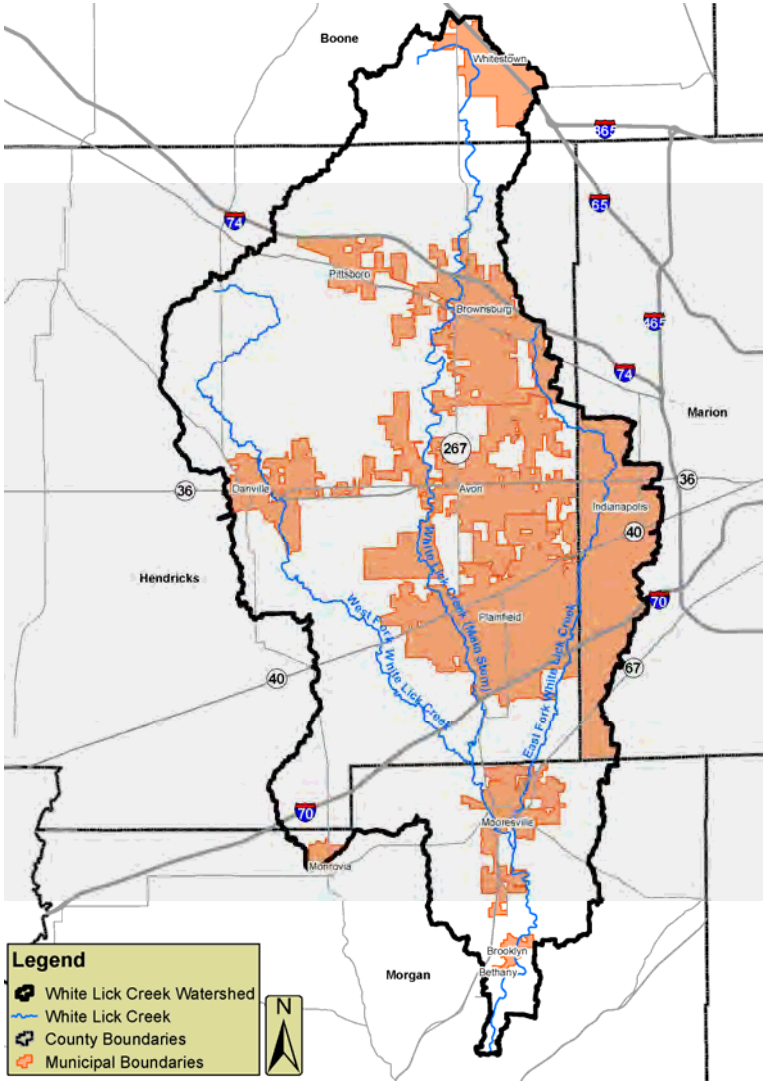
White Lick Creek

System Assessment

RiskMAP
Increasing Resilience Together

Location of the White Lick Creek Watershed



Total Drainage Area:
291 mi^2

Current Conditions

Wide channels with evidence of high sediment load

Current Conditions

Failed streambanks

Current Conditions

Debris jams

Current Conditions

General channel instability & lateral migration

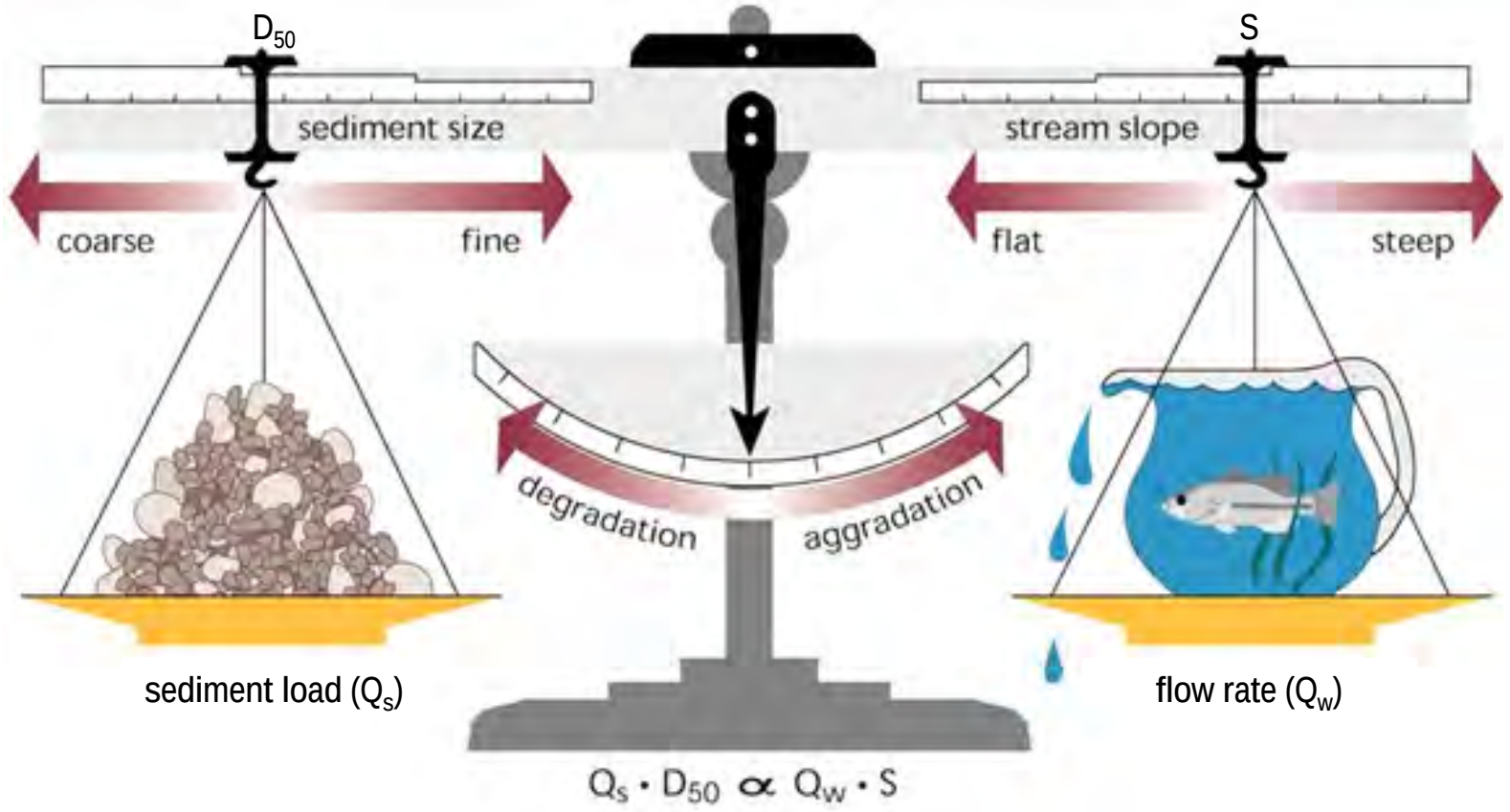
Project Scope

- **Data Gathering**
- **Flooding Risk Assessment**
- **Fluvial Risk System Assessment**
- **Conceptual Solution Development**
- **Report & Presentation**

System Assessment Process

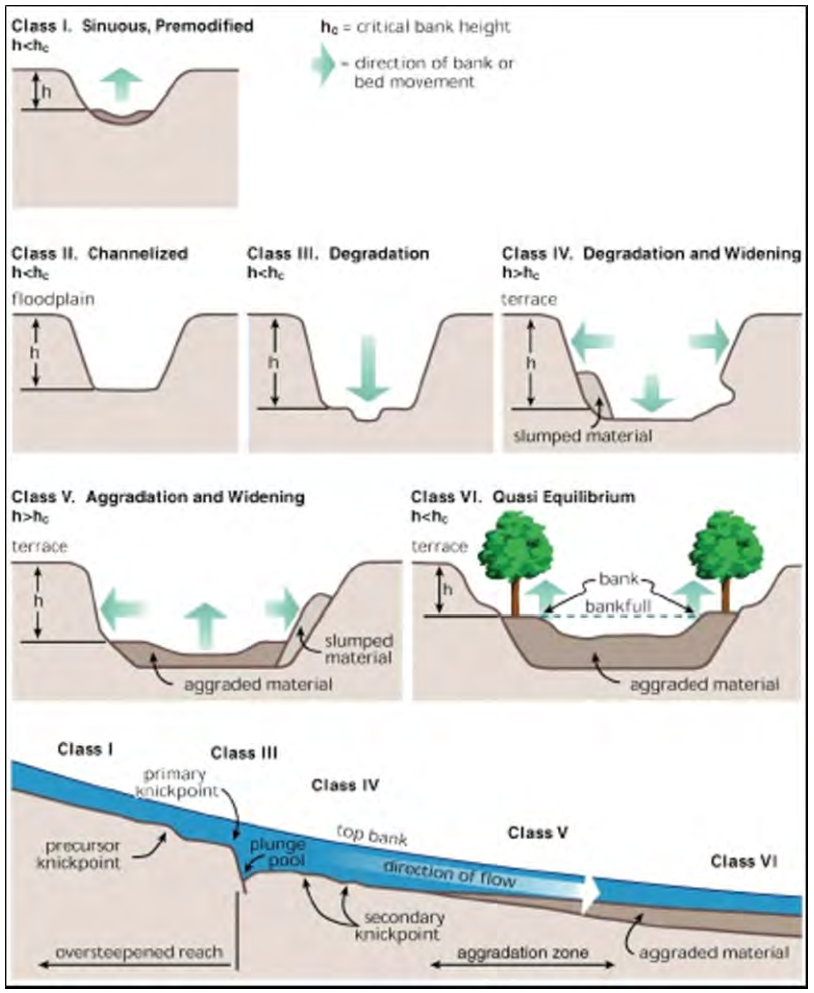
- **Watershed-based**
  - Rainfall Analysis
  - Land Use
  - Soils
  - Topography
- **Stream-based**
  - Channel Dimensions
  - Streamflow
  - Channel Material
  - Vegetation
  - Large Woody Debris
  - Bridges / Culverts
  - Channel Disturbance / Augmentation

Geomorphology Concepts



Lane's Balance

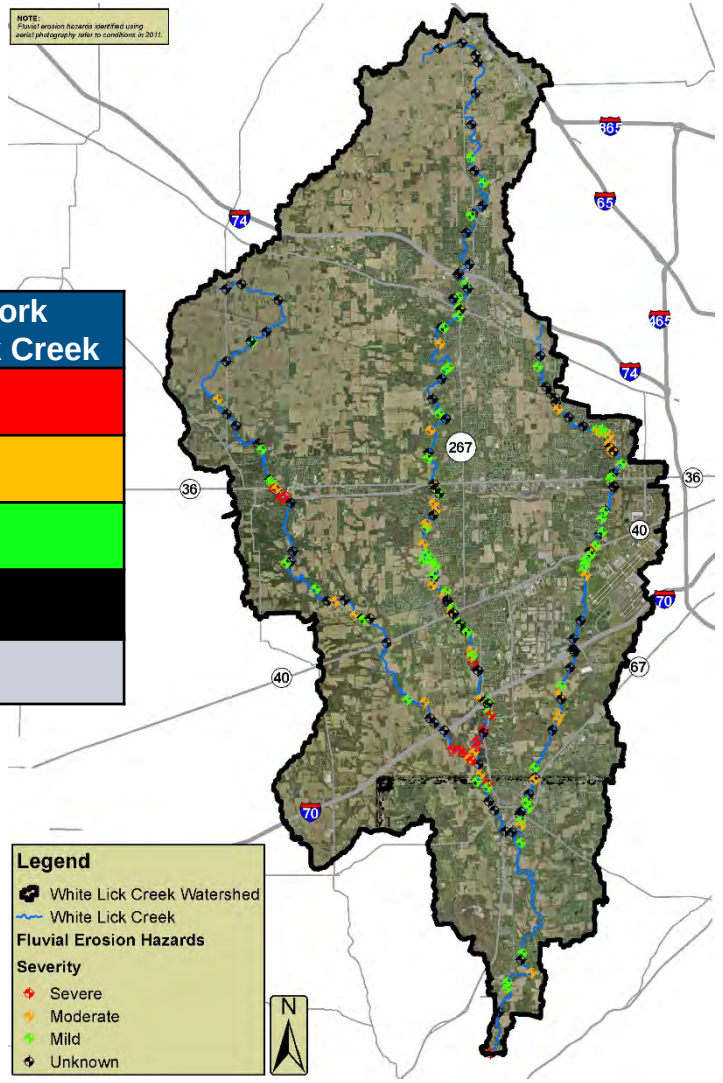
Geomorphology Concepts



Channel Evolution Model (after Schumm & Simon)

Fluvial Erosion Hazard Identification

Fluvial Erosion Hazard Level	East Fork White Lick Creek	Main Stem White Lick Creek	West Fork White Lick Creek
Severe	0	8	7
Moderate	15	17	6
Mild	22	35	8
Unknown	28	47	22
Total	65	107	43



Channel Erosion & Migration

Question: How did we get here? **Answer: It's where we started.**

1939 Aerial (Note white gravel bars)

Channel Erosion & Migration

1946 Aerial (Note white gravel bars)

Channel Erosion & Migration

1958 Aerial (Note white gravel bars)

Channel Erosion & Migration

1967 Aerial (Note white gravel bars)

Evidence of Previous Migration

Exposed channel bank
downstream of Avon, IN

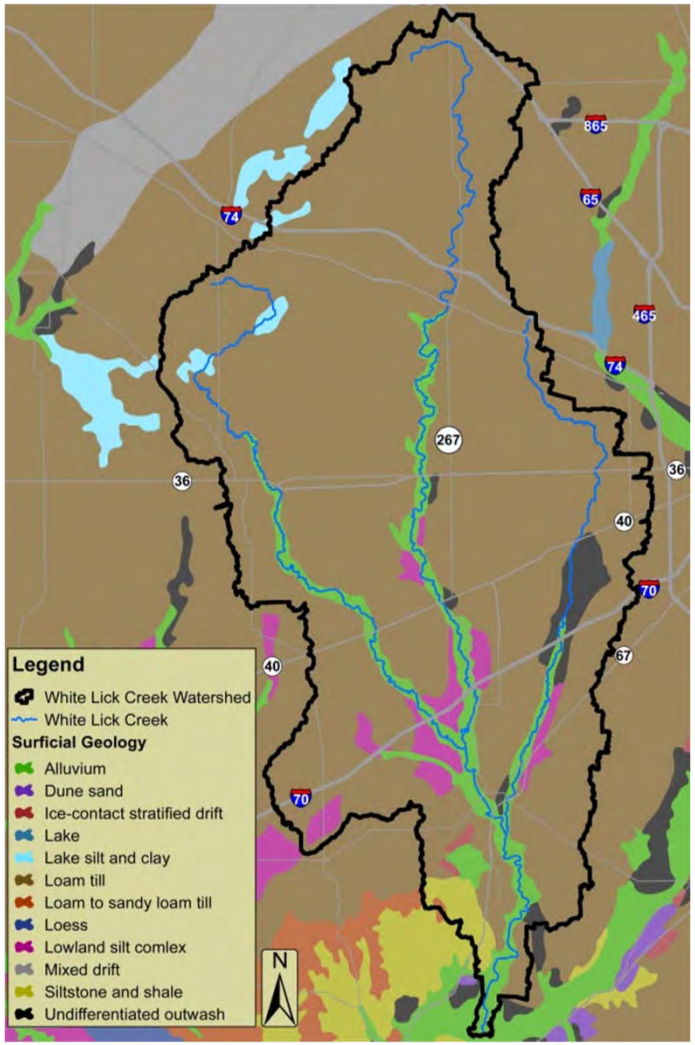
Vegetation / tree growth
immediately above exposed bank

