Oak Grove Road over Unnamed Tributary to Lawrence Creek: Confluences, Urbanization, and Permitting

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Consulting Engineers

Agenda

1) Project Background
2) Project Need
3) Hydrologic Methodology
4) Hydraulic Methodology
5) Design Criteria
6) County Stormwater Management Permit
7) Wetland Permitting
8) Lessons Learned

Project Background

Client: McHenry County Division of Transportation

Project Location

- Oak Grove Road at Unnamed Tributary to Lawrence Creek
- Chemung Township – Unincorporated McHenry County

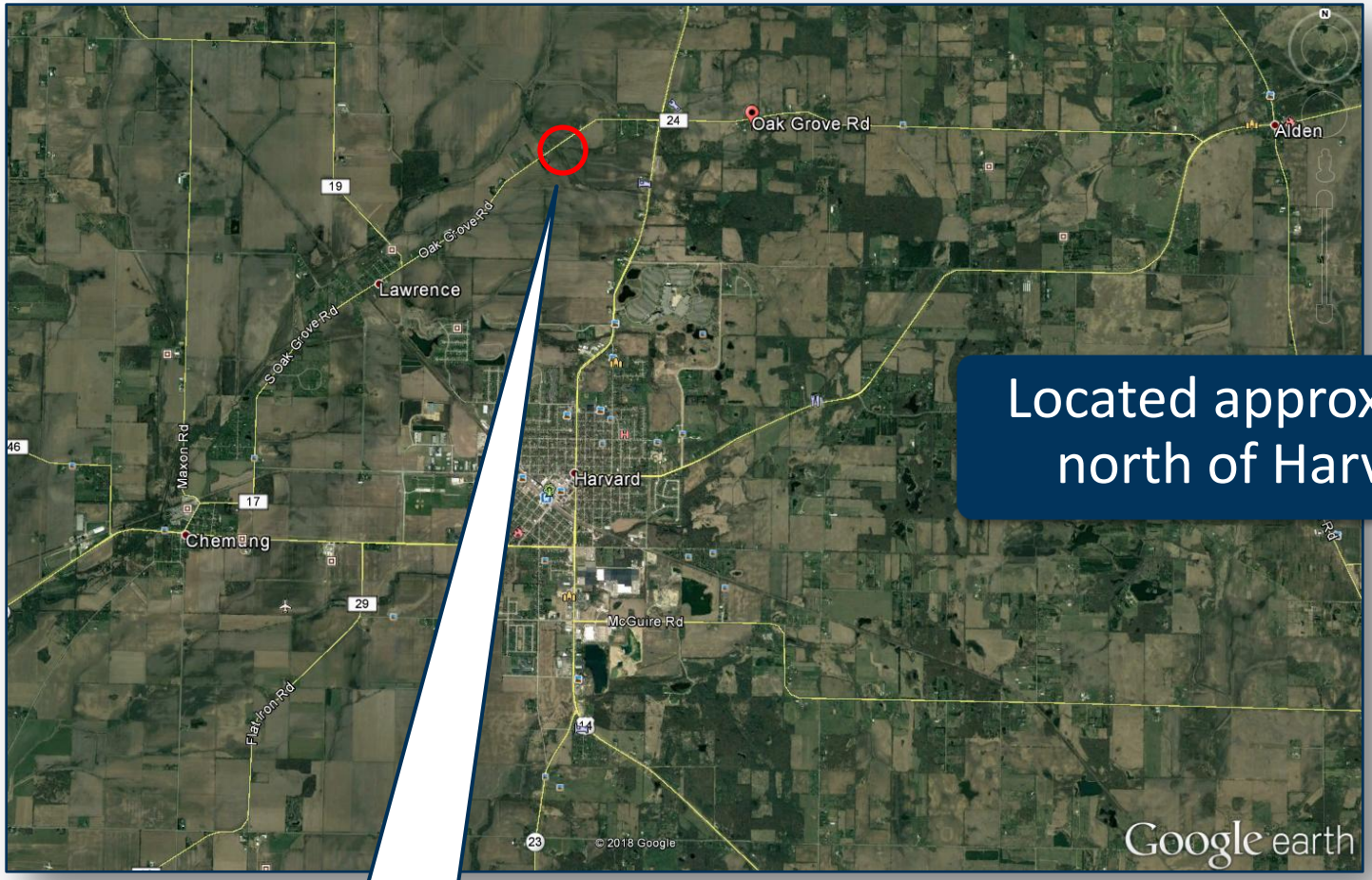
Project Improvements

- Bridge replacement (22’ Bridge to Triple 10’x7’ Culverts)
- Roadway widening
- Installation of Guardrail
- Ditch re-grading

Funding

- 80% Federal
- 20% Local (MCDOT)

Project Background

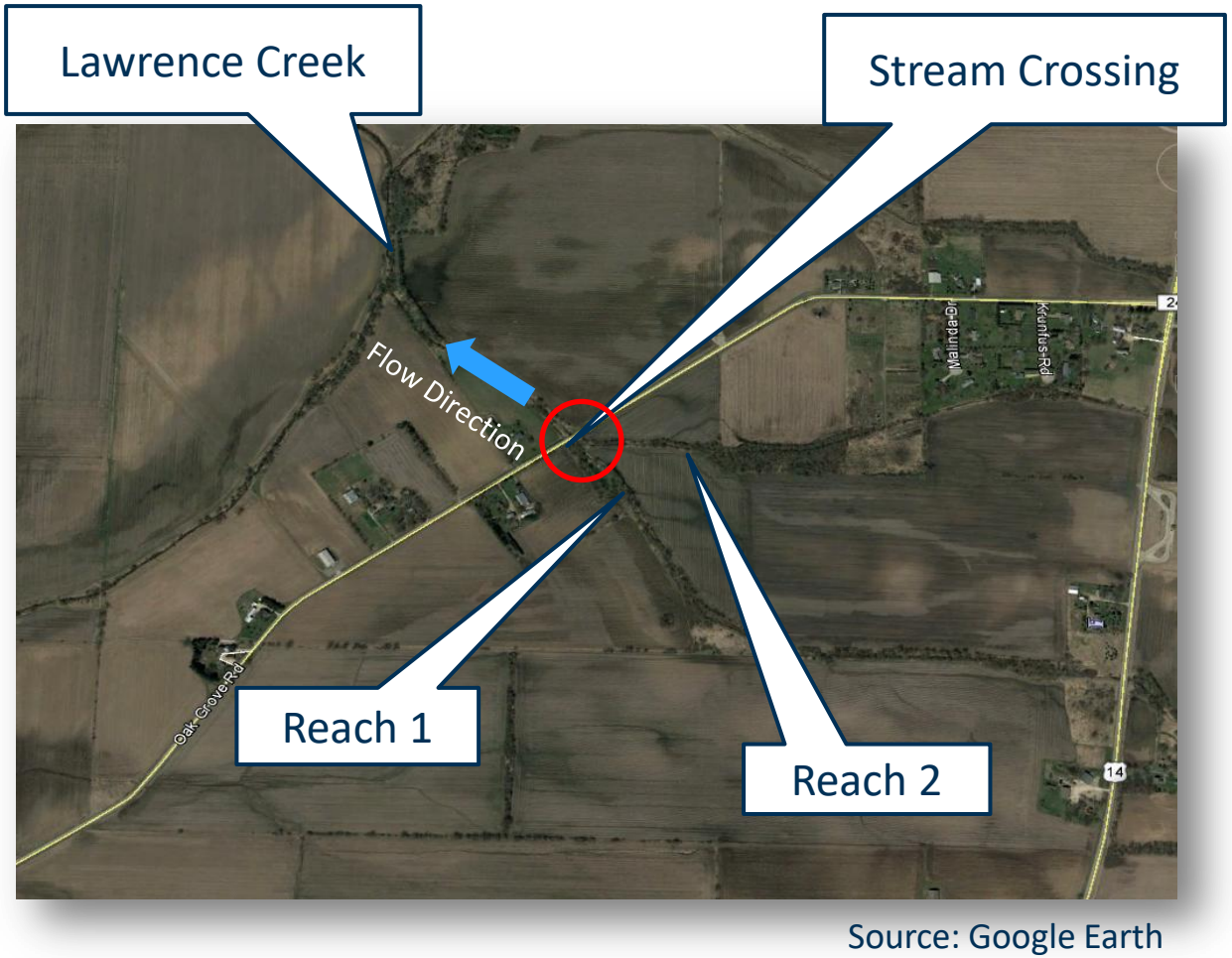


Located approx. 2 miles north of Harvard, IL

Source: Google Earth

Stream Crossing

Project Background



Source: Google Earth

- 2 stream branches converge into single stream approx. 70’ upstream of bridge crossing
- Approx. 1,700’ downstream of bridge crossing the stream flows into Lawrence Creek

