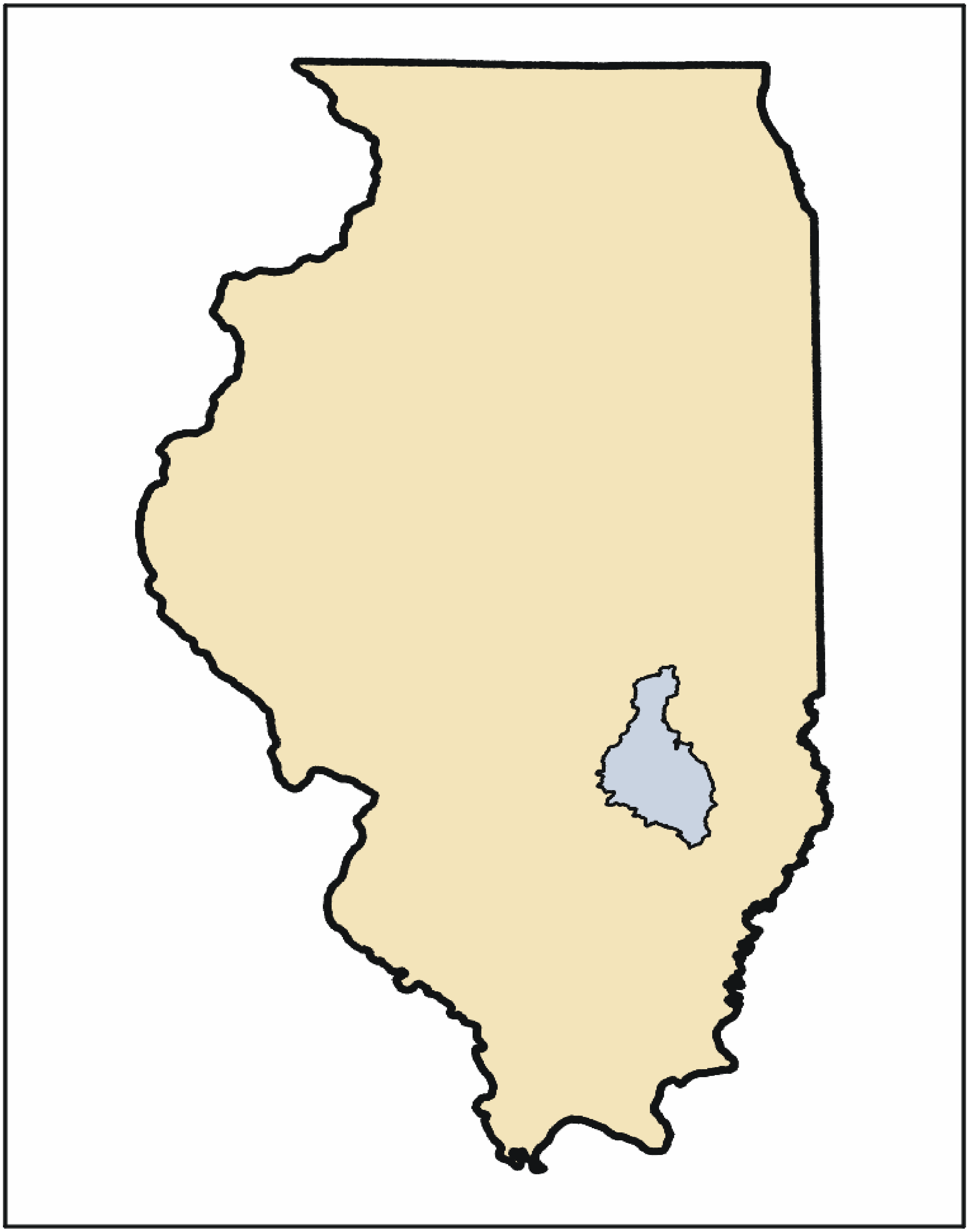

# AERIAL ASSESSMENT OF THE LITTLE WABASH RIVER
## COLES, SHELBY, EFFINGHAM AND CLAY COUNTIES
## June, 2005

**Prepared by Wayne Kinney for IL. Dept. of Agriculture**

The TMDL process on the Little Wabash River in Shelby, Effingham, Coles, Cumberland and Clay Counties started in October 2003. The 2004 303(d) impairments identified in the mainstem of the Little Wabash River are manganese, pH, DO, pathogens, TSS, atrazine and phosphorus. The impairments to be addressed by the TMDL are manganese, pH, DO, pathogens and atrazine. At this time there are no Phase 1 reports published to further identify potential sources and/or treatment needs for this study area.

The study area also includes East Branch Green Creek, Second Salt Creek, Salt Creek, First Salt Creek, Sara Lake, Mattoon Lake and Paradise Lake. This aerial assessment however is limited to approximately 97 miles of the Little Wabash River extending from the confluence with Hog Run Creek at the Clay County line to Lake Mattoon in Shelby County. (Fig. 1) The USGS Gage #03378635 located on the Little Wabash near Effingham has been used to calculate the adjusted 2 yr. storm peak discharges throughout the study area.