Evidence of Previous Migration

Exposed channel bank downstream of Avon, IN

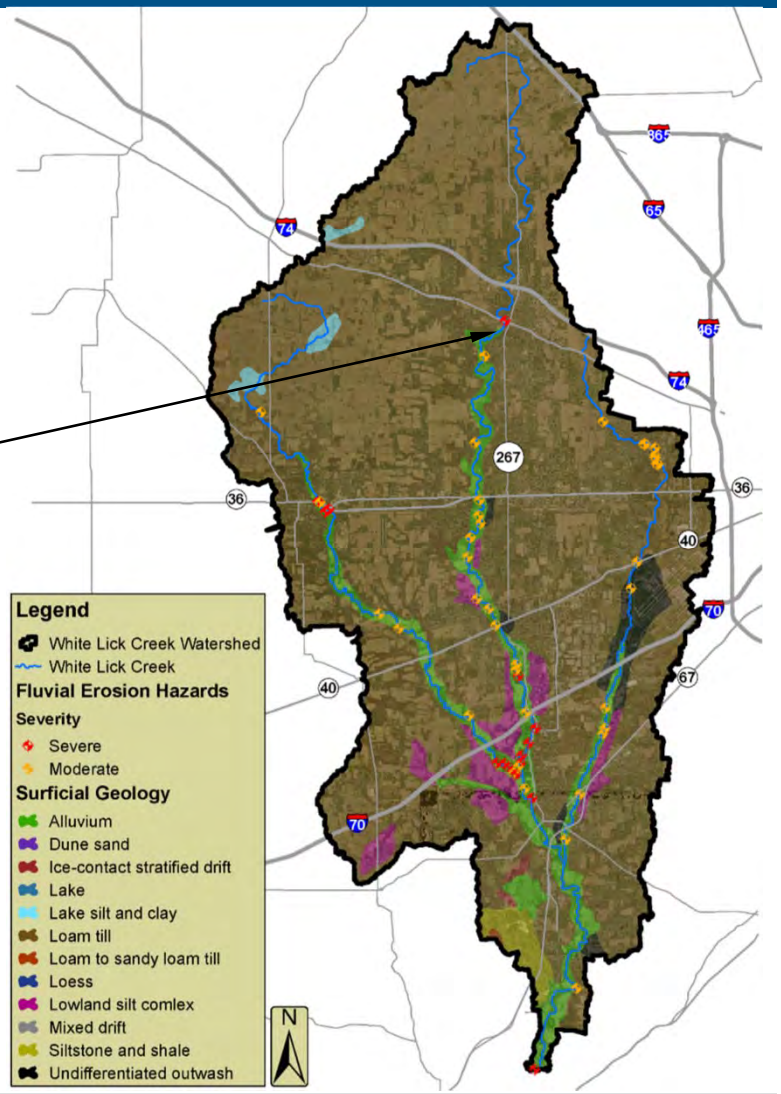
Vegetation / tree growth immediately above exposed bank

Highly Erodible Channel Material



Highly Erodible Channel Material

- 70% of moderate & severe FEHs are in alluvium
- First signs of heavy sediment transport are at upstream extent of alluvium



Highly Erodible Channel Material

- No vegetation on gravel bars indicates frequent mobilization
- Plane-bed with low flow channel indicates that nearly the entire bed is mobile during significant events
- Sand / gravel material is abundant and available for transport

Main Stem White Lick Creek
downstream of confluence w/ West Fork

Human Influence

1989

Billy Joel writes *We Didn't Start the Fire*

&

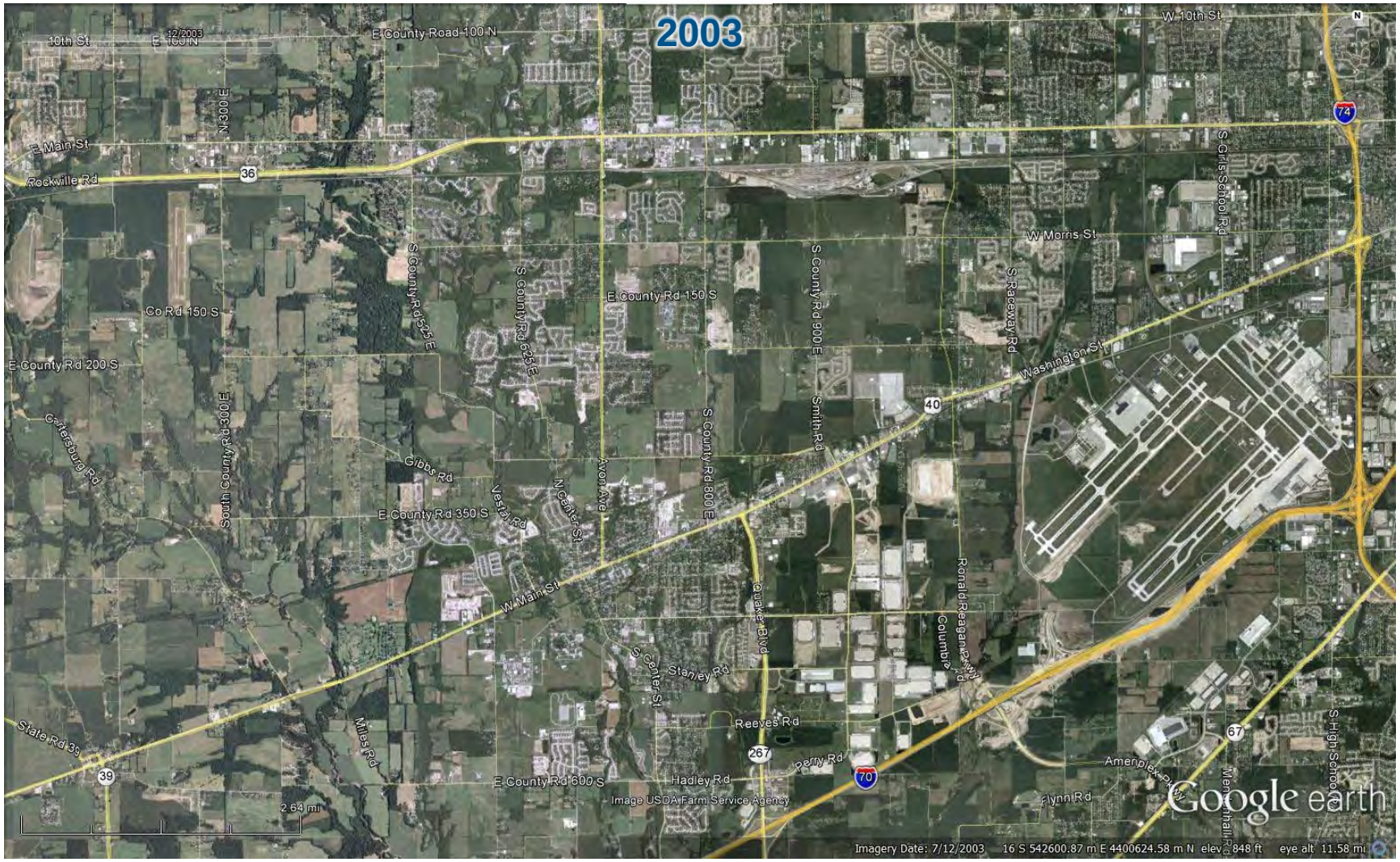
Development in eastern Hendricks County and western Marion County starts to increase

We didn't start the scour
It was already churning
Since the world's been turning

We didn't start the scour
Didn't chart the course
But we made worse

Human Influence

Human Influence



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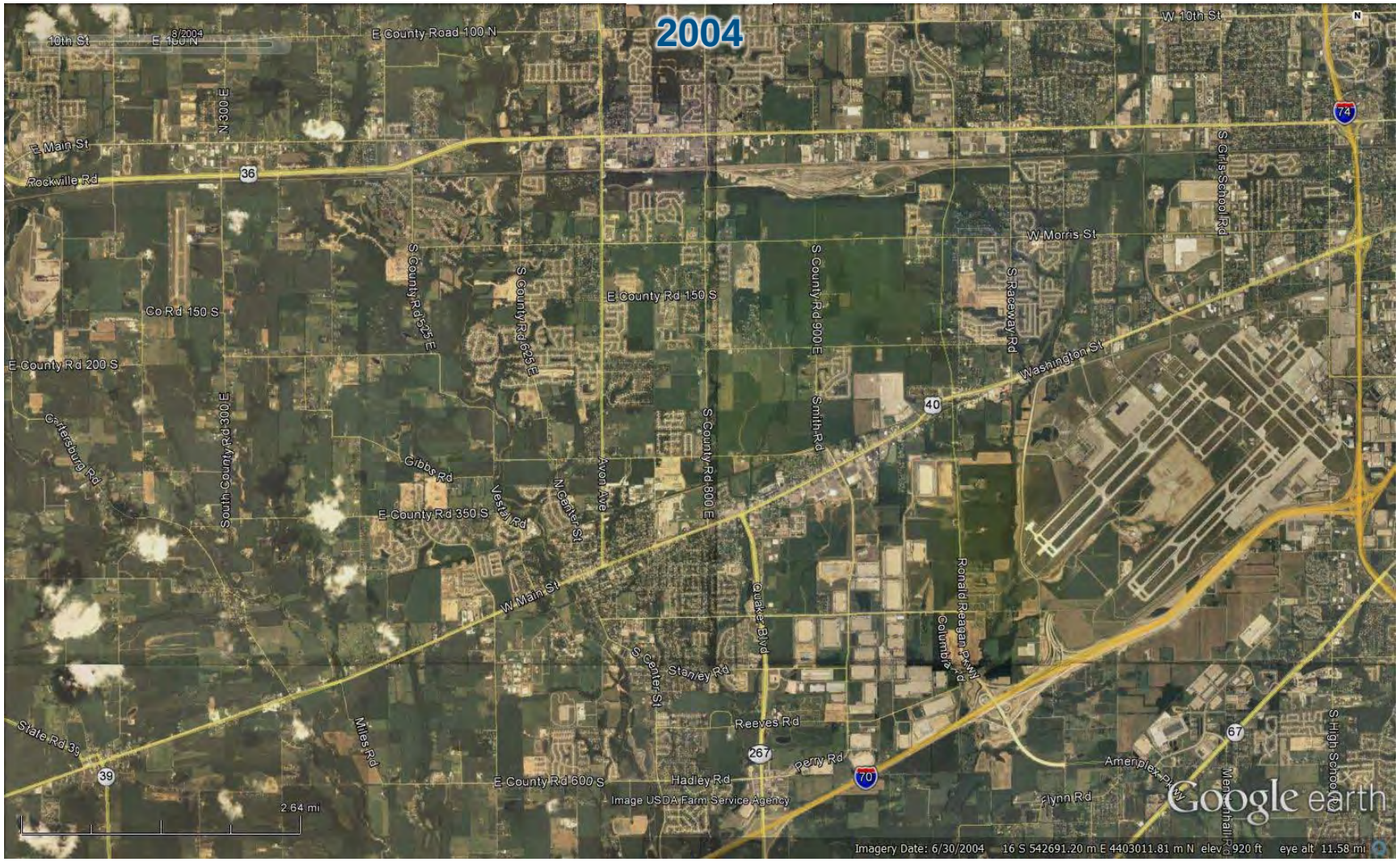

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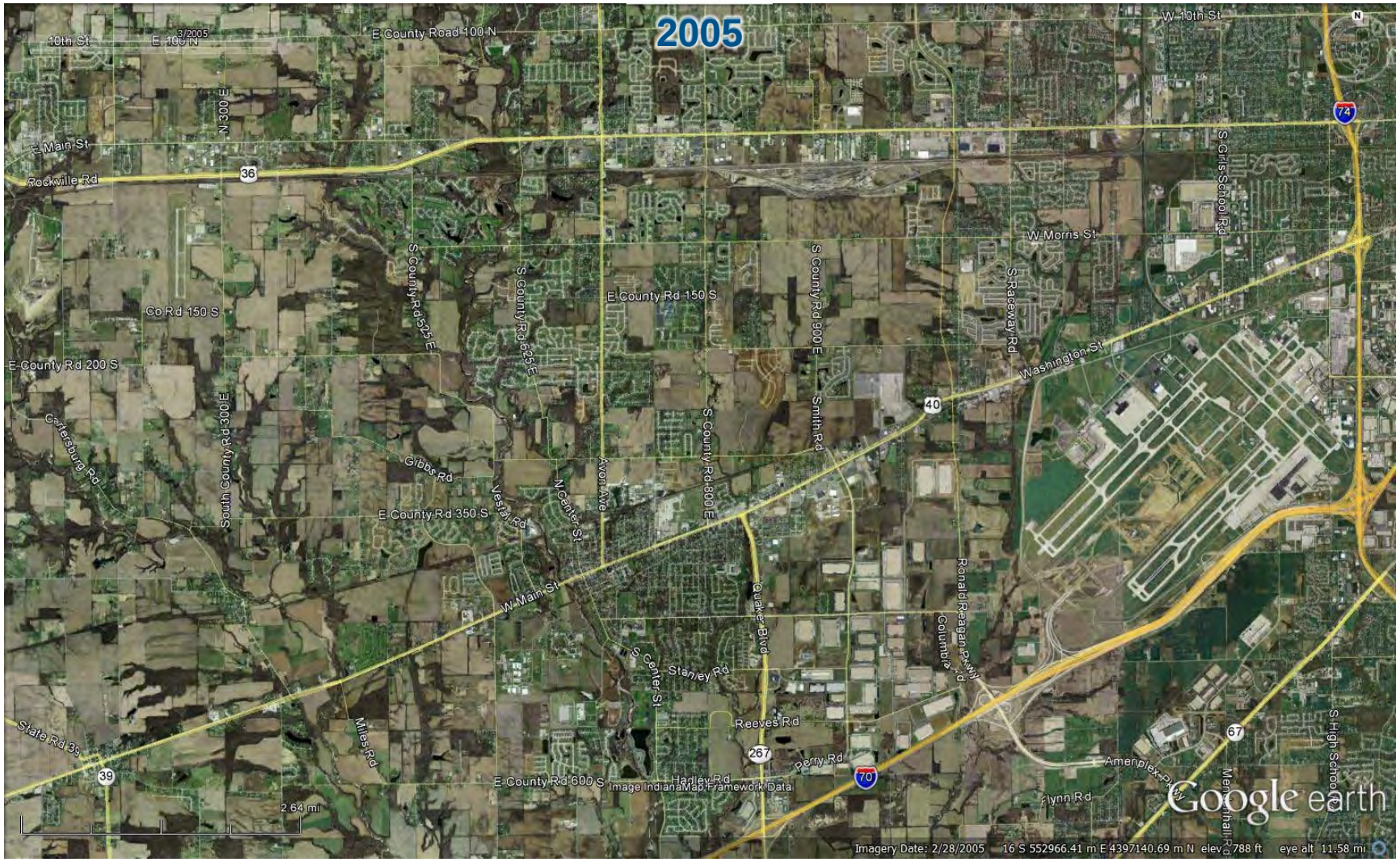