Project Need

- Existing superstructure of bridge is structurally deficient
- Benefits of project include:
  - Safer movement of vehicular traffic
  - Reduced risk of flooding
  - Improvement in ride quality
  - Reduction of future maintenance costs

Project Need

- Phase I (2015) Scope to Determine:
  - Structure Type
  - Waterway Opening
  - Geometric Deficiencies
  - Cost
  - Required R.O.W.
  - Permitting Need

Project Need

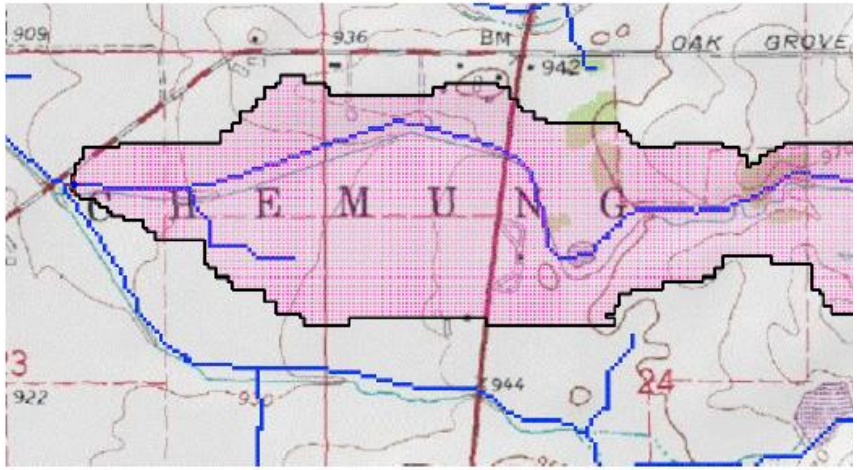
- Phase II (2017) Scope:
  - Detailed Design
  - Permitting
    - Issuance of Stormwater Management Permit / Approval of Hydraulics
    - County DOT
    - IDOT BLRS
    - USACE

Hydrologic Methodology

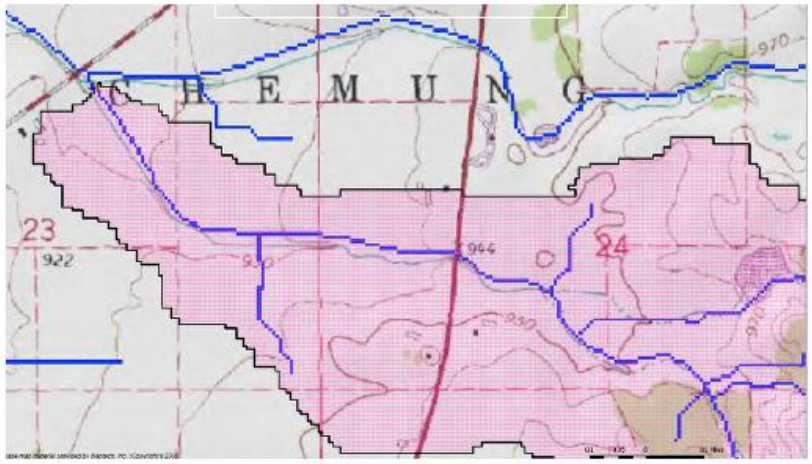
StreamStats

- Used to determine discharges (Rural Regression Equations)
- No regulatory data available
- Separate analyses for each reach upstream of the bridge

