - Adjustments could result in 20-30% difference in results
 - Preliminary Results
- Level of Mitigation = 0.1ft vs. 0.5ft



FLOOD MITIGATION WITH $< 0.1'$ IMPACT

30,000,000 CY Excavation
15 Miles of levee
2000 Acres of Land

Estimated Construction = \$150M
Estimated Land = \$30M
Estimated Total = \$180M



FLOOD MITIGATION WITH < 0.5' IMPACT

20,000,000 CY Excavation
10 Miles of levee
1300 Acres of Land

Estimated Construction = \$100M
Estimated Land = \$20M
Estimated Total = \$120M