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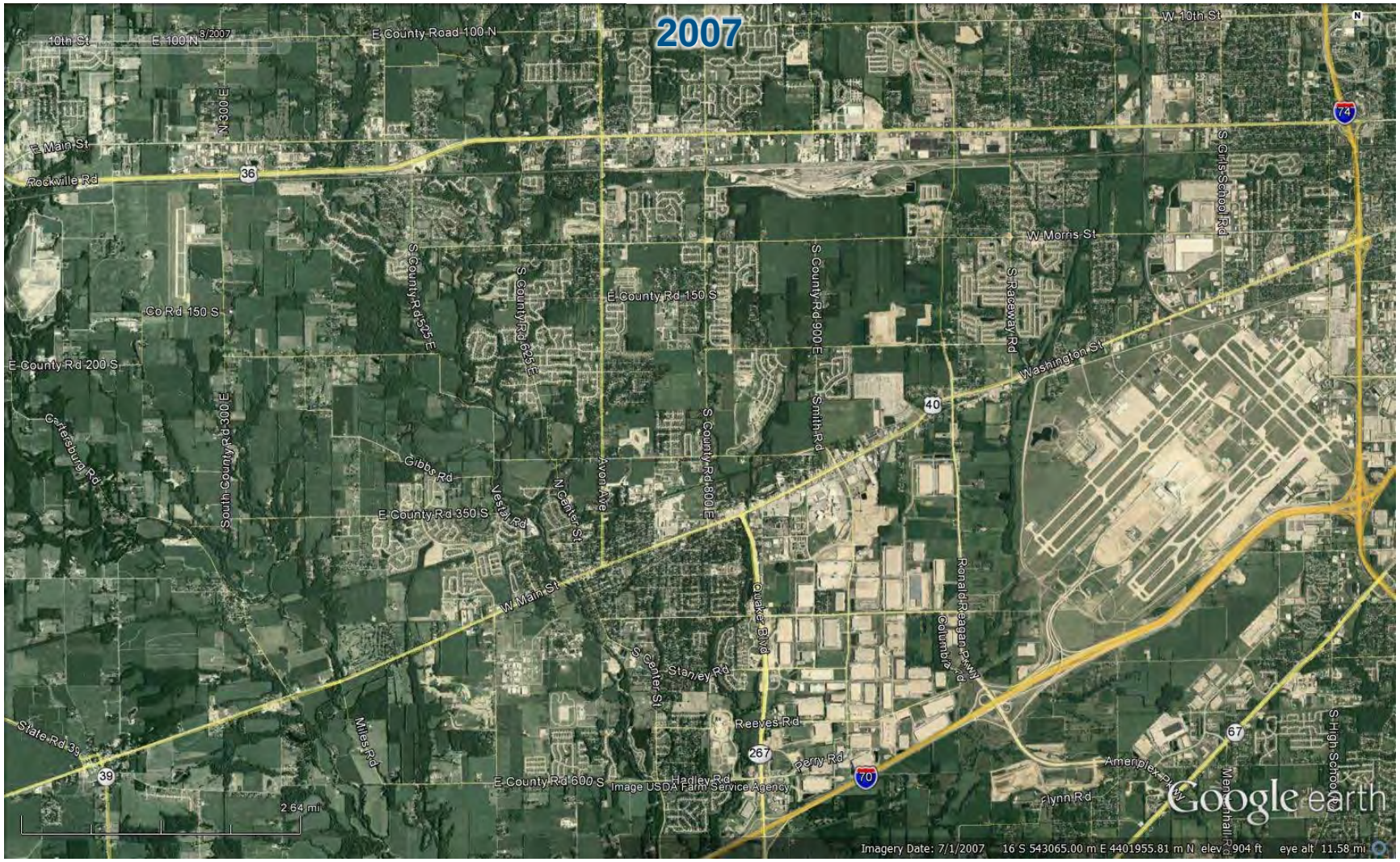

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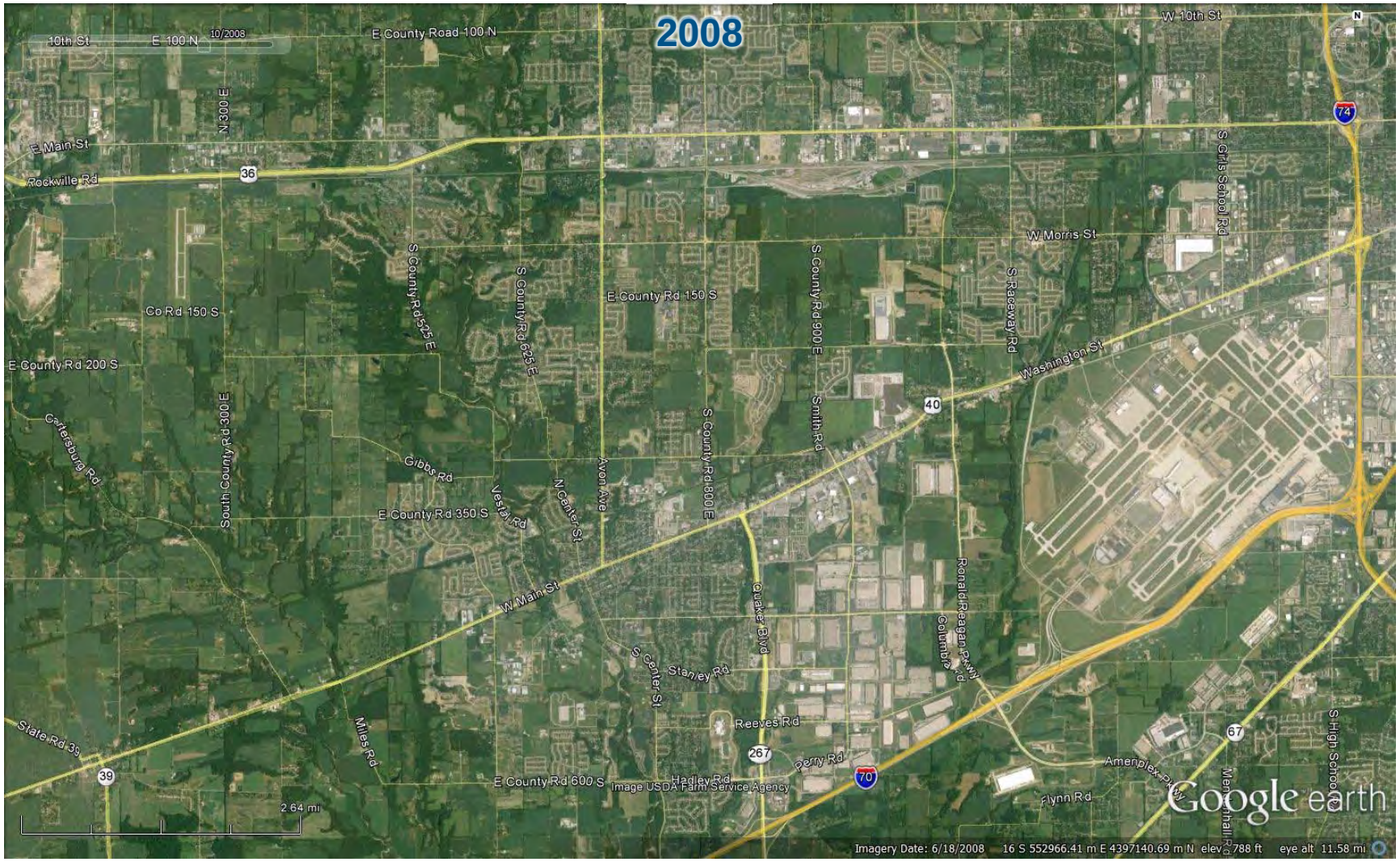

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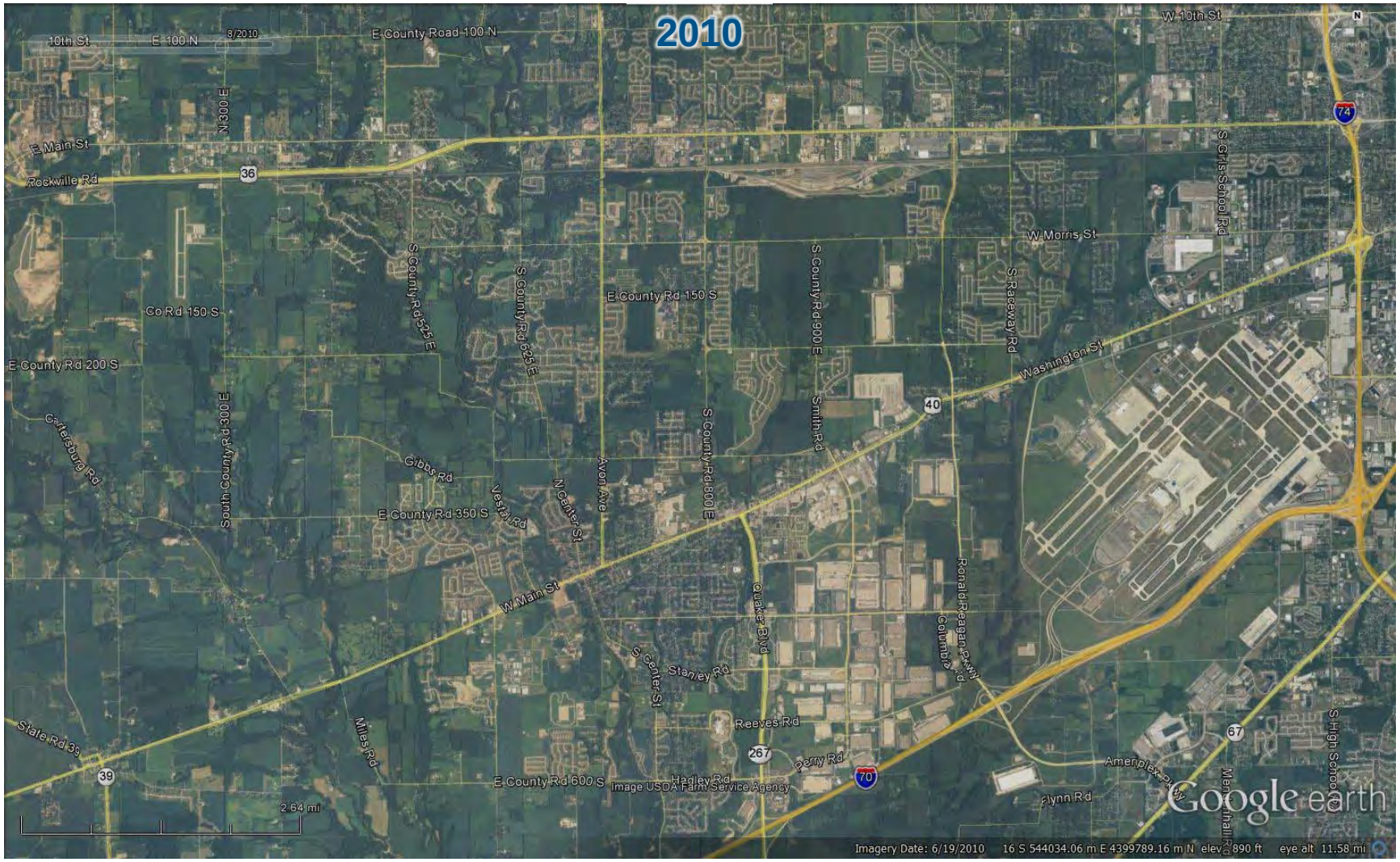

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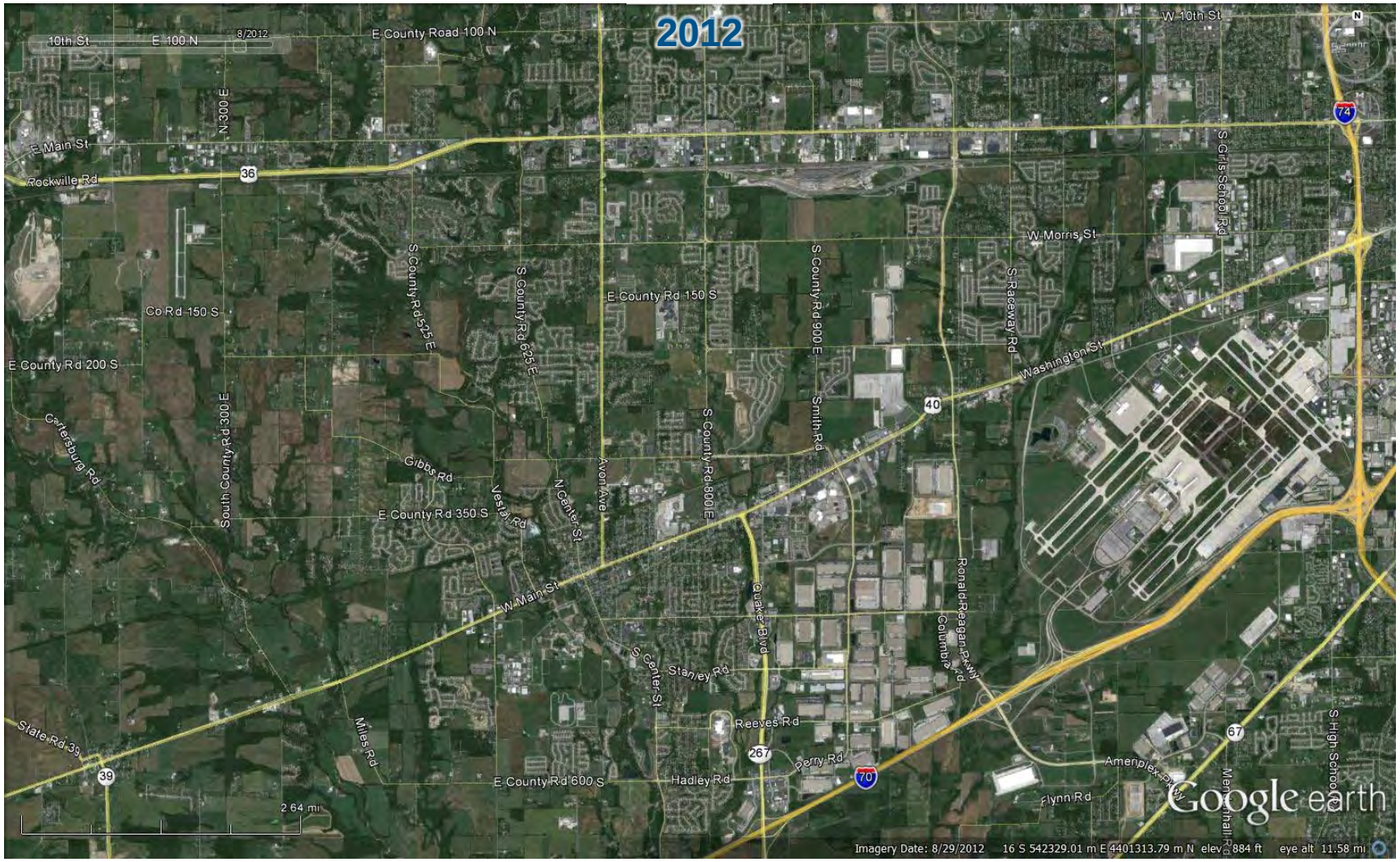