Reach 2 - Northern Reach



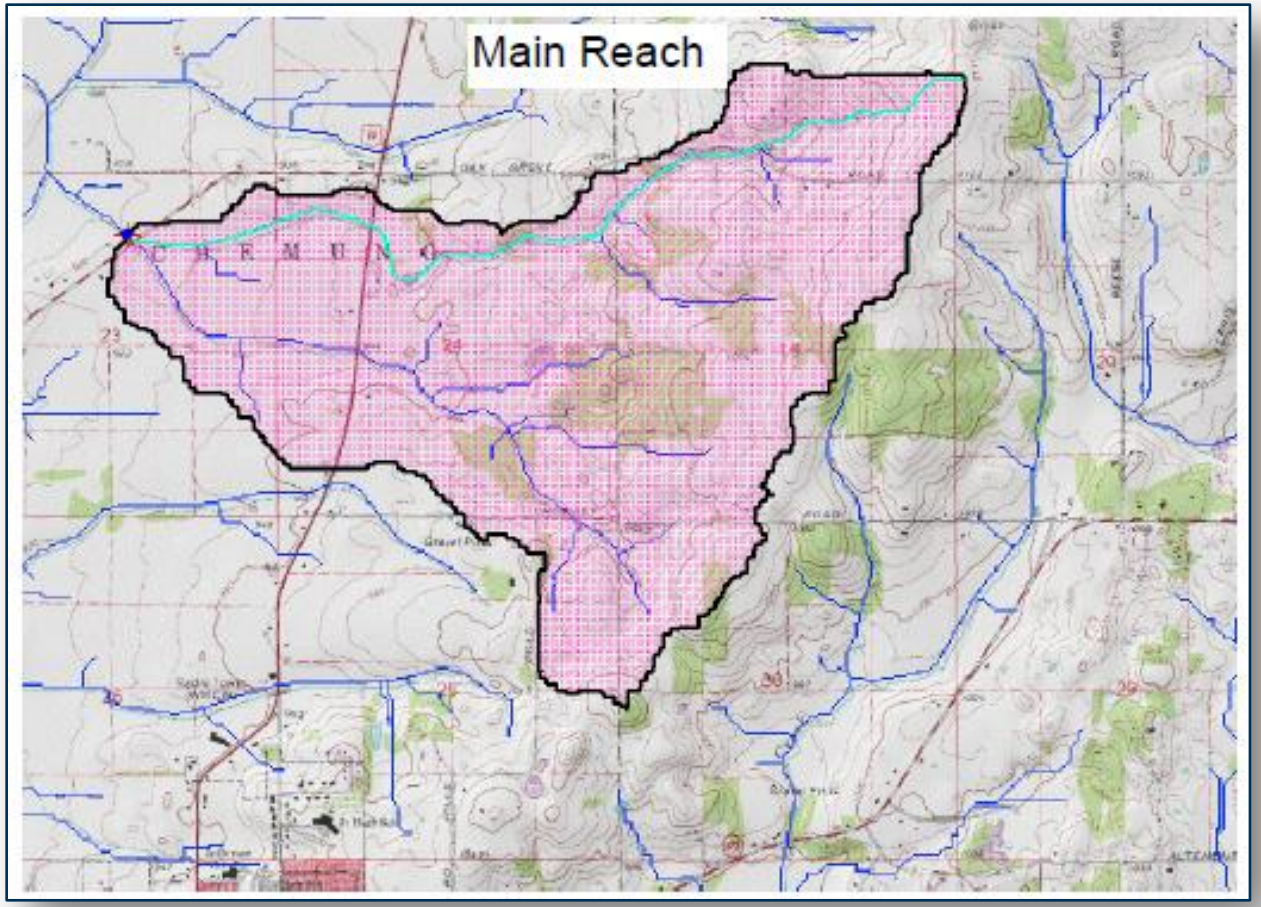
Reach 1 - Southern Reach



Source: USGS StreamStats

Hydrologic Methodology

StreamStats

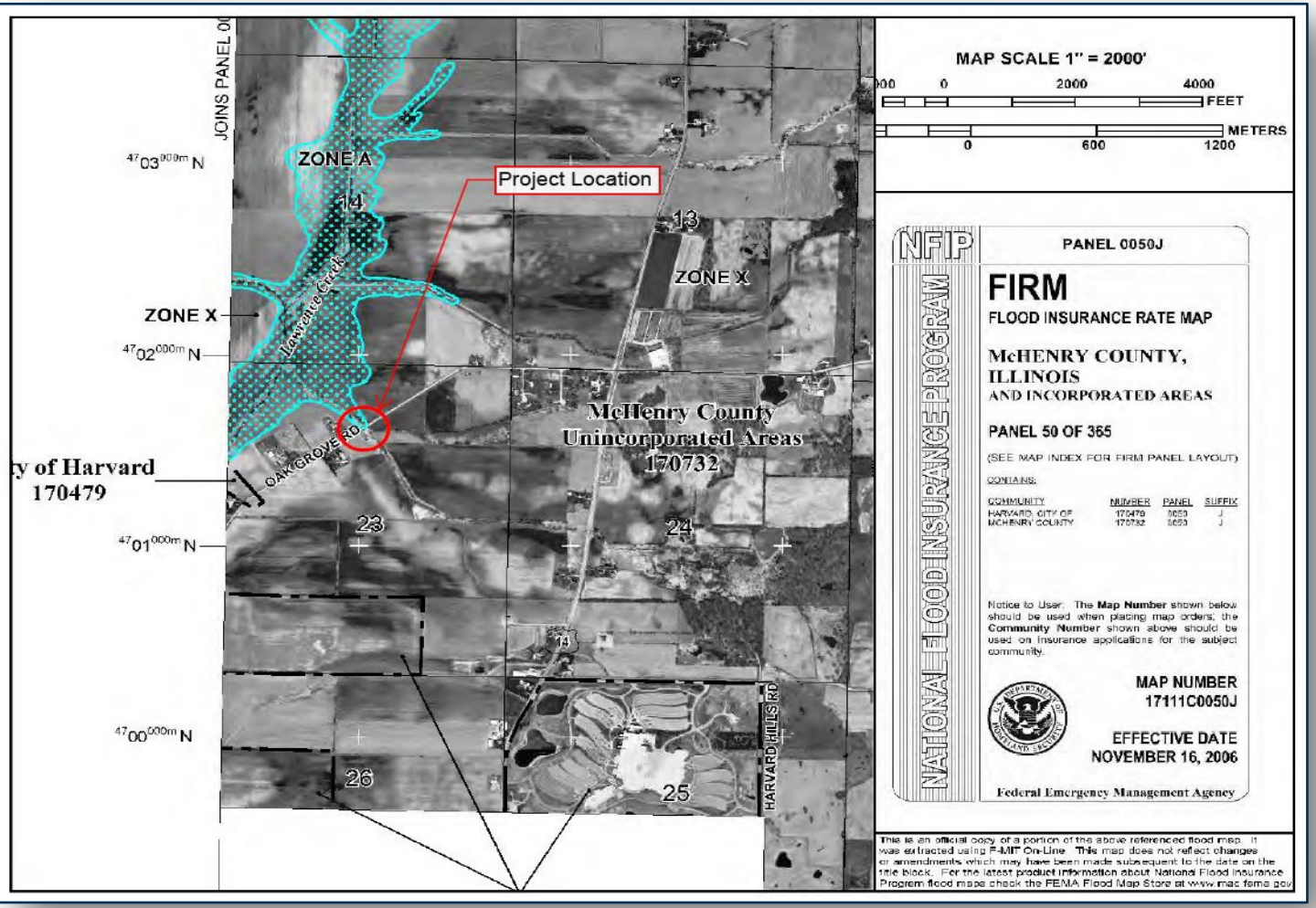


Source: USGS StreamStats

Separate StreamStats for stream downstream of confluence and upstream of bridge

Hydrologic Methodology

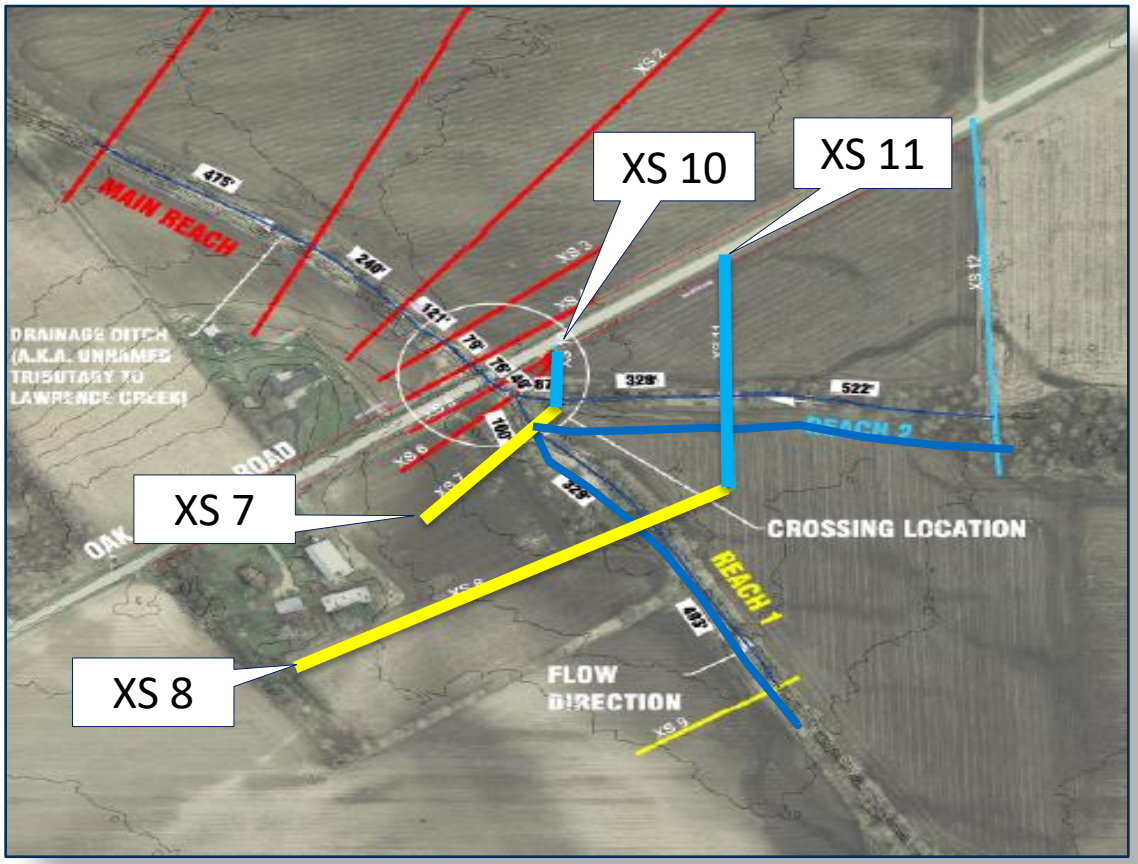
FEMA FIRM



- Zone A Floodplain immediately downstream
- No designated floodplain upstream

Hydrologic Methodology

HEC-RAS Flow Calibration – Iterative Process



XS 7, 8:

+66 cfs added to these sections

XS 10, 11:

-66 cfs subtracted from these sections

- XS 7 & 8 shared ground points with XS 10 & 11
- Iterative process to obtain matching Water Surface Elevations

Hydrologic Methodology

HEC-RAS Flow Calibration – Iterative Process

Flow Calibration

Oak Grove Rd. Bridge
EXISTING Reach 1

When change in elev crosses 0 (neg to pos)

Within a hundred

Reach 2

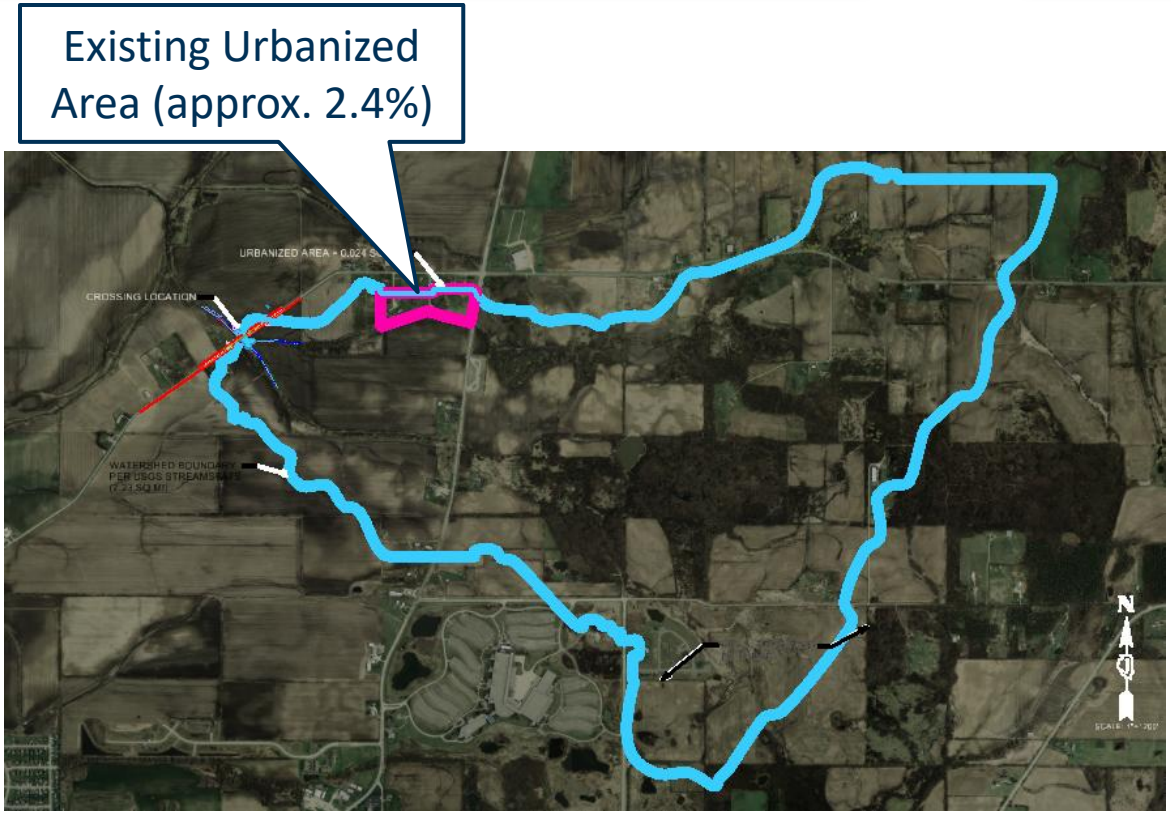
XS 7	Reach 1		XS 10	Reach 2		XS 7 - XS 10	XS 8	Reach 1		XS 11	Reach 2		XS 8 - XS 11	Change in flow from Streamstats Reach 1	Reach 2
Profile (YR)	Flow (cfs)	Elevation (ft)	Profile (YR)	Flow (cfs)	Elevation (ft)	Elevation (ft)	Profile (YR)	Flow (cfs)	Elevation (ft)	Profile (YR)	Flow (cfs)	Elevation (ft)	Elevation (ft)		
10	247	913.6825	10	239	913.6799	0.0026	10	247	915.2258	10	239	915.7674	-0.5416	0	0
20	304	914.1385	20	296	914.1226	0.0159	20	304	915.4846	20	296	915.8271	-0.3425	0	0
100	438	915.1086	100	429	915.0779	0.0307	100	438	915.8279	100	429	916.1062	-0.2783	0	0
200	498	915.5225	200	488	915.4894	0.0331	200	498	915.9354	200	488	916.2833	-0.3479	0	0
500	573	916.8276	500	564	916.8021	0.0255	500	573	916.8953	500	564	917.0653	-0.17	0	0
	20			-20				20			-20				
	5			-5				5							
10	**313**	913.68	10	177	913.68	0	10	313	915.52	10	**177**	915.43	0.0900	66	-62
20	**370**	914.13	20	234	914.1	0.03	20	370	915.69	20	**234**	915.56	0.1300	66	-62
100	**505**	915.11	100	368	915.09	0.02	100	505	915.94	100	**368**	915.94	0.0000	67	-61
200	**567**	915.56	200	431	915.53	0.03	200	567	916.02	200	**431**	916.19	-0.1700	69	-57
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
10	347		10	139		0	10	347	915.6362	10	139	915.0872	0.549	100	-100
20	404		20	196		0	20	404	915.7689	20	196	915.2971	0.4718	100	-100
100	538		100	329		0	100	538	915.9833	100	329	915.8237	0.1596	100	-100
200	598		200	388		0	200	598	916.0542	200	388	916.0922	-0.038	100	-100
500	673		500	464		0	500	673	916.9177	500	464	916.994	-0.0763	100	-100
	10			-10				10			-10				
10	357	913.6557	10	129	913.7007	-0.045	10	357	915.6614	10	129	914.9786	0.6828	110	-110
20	414	914.1469	20	186	914.1341	0.0128	20	414	915.7891	20	186	915.2147	0.5744	110	-110
100	548	915.1008	100	319	915.0862	0.0146	100	548	915.9965	100	319	915.7919	0.2046	110	-110
200	608	915.5175	200	378	915.4974	0.0201	200	608	916.0658	200	378	916.0709	-0.0051	110	-110
500	683	916.825	500	454	916.8096	0.0154	500	683	916.9202	500	454	916.988	-0.0678	110	-110

- Reach 1 – approx. 66 cfs added: 10yr: 247 cfs ⇨ 313 cfs
- Reach 2 - approx. 66 cfs subtracted: 10yr: 239 cfs ⇨ 177 cfs

Hydrologic Methodology

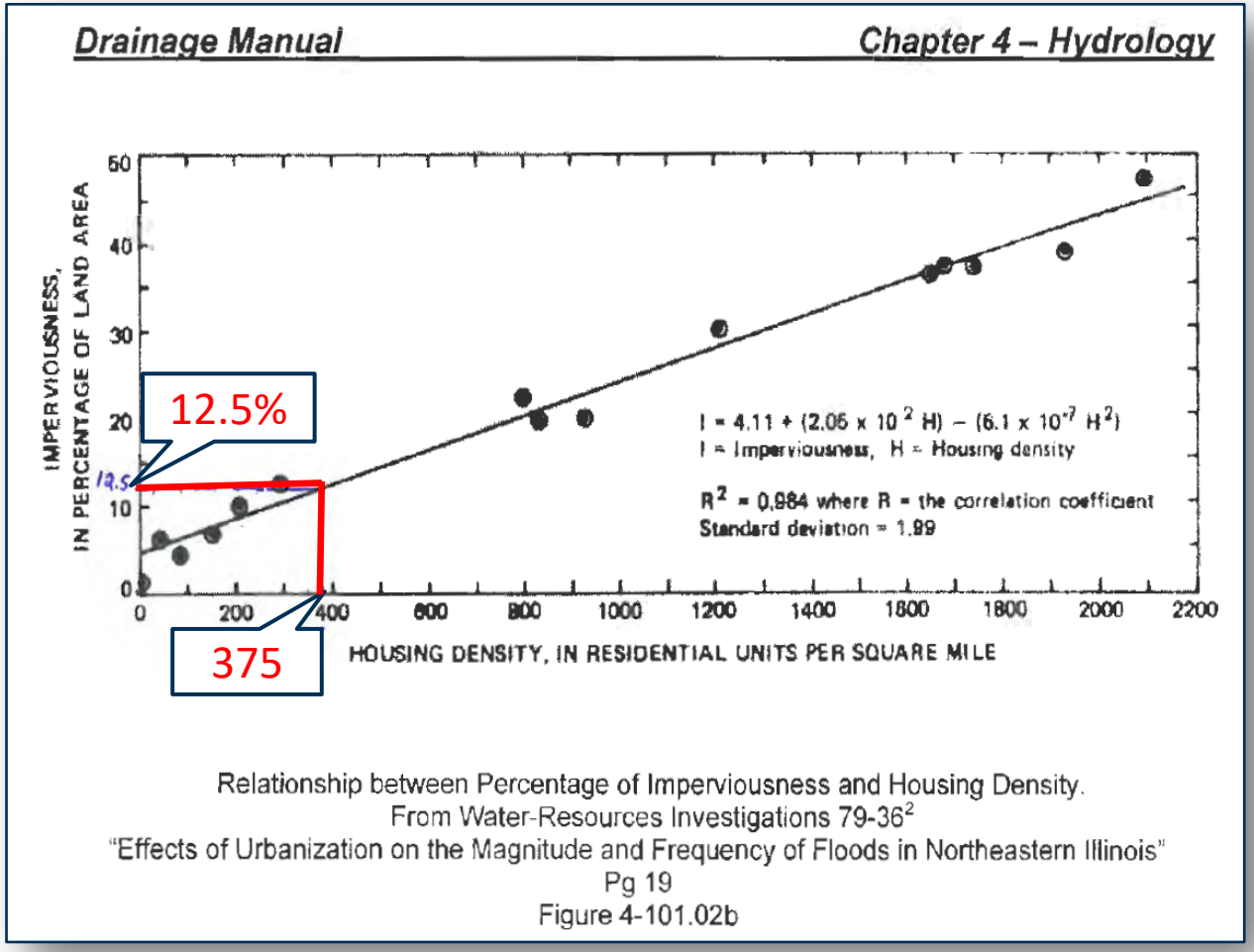
Urbanization

- Account for existing urbanized/developments in the watershed
- Urban Technique to convert rural regression eqn's (StreamStats) to urbanized flows
- 0.024 sq.mi. out of 1.01 sq.mi for 2.4%



Hydrologic Methodology

Percent Imperviousness within urbanized area – 12.5%

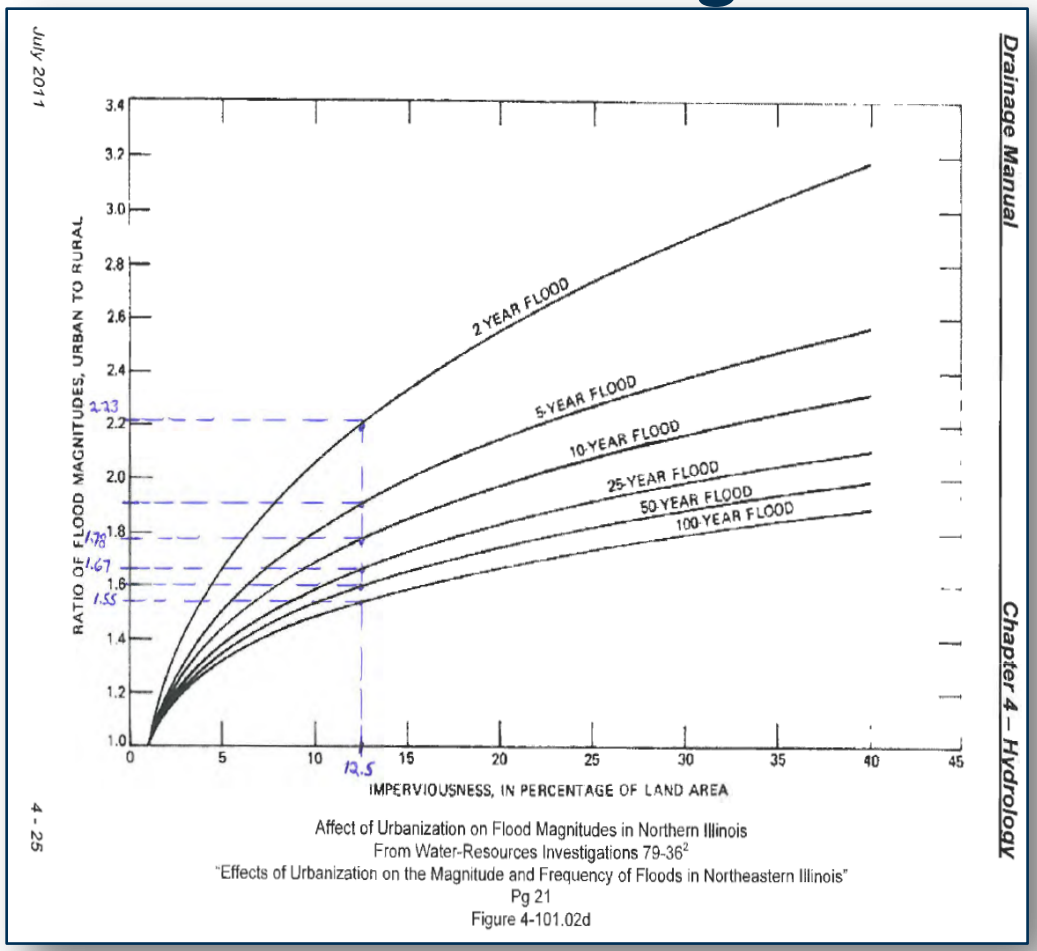


- 9 residential units within 0.024 sq.mi. urbanized area, which is 375 residential units per sq.mi.
- 375 residential units per sq.mi. equates to 12.5% imperviousness within urbanized area

Figure 4-101.02b – IDOT Drainage Manual

Hydrologic Methodology

Ratio of Flood Magnitudes for Flood Frequency



Affect of Urbanization on Flood Magnitudes in Northern Illinois
From Water-Resources Investigations 79-36[2]
"Effects of Urbanization on the Magnitude and Frequency of Floods in Northeastern Illinois"
Pg 21
Figure 4-101.02d

- 2.23 for 2-yr flood
- 1.78 for 10-yr flood
- 1.67 for 25-yr flood
- 1.60 for 50-yr flood
- 1.55 for 100-yr flood

Figure 4-101.02d - IDOT Drainage Manual

Hydrologic Methodology

Determination of Urbanized Flow

Converted StreamStats Flow Rates

Reach 2 (northern reach)