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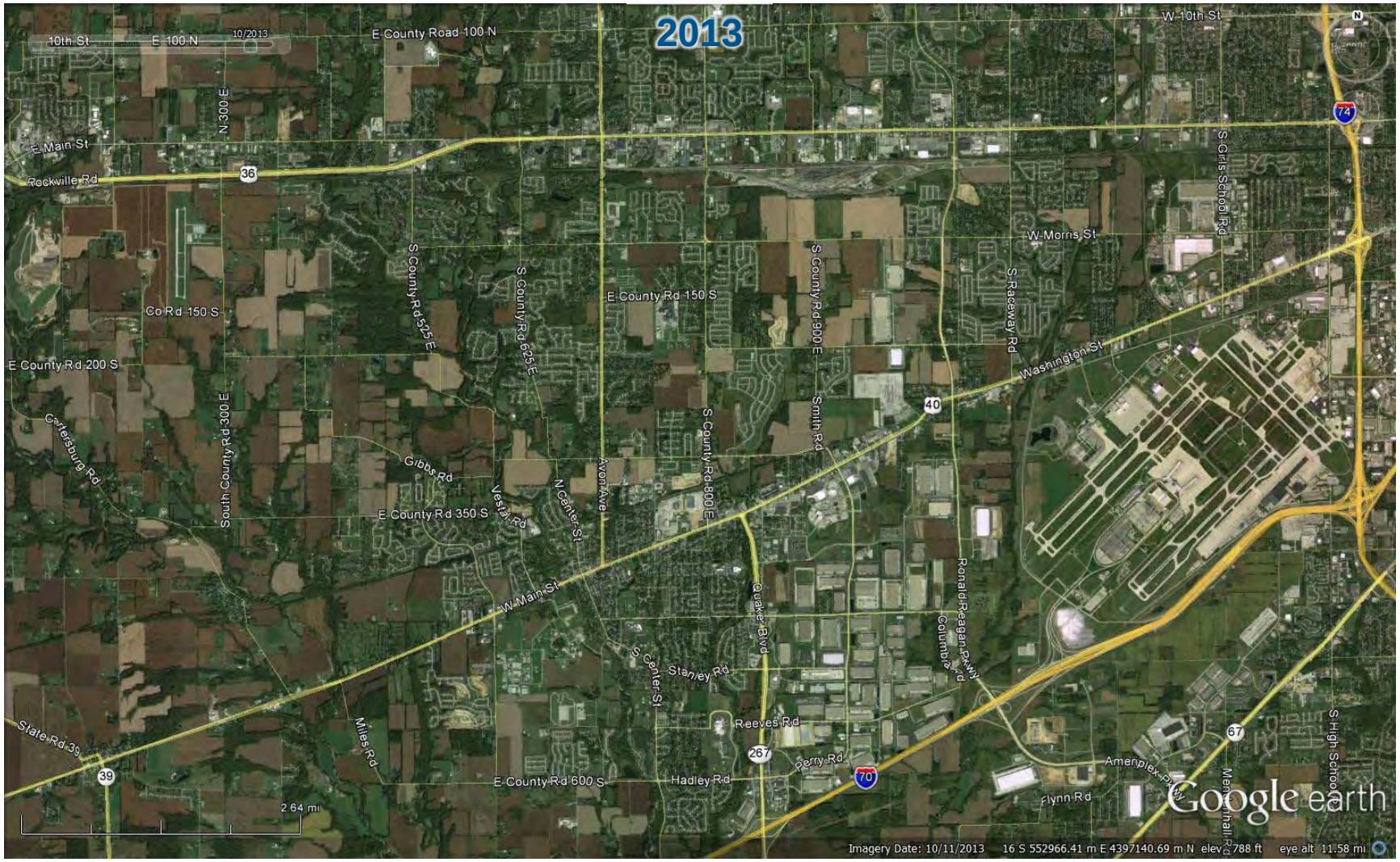

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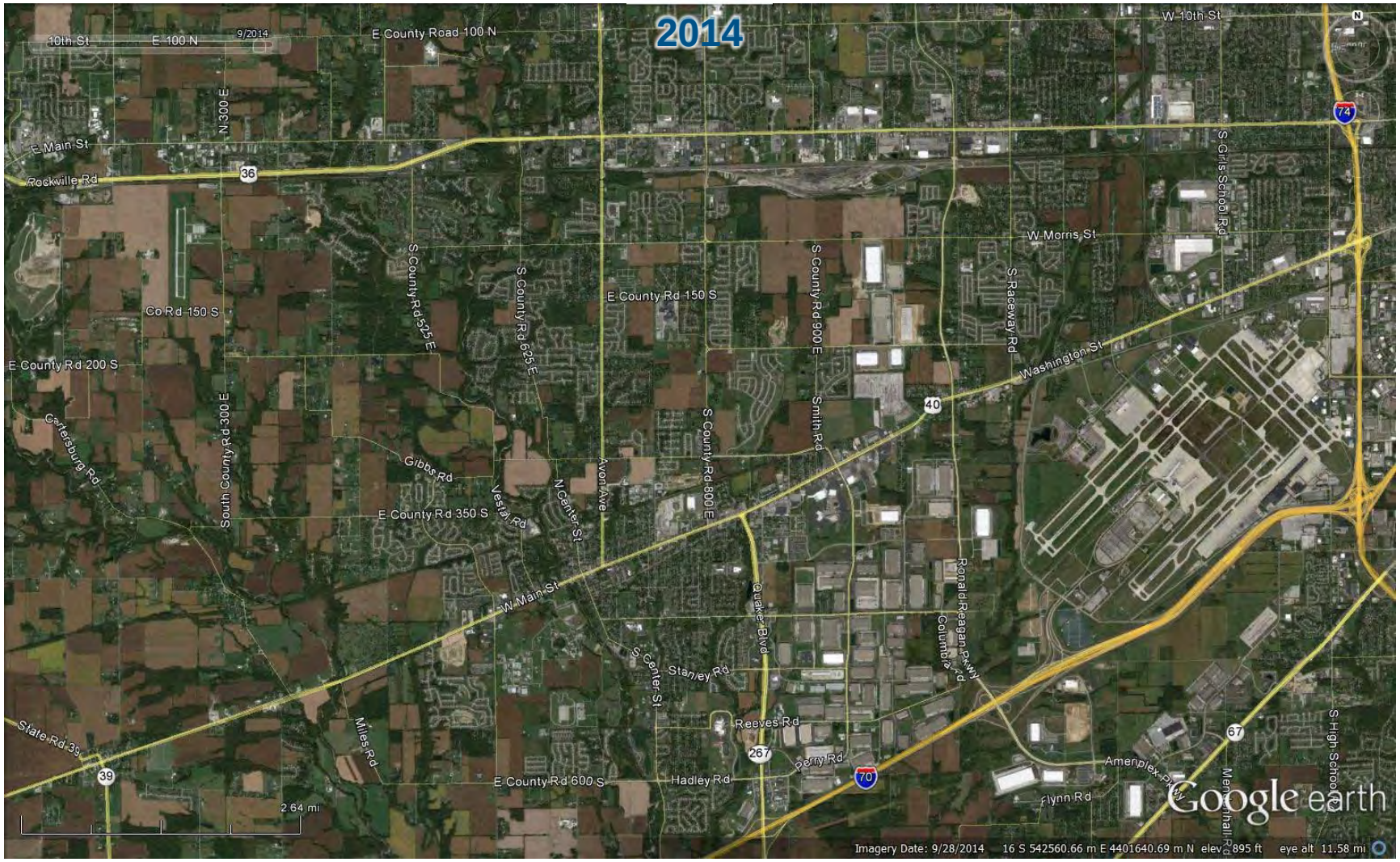

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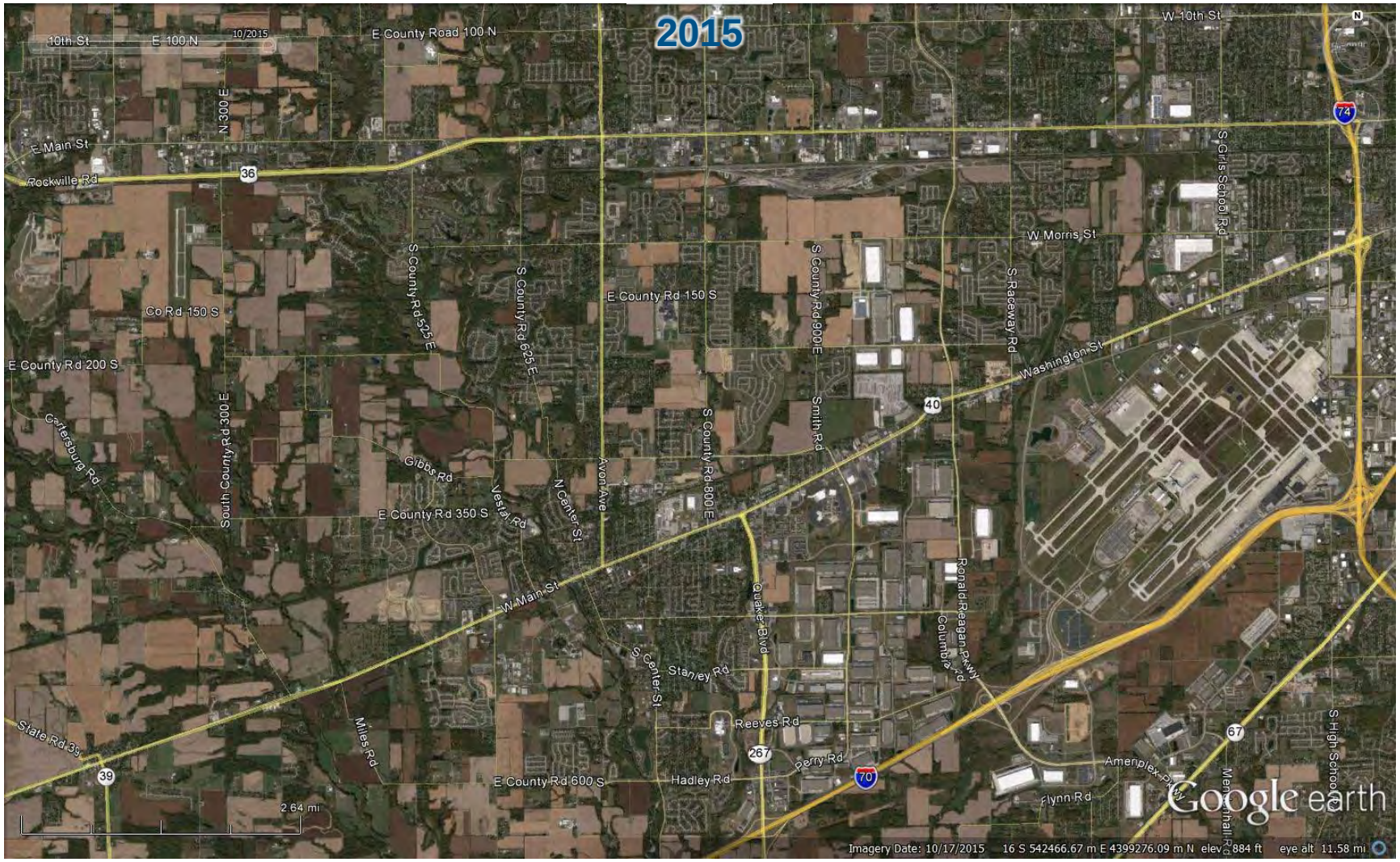
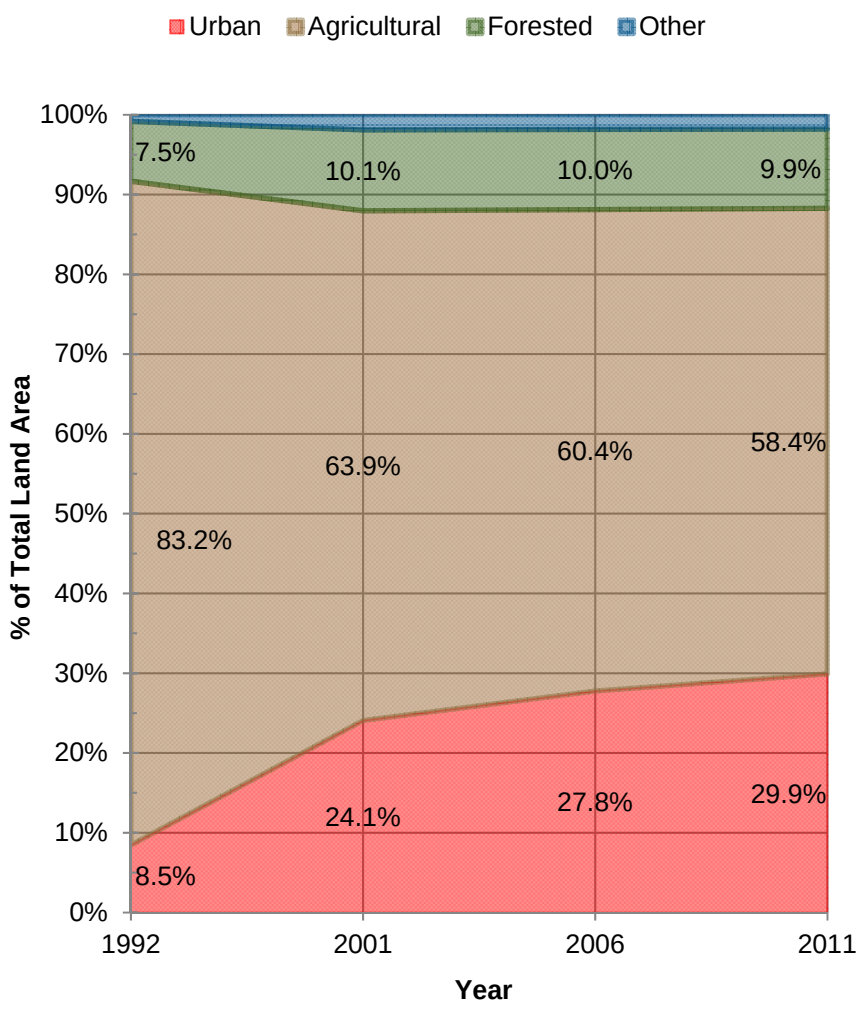
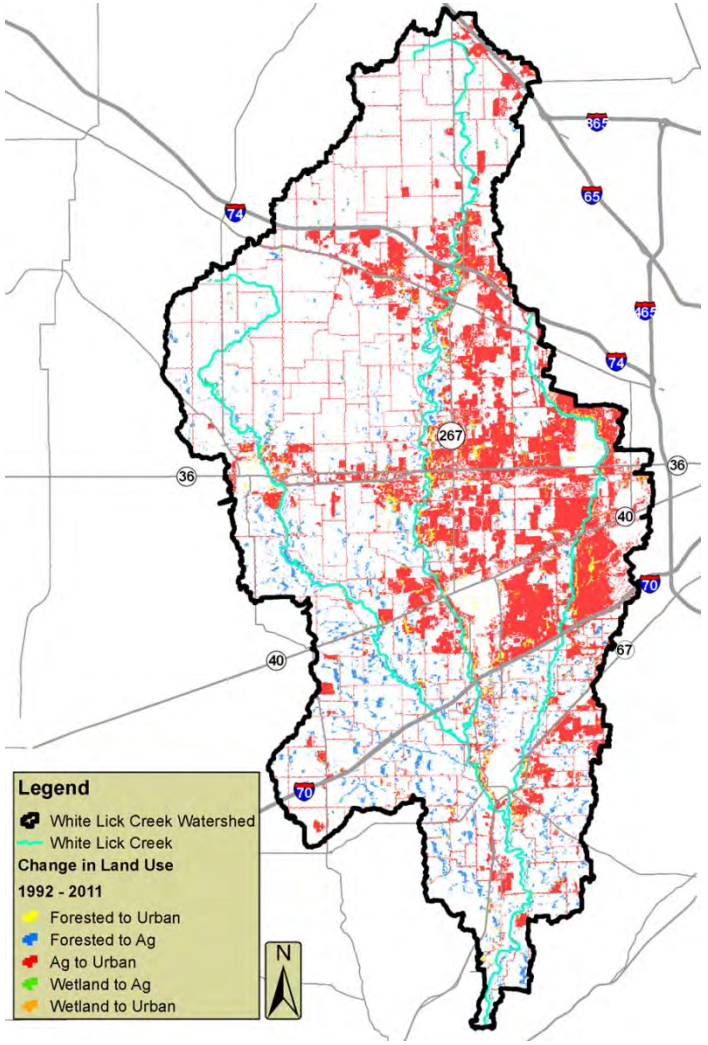