Storm Event	StreamStats Flows, cfs	2.4% of StreamStats Flows	Ratio of Flood Magnitudes	Urbanized Flows, cfs	Adjusted Rural Flows, cfs	Revised Flows, cfs	**Increase in Flow from Original StreamStats Flow, cfs**
	A	B	C	D = BxC	E = A*(1-0.024)	F = D+E	**G = F-A**
2-yr	101	2	2.23	5	99	104	**3**
10-yr	239	6	1.78	10	233	243	**4**
20-yr	296	7	N/A.	N/A.	289	300 *	**4**
25-yr	314	8	1.67	13	306	319	**5**
50-yr	373	9	1.60	14	364	378	**5**
100-yr	429	10	1.55	16	419	435	**6**
200-yr	488	12	N/A.	N/A.	476	500 *	**12**

Source: Google

Urbanized Flow Rates applied to Reach 2 (Northern Reach Only)

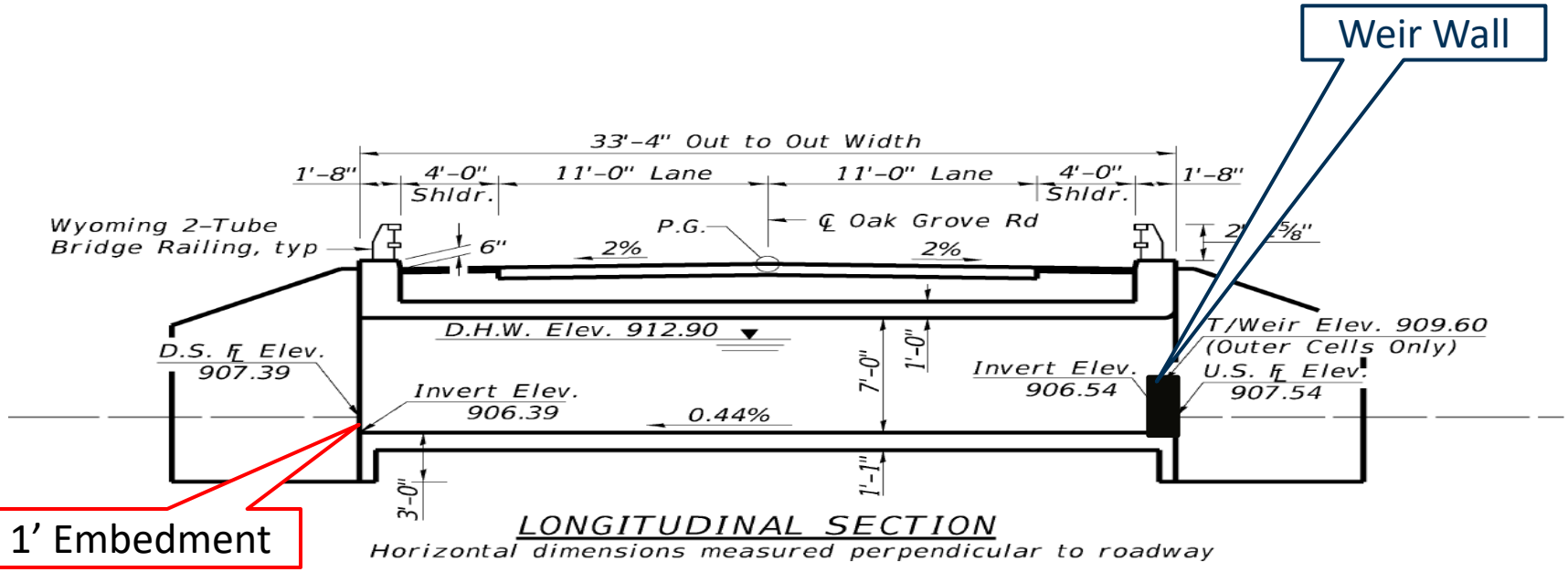
10-yr: 4 cfs added to original StreamStats rural flow

100-yr: 6 cfs added to original StreamStats rural flow

Hydraulic Methodology

HEC-RAS used for Hydraulics

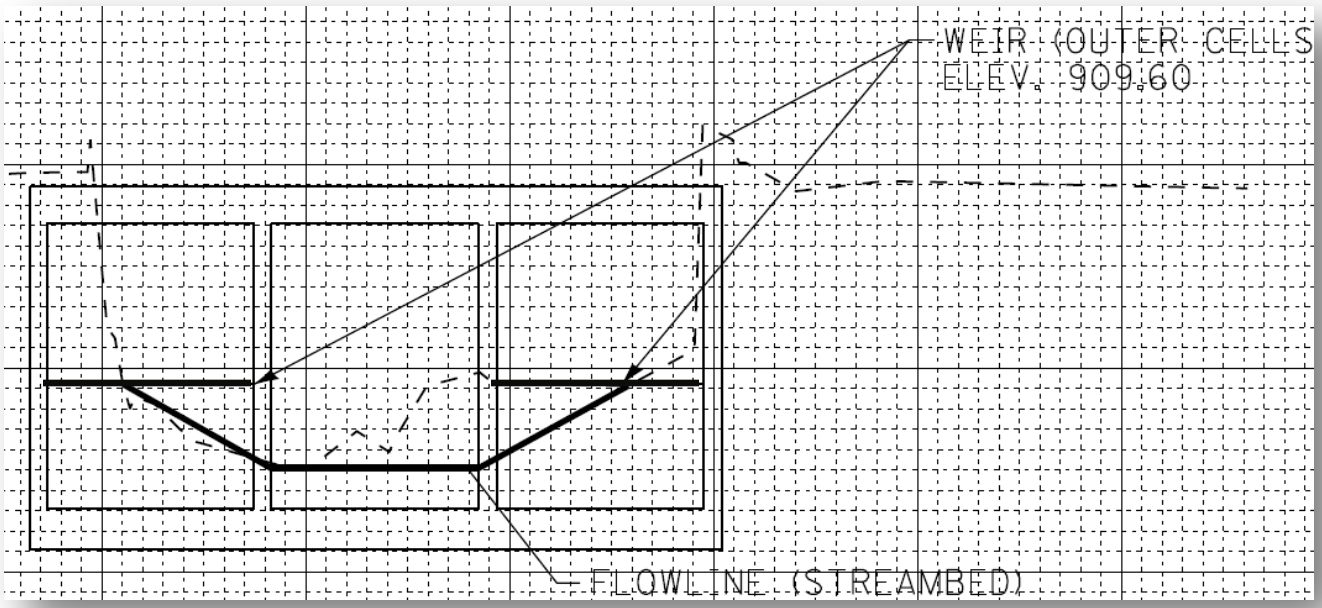
- Existing, Natural, and Proposed Conditions Modeled
- Proposed Conditions: 1’ Embedment and 2’ weir walls
- No HEC-18 scour analysis required



Hydraulic Methodology

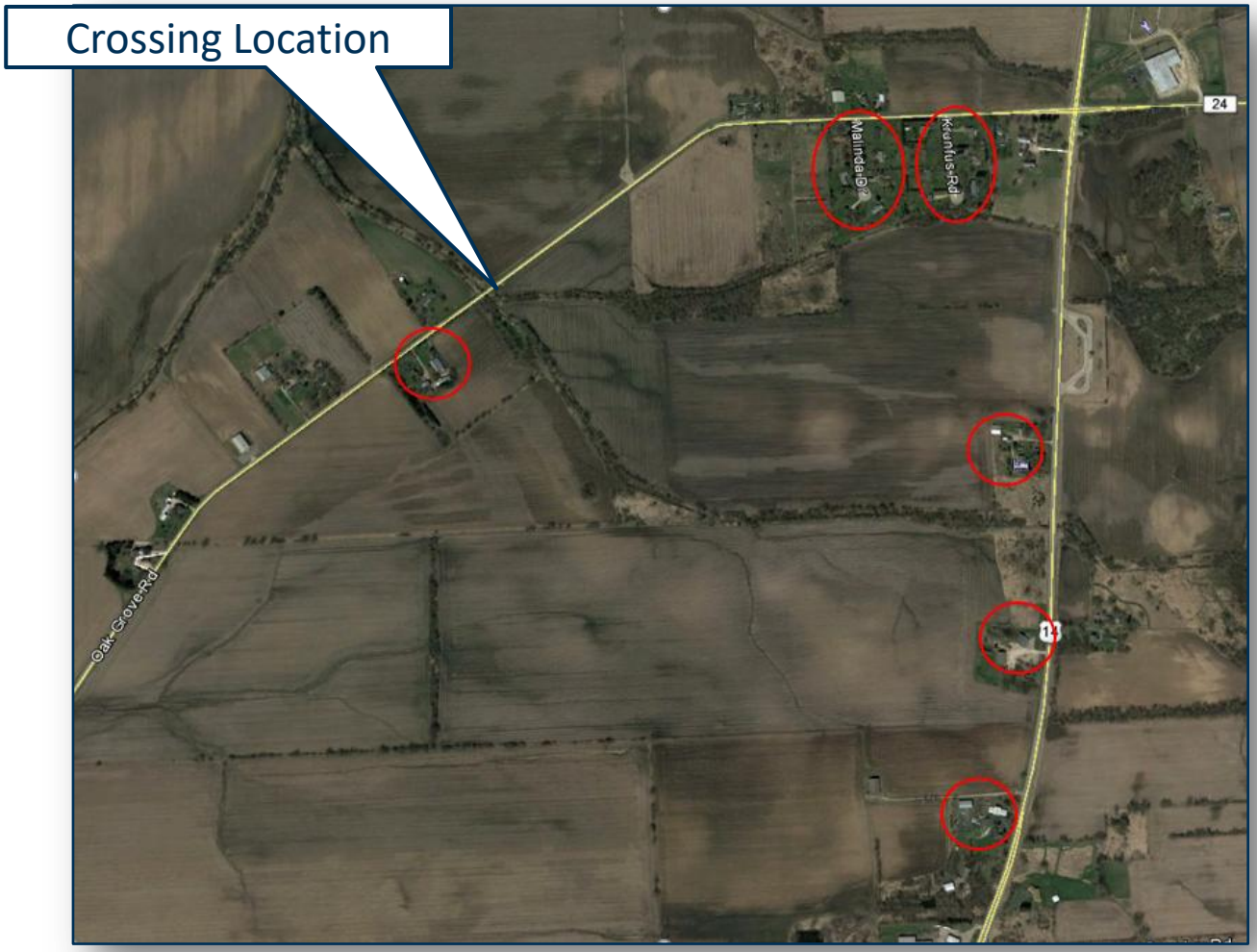
HEC-RAS used for Hydraulics

- Weir walls modeled using Depth Blocked function
- Manning's roughness (n) for natural bottom
- Weir walls conform to stream geometry at overbanks



Design Criteria

Assessment of Sensitive Flood Receptors



Upstream homes assessed for flooding due to backwater

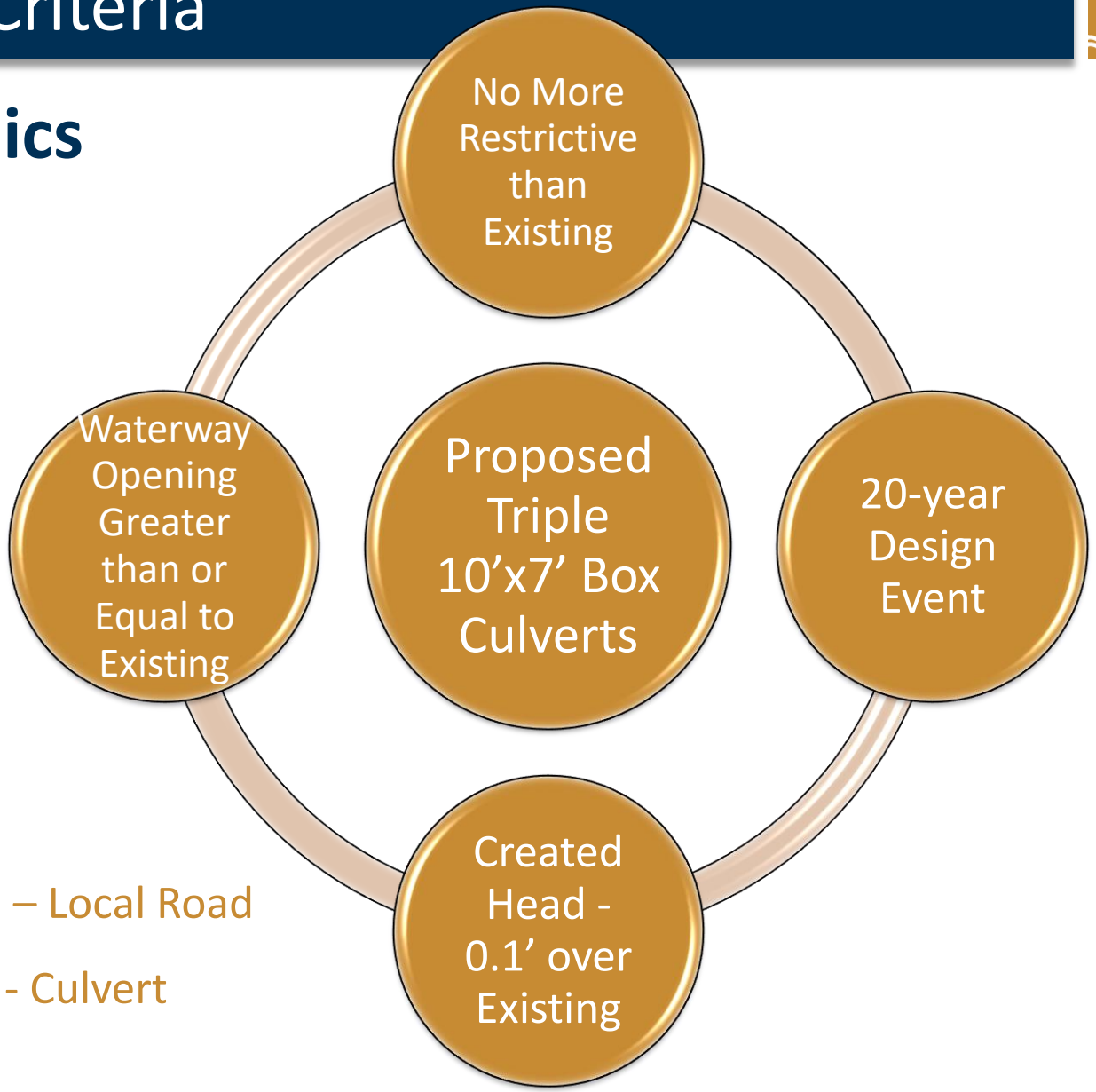
No homes in danger of flooding

Bridge not source of flood damage, as certified by Chemung Township

Source: Google Earth

Design Criteria

Hydraulics



- No Freeboard – Local Road
- No Clearance - Culvert

County Stormwater Management Permit

Will this project require a Floodway Construction Permit?

Non-designated floodway

- IDOT will not issue Floodway Construction Permit

Watershed classified as rural and less than 10 sq mi.

- IDNR does not have jurisdiction, therefore Construction Permit is not needed

McHenry County Dept. of Planning and Development review

- Issue County Stormwater Management Permit

County Stormwater Management Permit

McHenry County Department of Planning & Development

- Compensatory Storage required for fill within the floodplain
- Insufficient Compensatory Storage for 10-yr to 100-yr
- A Request for Waiver from compensatory storage requirement for 10-100 yr floodplain cut
- Waiver request granted by McHenry County

Permanent Impacts to Waters of the U.S.