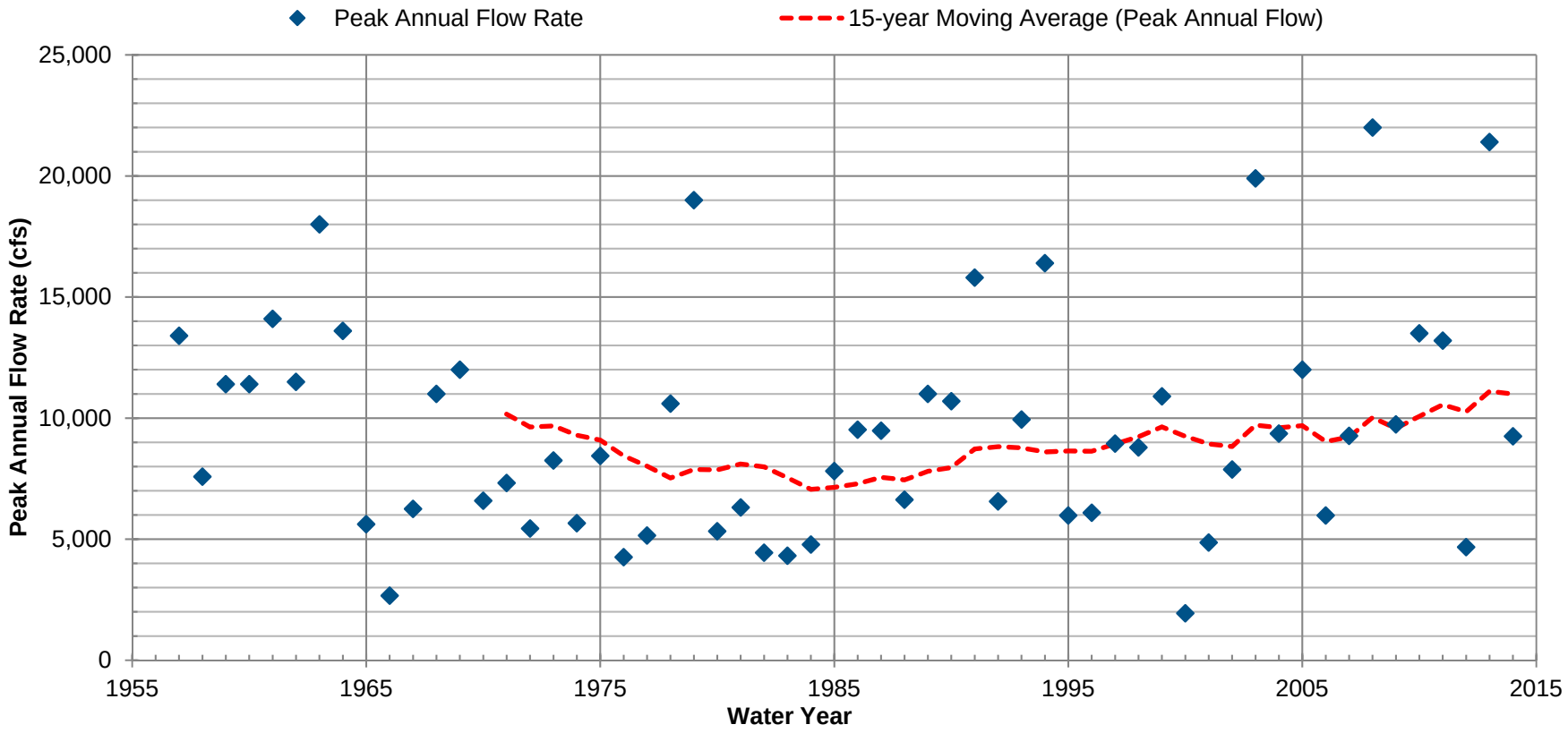
Land Use Change: Urbanization





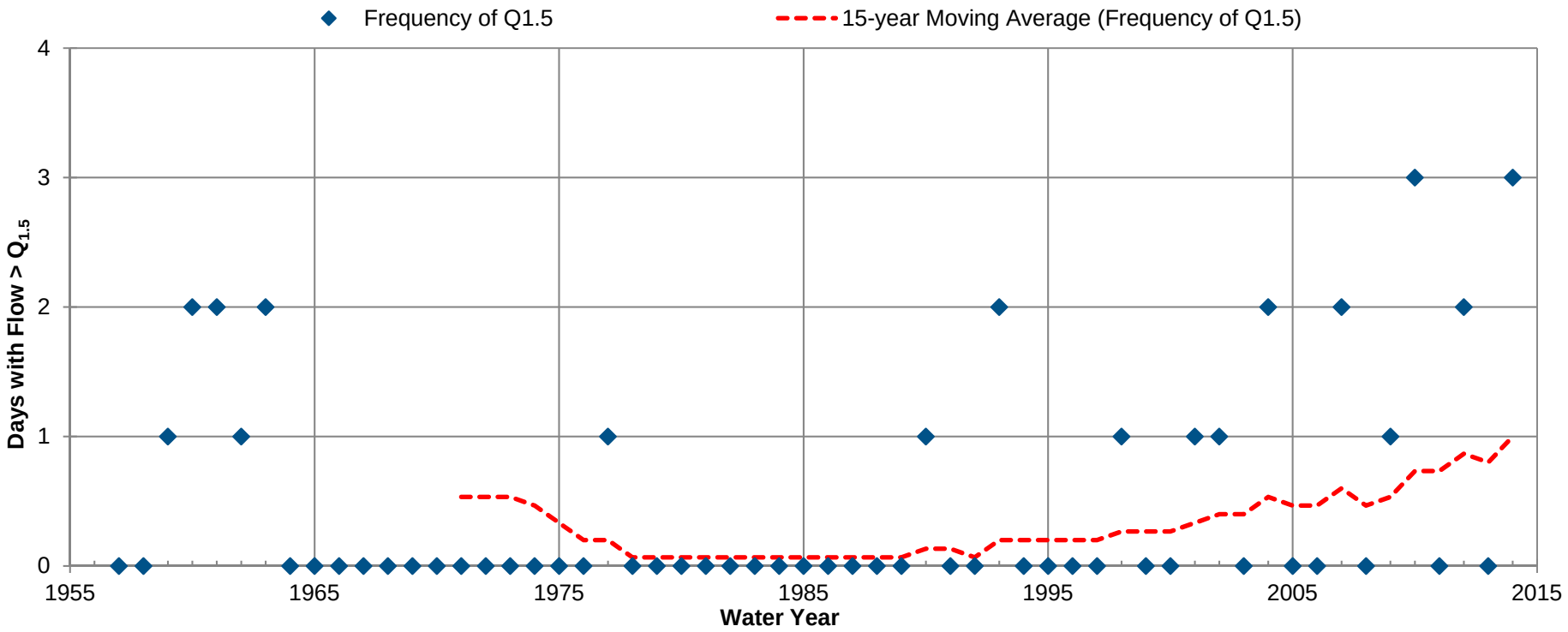
Land Use Change: Peak Flow

- The 15-year moving average of the peak annual flow has increased by approximately 130 cfs each year for the past 30 years.



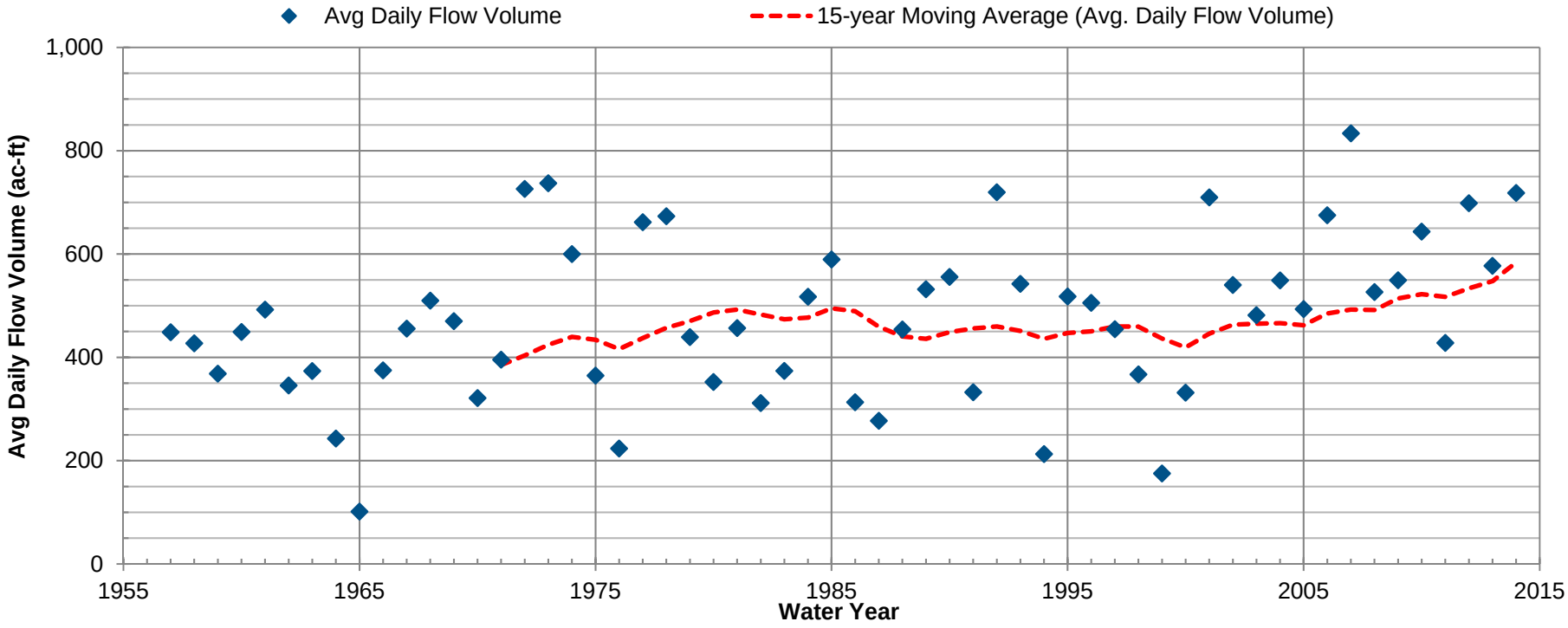
Land Use Change: Bankfull Flow

- The bankfull flow has been experienced much more frequently and for a longer duration since the early 1990s.
- Increased frequency of bankfull flow results in more erosion



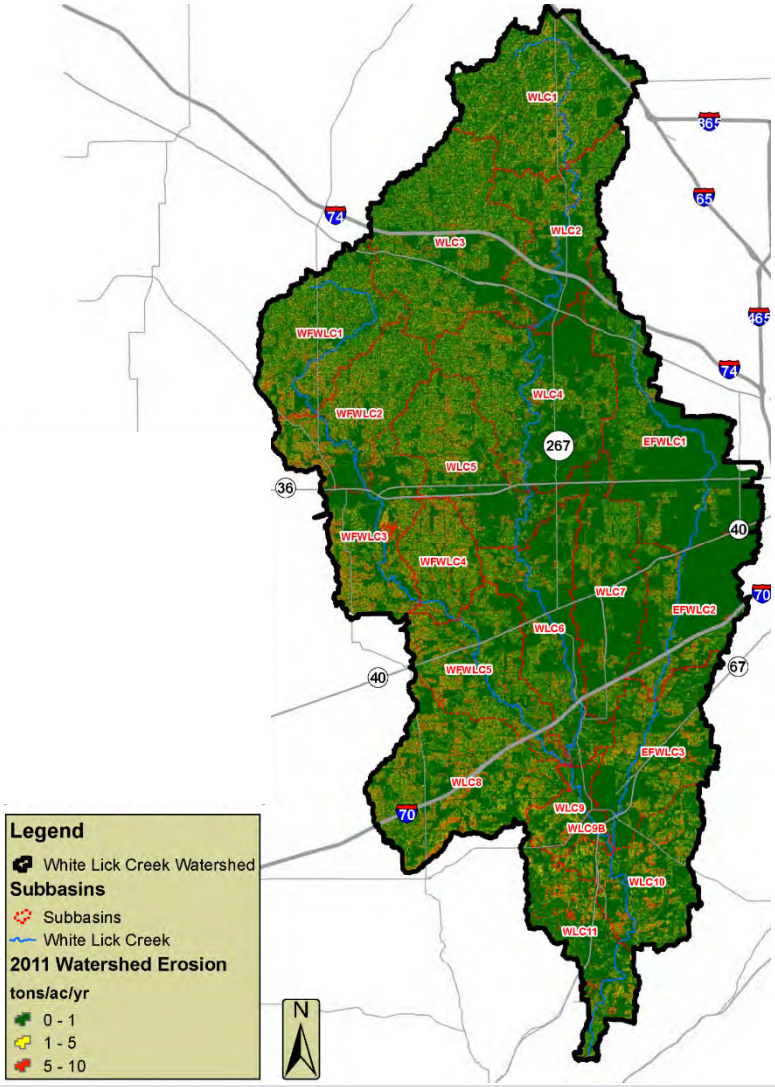
Land Use Change: Flow Volume

- The average daily flow volume is now more than 150% of what it was in 1971.
- Increased flow volume leads to higher peak flows and flooding that occurs for a longer period of time.

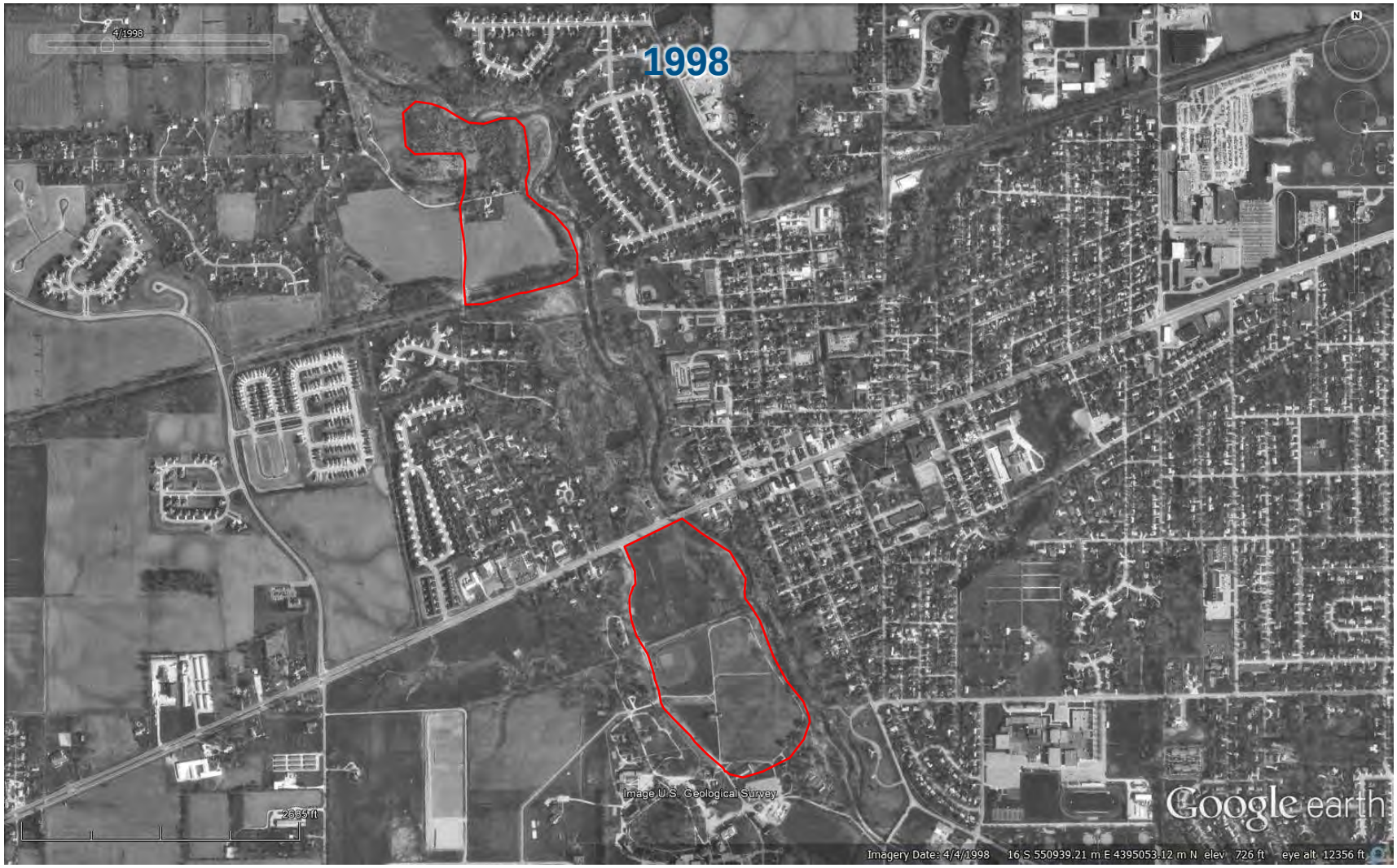


Land Use Change: Sediment Supply

- The increase in impervious land cover associated with urbanization results in less sediment supplied to the channel
- Decreased watershed sediment supply leads to more channel erosion



Channel Encroachment & Restriction



Channel Encroachment & Restriction

Channel Encroachment & Restriction

Channel Encroachment & Restriction

Channel Encroachment & Restriction

Channel Encroachment & Restriction

- Restrictive bridges and culverts

Flow Restriction Severity[1]	East Fork White Lick Creek	Main Stem White Lick Creek	West Fork White Lick Creek
Severe (4+ feet)	2	0	1
Moderate (2 – 4 feet)	4	4	0
Mild (0 – 2 feet)	8	16	4
Unknown	0	2	0
Total	14	22	5

1 Flow restriction severity determined by difference in upstream and downstream water surface elevations during the 100-year flooding event.

Induced Channel Instability

Induced Channel Instability

Induced Channel Instability

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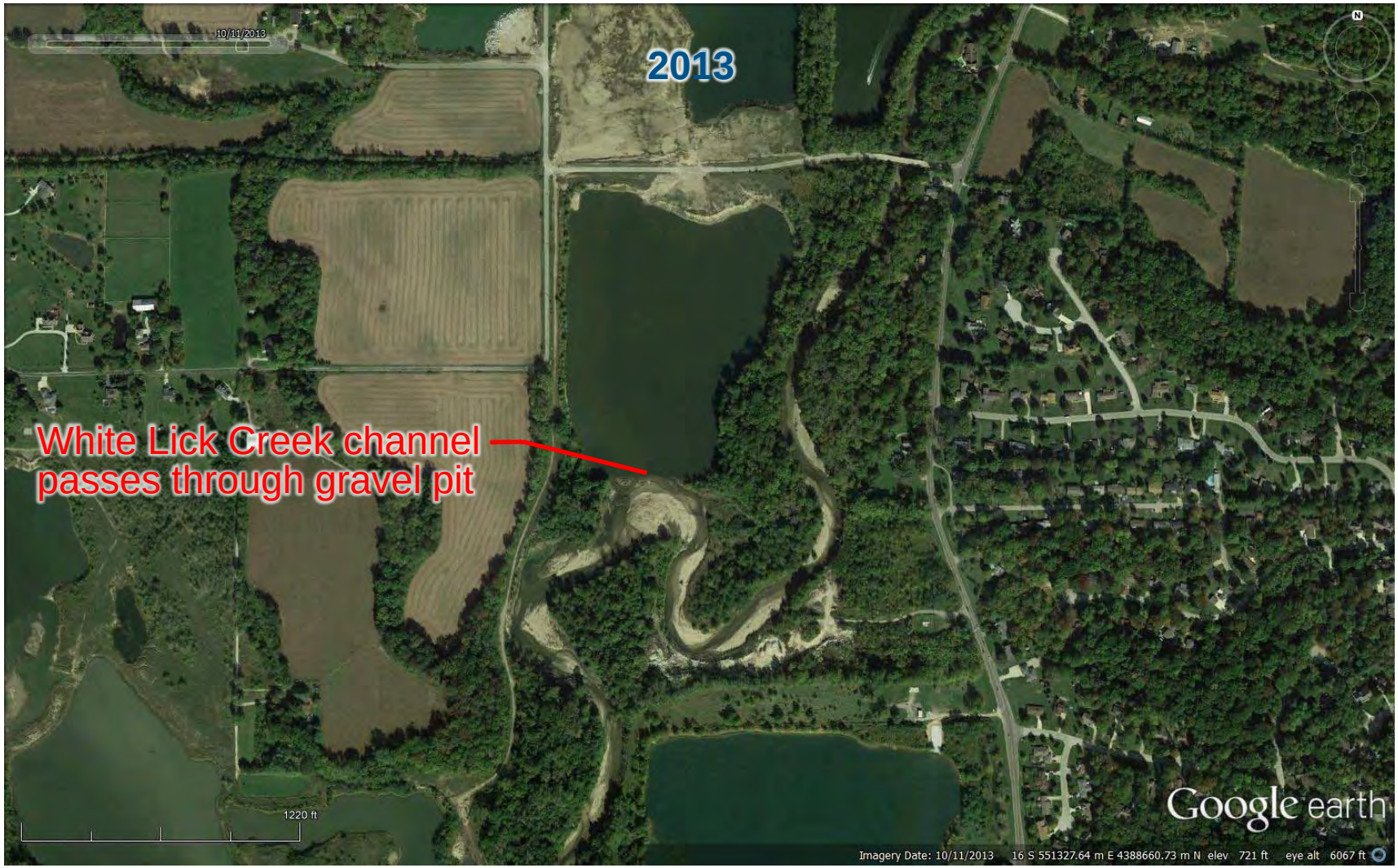

Induced Channel Instability

Induced Channel Instability

Additional Factors: Debris Jams

- Debris jams block bridge / culvert openings and increase flooding

Main Stem White Lick Creek
at E CR 300 S near Plainfield, IN

Main Stem White Lick Creek
at W Main St near Brownsburg, IN

Additional Factors: Debris Jams

Additional Factors: Compounding Issues

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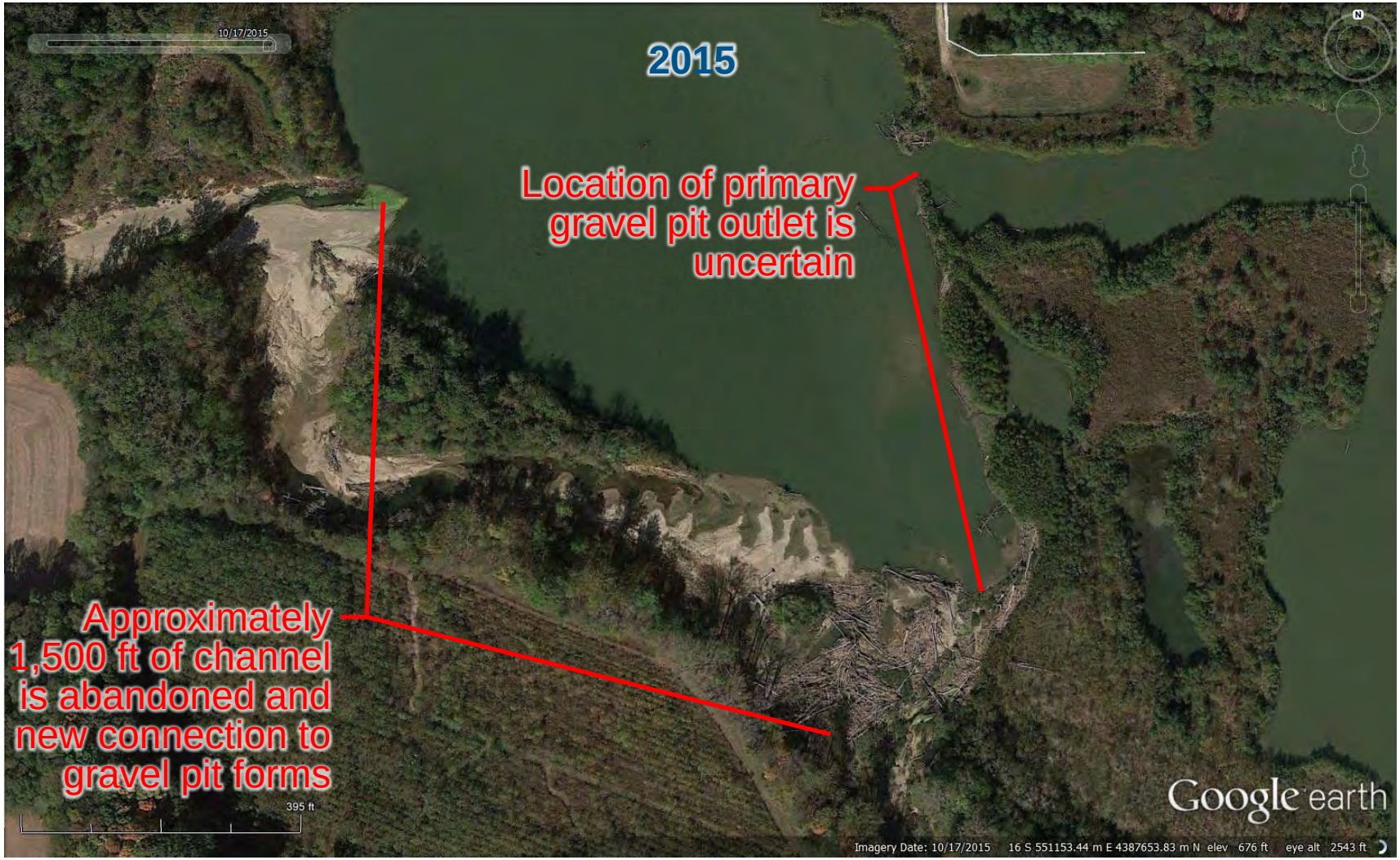
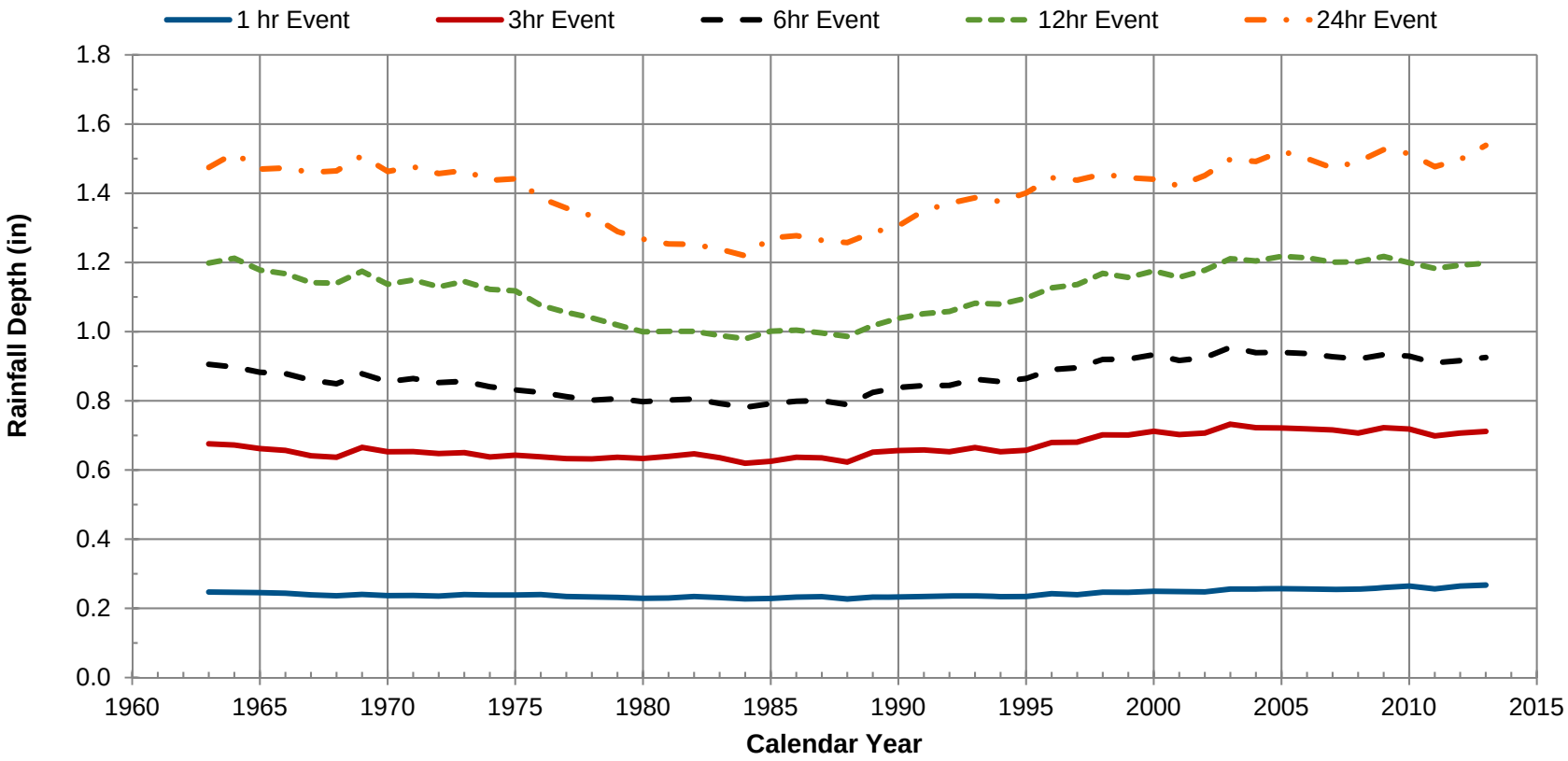