- Impacts to wetlands
- Permanent Impacts to WOUS = 0.06 acres
- Compensatory mitigation not required (USACE) since < 0.10 acres
- IDOT required mitigation, which was done through wetland banking

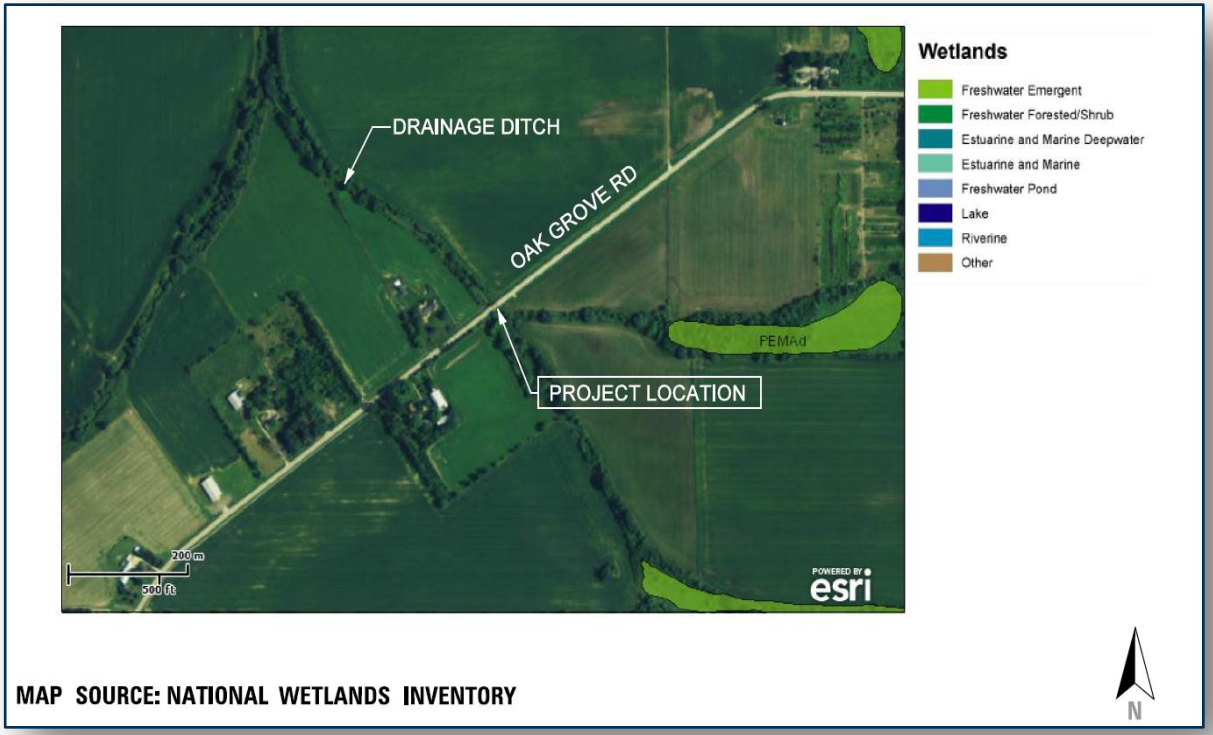
Wetland Permitting

- Minimize impacts by:
  - Maintaining alignment of channel with proposed culverts
  - Embedment of culvert – low flow fish passage (bridge to culvert)
- RP3 (Transportation Projects) and RP7 (Temporary Construction Activities) of the Regional Permit Program by USACE

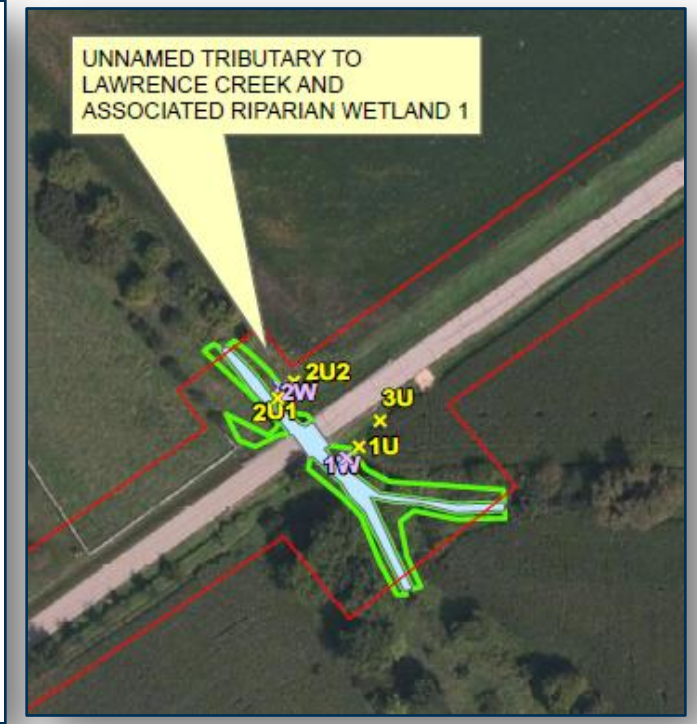
Source: Google

Wetland Permitting

National Wetlands Inventory Map vs Delineated Wetlands



MAP SOURCE: NATIONAL WETLANDS INVENTORY



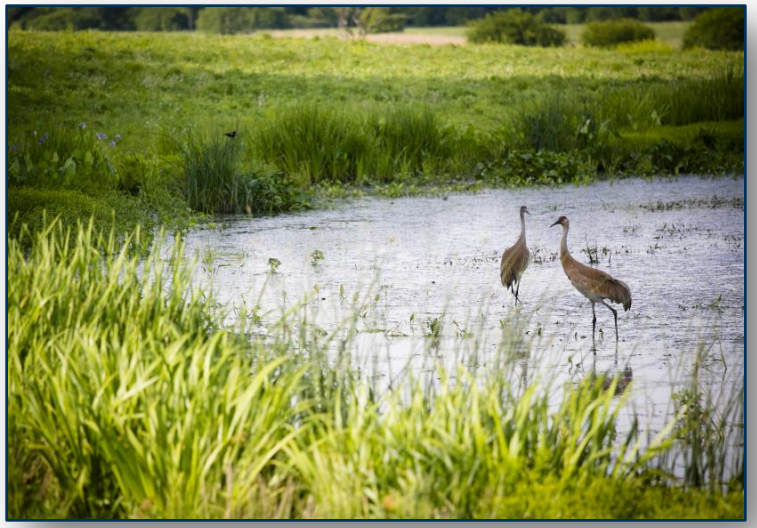
Wetland Banking

- Mitigation Agreement between Sybaquay Council Wetland Mitigation Bank and McHenry County Division of Transportation
- County purchased 0.05 credits for impacted 0.03 ac of wetlands
  - Based on 1.5:1 ratio

Wetland Banking in McHenry County

McHenry County Wetland Restoration Fund

- Isolated wetlands within Fox River Watershed
- Review matrix for eligibility of potential projects
- Total fund availability for all projects is up to $198,490
- Info available at: https://www.co.mchenry.il.us/county-government/departments-j-z/planning-development/divisions/water-resources



Source: Google

Lessons Learned

- Flow Optimization required to accurately model 2 reaches and a confluence
- Urbanization (existing land use) of the watershed required;
  - Current StreamStats incorporates urban regression equations
- Open communication is needed, especially when coordinating with multiple agencies
  - IDOT BLRS
  - McHenry County DOT
  - McHenry County P&D
  - USACE

Source: Google

Source: Google

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