Additional Factors: Rainfall



Rainfall Depth Exceeded by Top 5% of Events by Duration
(15-year Moving Average of IND Rainfall gauge)

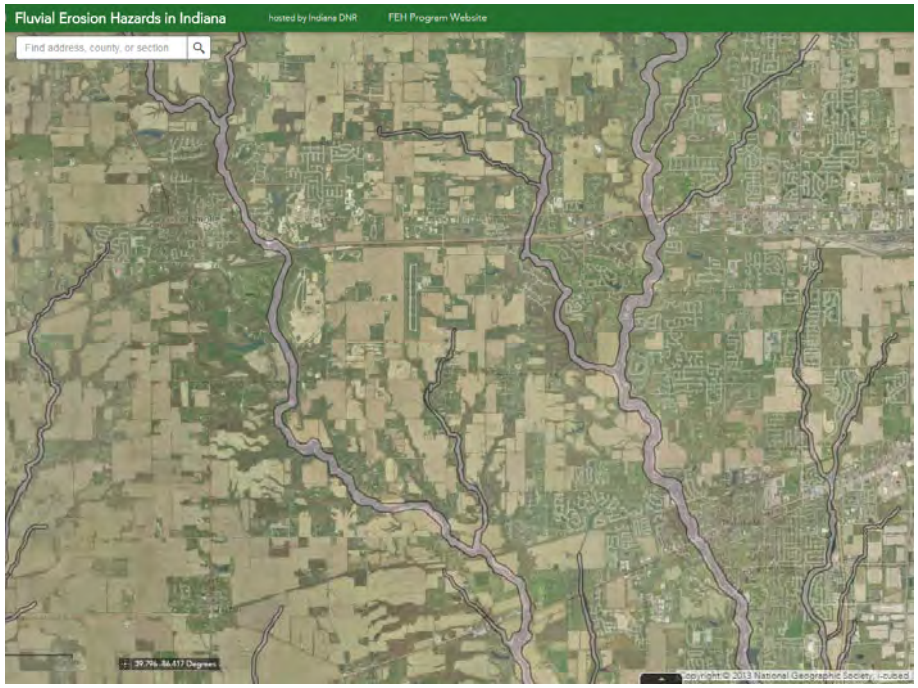
Additional Factors

- **Perception**
  - Development closer to stream
  - Recent increase in rainfall & streamflow
  - Recent decrease in watershed sediment supply
- **Awareness**
  - General transition from conveyance-centric thought to more holistic consideration (conveyance, erosion, & ecological)
  - Budget limitations & growing costs

Risk Reduction Strategies

1. Stay Away

- Erosion & channel migration will continue
- Limit exposure
- When possible, move infrastructure out of stream corridor
- Increase mitigation requirements to discourage development in stream corridor

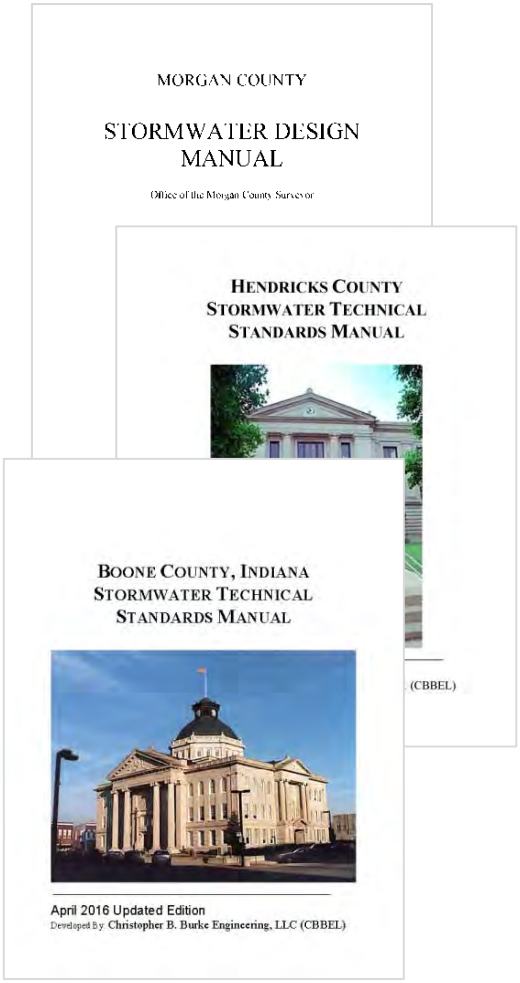


Refined Corridor Map
Available at:
http://indnr.maps.arcgis.com/apps/webappviewer/index.html?id=43e7b307a0184c7c851b5068941e2e23

Risk Reduction Strategies

2. More Stringent Development Standards

- Increase detention requirements (Channel protection volume)
- Promote / require use of LID & green infrastructure stormwater management strategies
- Institute riparian corridor with use restrictions



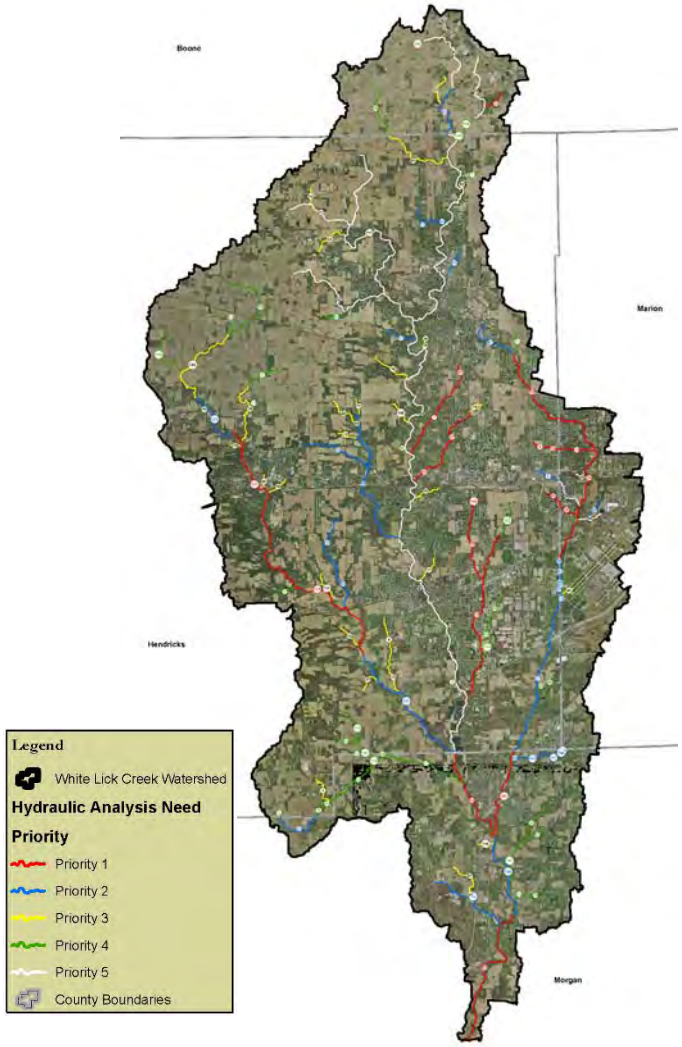
Stormwater Ordinance & Technical Standards

Risk Reduction Strategies

3. Improve Planning & Risk Assessment

- Update regulatory flow rates
- Improve / update floodplain models
- Lateral migration monitoring

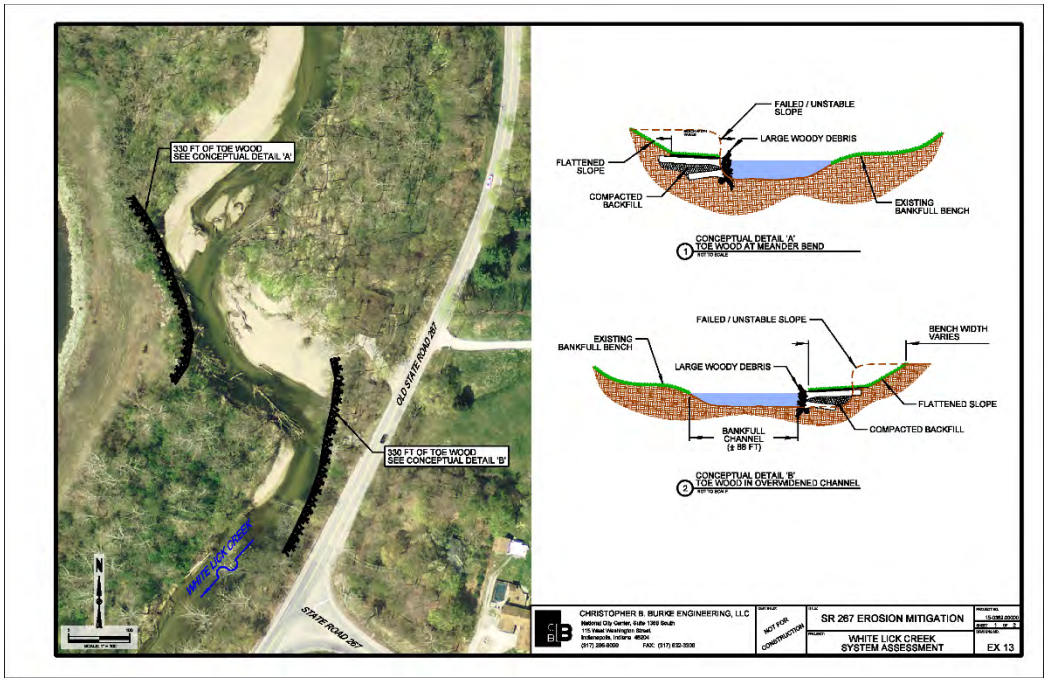
Change in FEH Status from Channel Migration
(Left Image taken 8/29/12; Right image taken 10/17/15, from Google Earth)



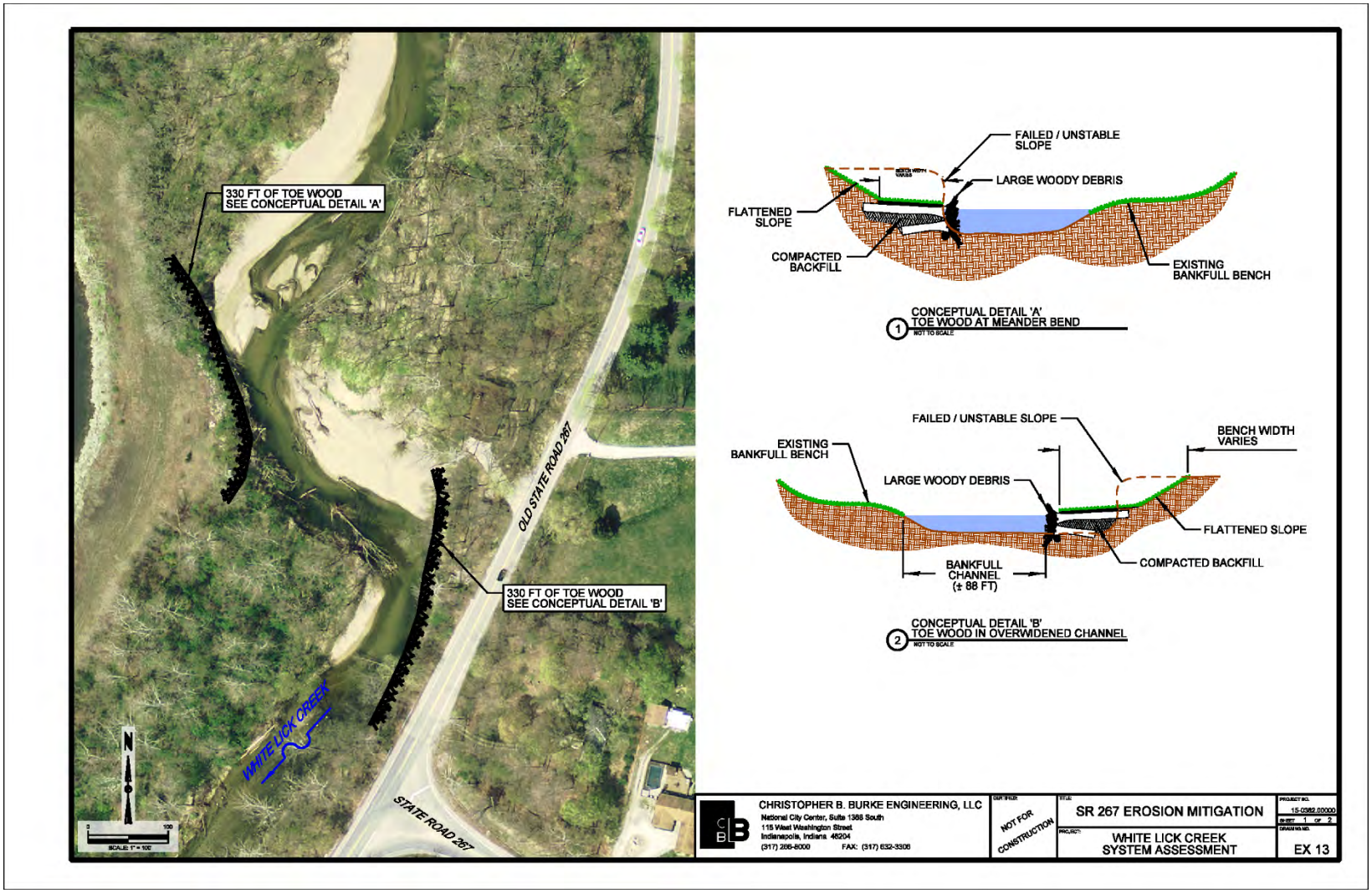
Risk Reduction Strategies

4. Improve Maintenance & Protect Critical Infrastructure

- Tree maintenance program
- Strategic / critical erosion mitigation projects

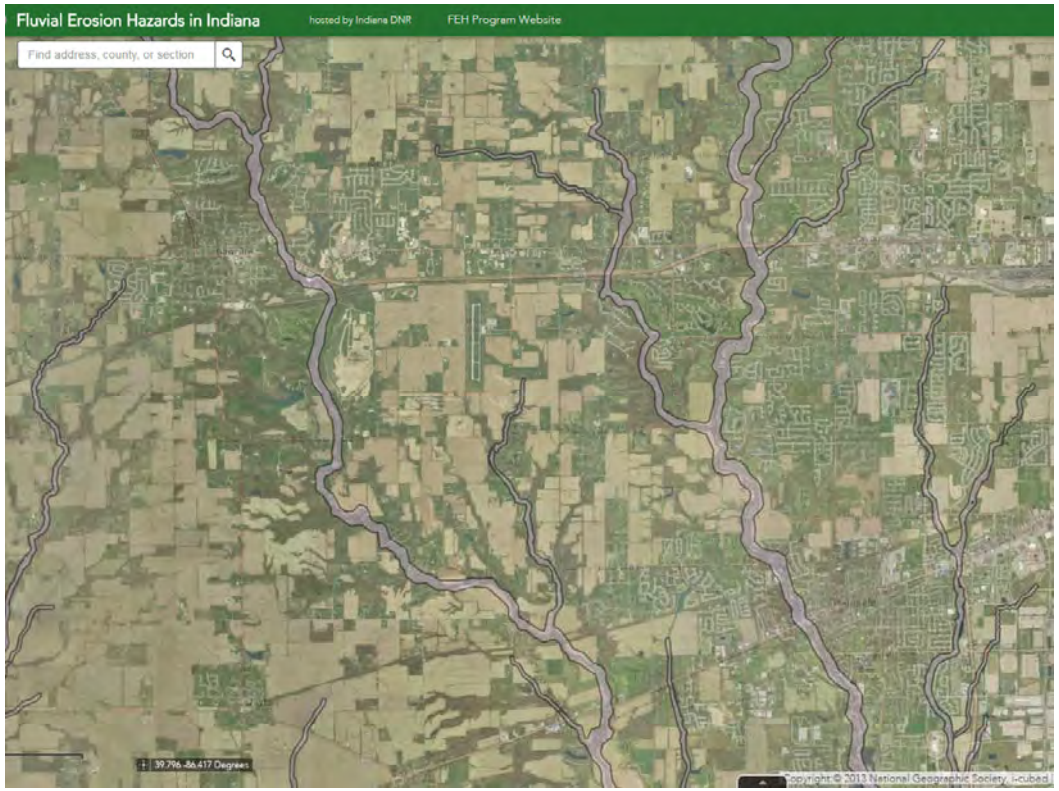


Risk Reduction Strategies



Things to Remember:

- **Expect continued significant migration within expected erosional corridors**
- **Increase in urbanization within the watershed has exacerbated the issues**
- **"Fixing" the problem not likely feasible**
- **The recommended strategies**



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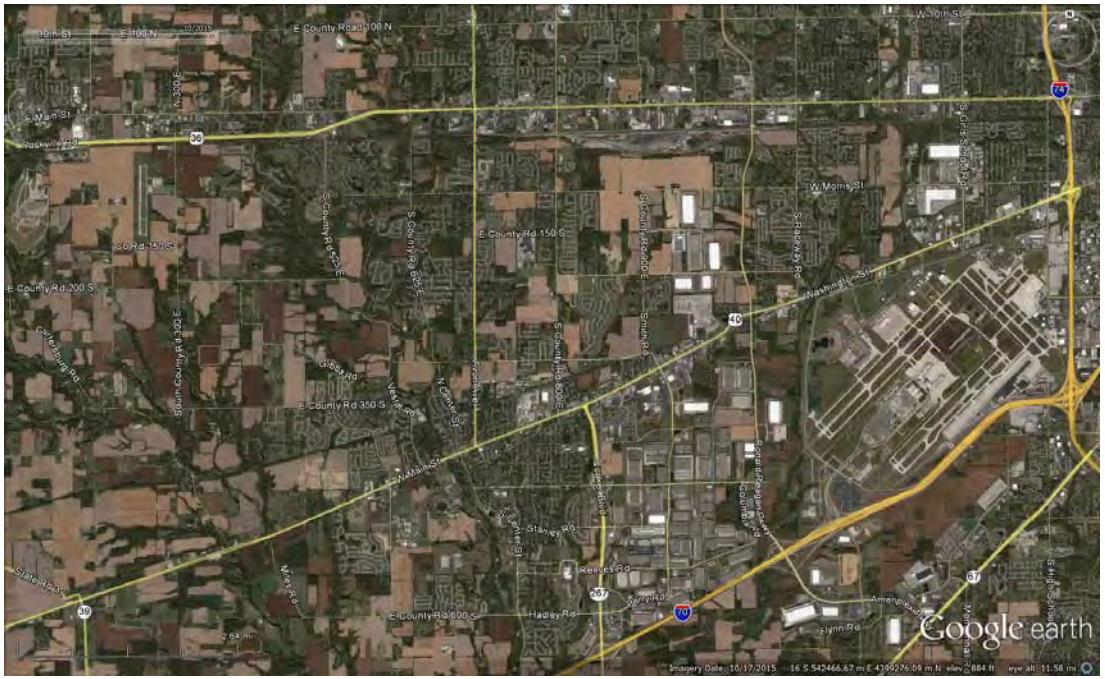

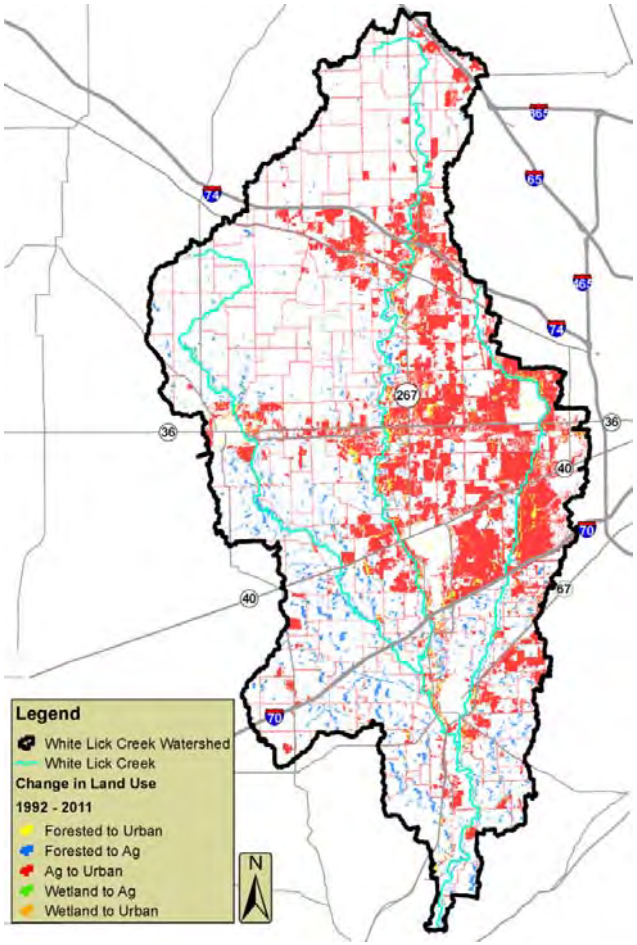

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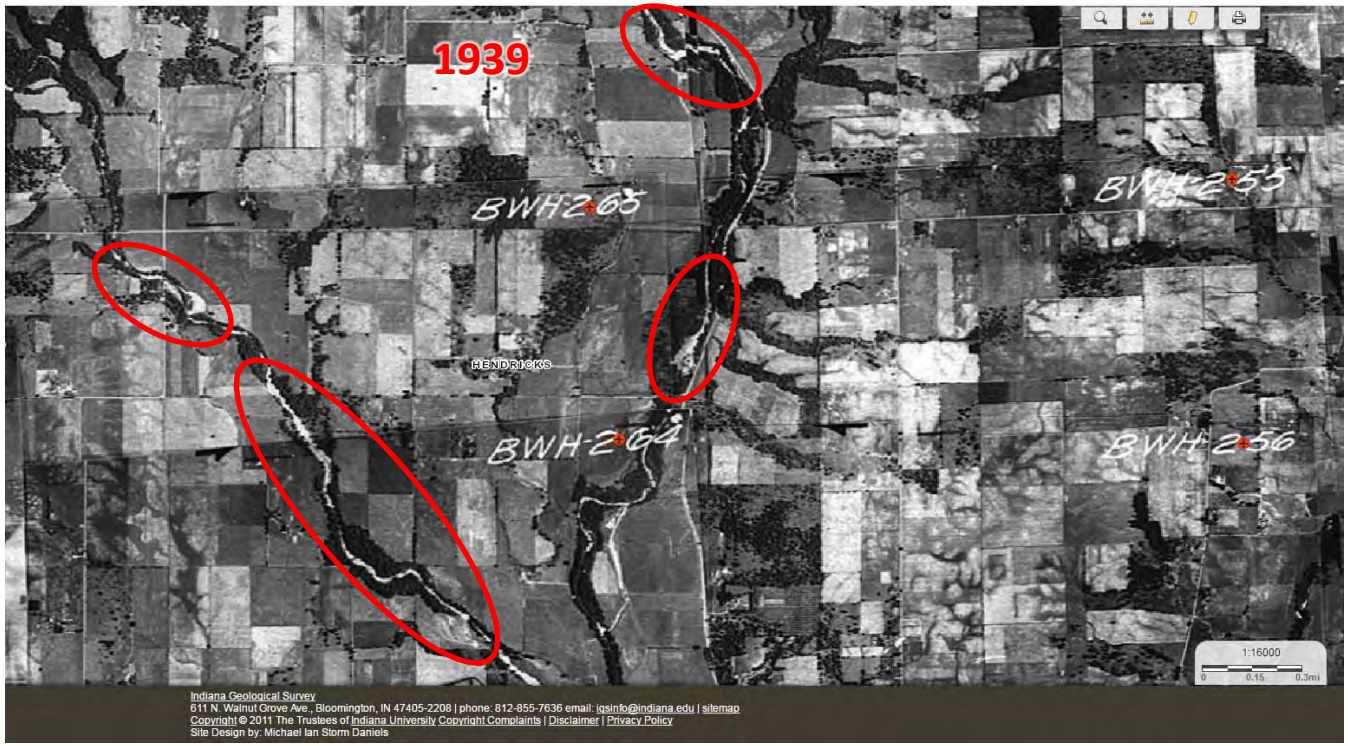
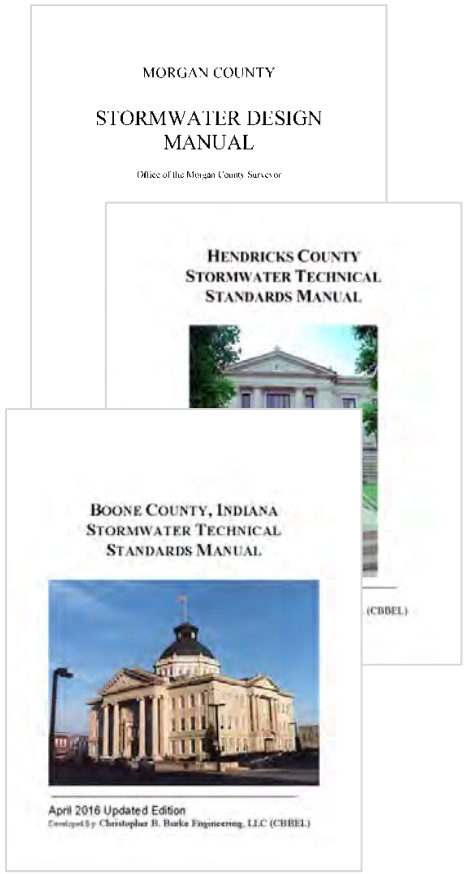


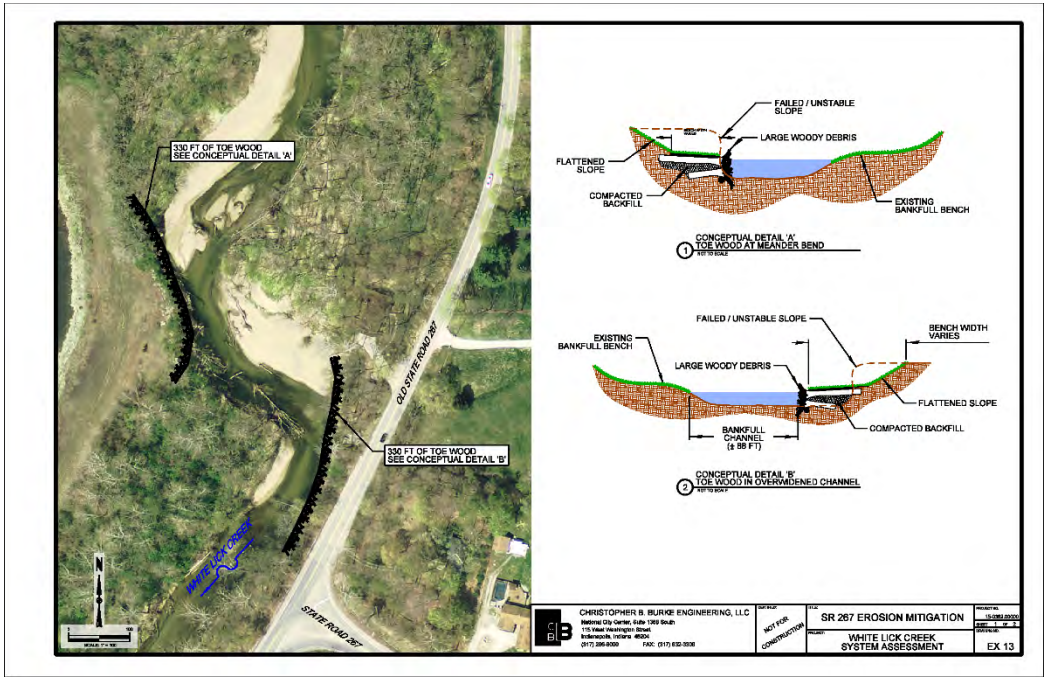


Things to Remember:

- Expect continued significant migration within expected erosional corridors
- Increase in urbanization within the watershed has exacerbated the issues
- "Fixing" the problem not likely feasible
- **The recommended strategies**
  - Multi-jurisdictional Coordination
  - Disturbance Avoidance Zones
  - Channel Protection Volume & GI
  - Detailed Geomorphic Assessment
  - Relocating Threatened Assets
  - Monitoring At-risk Structures
  - Protecting In-place Infrastructure
  - Balanced Tree Management Strategies

STAY AWAY!

(WHERE POSSIBLE)



Questions or Comments?

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Things to Remember:

- **Expect continued significant migration within expected erosional corridors**
- **Increase in urbanization within the watershed has exacerbated the issues by:**
  - Reducing the supply of sediment to stream
  - Increasing flow volume and peak discharge
  - increasing frequency and duration of channel forming (bankfull) events
- **"Fixing" the problem not likely feasible, but one can:**
  - Pursue strategies that would prevent problems from getting worse
  - Pursue strategies that can address the most pressing of the problems in an NAI fashion
- **The recommended strategies include:**
  - Multi-jurisdictional coordination and cooperation within watershed
  - Adopting and enforcing disturbance avoidance zones along undeveloped reaches of streams within the watershed
  - Watershed-wide adoption of Channel Protection Volume and LID/Green Infrastructure provisions
  - Requiring detailed geomorphic assessment for unavoidable projects within erosional corridor
  - Relocating, when feasible, damaged/threatened infrastructure out of the expected erosional corridor
  - Monitoring at-risk structures and assets within the expected erosional corridor
  - Case by case nature-based and morphologically informed streambank stabilization of existing assets in erosional corridor
  - Adopting appropriate morphologically-informed tree management strategies