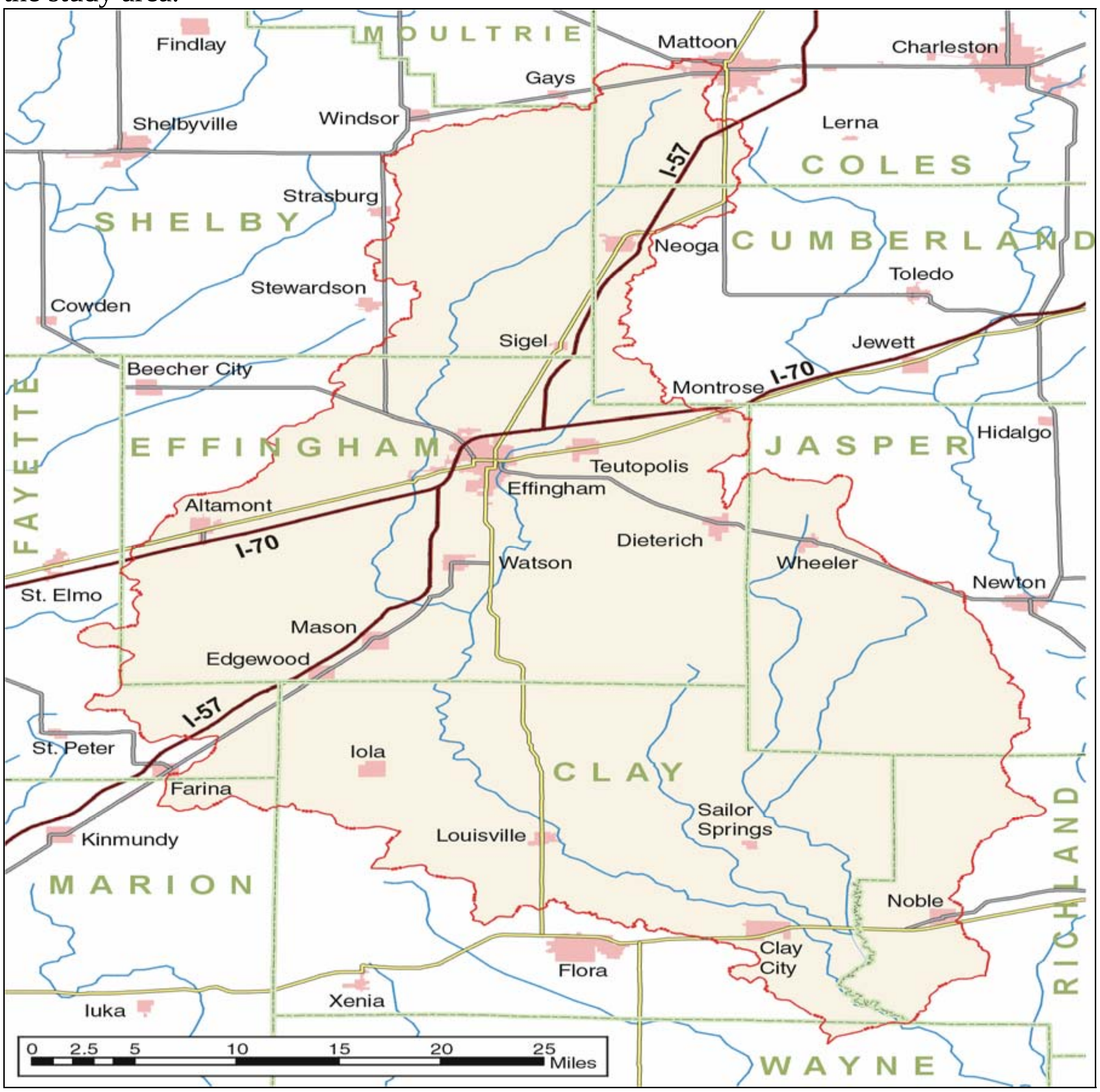


Figure 1. Little Wabash Study Area

**Assessment Procedure**

Low level geo-referenced video was taken of the Little Wabash River in April, 2004. Video taping was completed by Fostaire Helicopters, Sauget, IL, using a camera mounted beneath a helicopter to record data from just above tree top level in DVD format for further evaluation and assessment. Video mapping began at the confluence of Hog Run Creek and continued upstream to Lake Mattoon. Aerial video of tributaries was not part of the project, regardless of the stream size or vegetation.

After videotaping the stream, the DVD tapes were processed by USGS to produce a geo-referenced DVD showing flight data and location. Next, USGS identified features from the video and created shapefiles containing the GPS location, type of feature identified, and the time on the DVD to allow cross referencing. The shape-files along with the DVD were then used to identify and locate the points where ground investigations were needed to verify aerial assessment assumptions and gather additional data.

The ground investigations or “ground truthing” is intended to accomplish two primary functions. First, it provides those viewing videos the opportunity to verify the correct interpretation of the video. Second, the video allows the user to identify and gather field data at the most appropriate locations to more closely represent the entire study portion of the stream.

Detailed elevation data is not available; therefore the channel slope is calculated from USGS topo maps by measuring the channel length between contour lines. The report refers to this as “valley profile” although a true valley profile would use a straight line distance down the floodplain rather than channel length. However, this method is used because it incorporates sinuosity into the calculation and allows the channel slope to be assume equal to “valley slope” in order to estimate channel capacity, velocity, etc., although there are short segments where the channel slope may differ significantly near roads, logjams, knickpoints, etc.

The DVD has been divided in “chapters” of approximately ten minutes of video (Fig. 2) to enhance the ability to navigate within the flight video and provide a simple way to identify and discuss different stream segments. Although the report will begin with a broader more general assessment of the entire study reach, it will also provide an assessment and treatment recommendations by chapter. The chapter divisions are clearly arbitrary and do not reflect “change points” in the stream characteristics or treatment recommendations. For clarity the conclusions and recommendations are presented for each stream “chapter”.

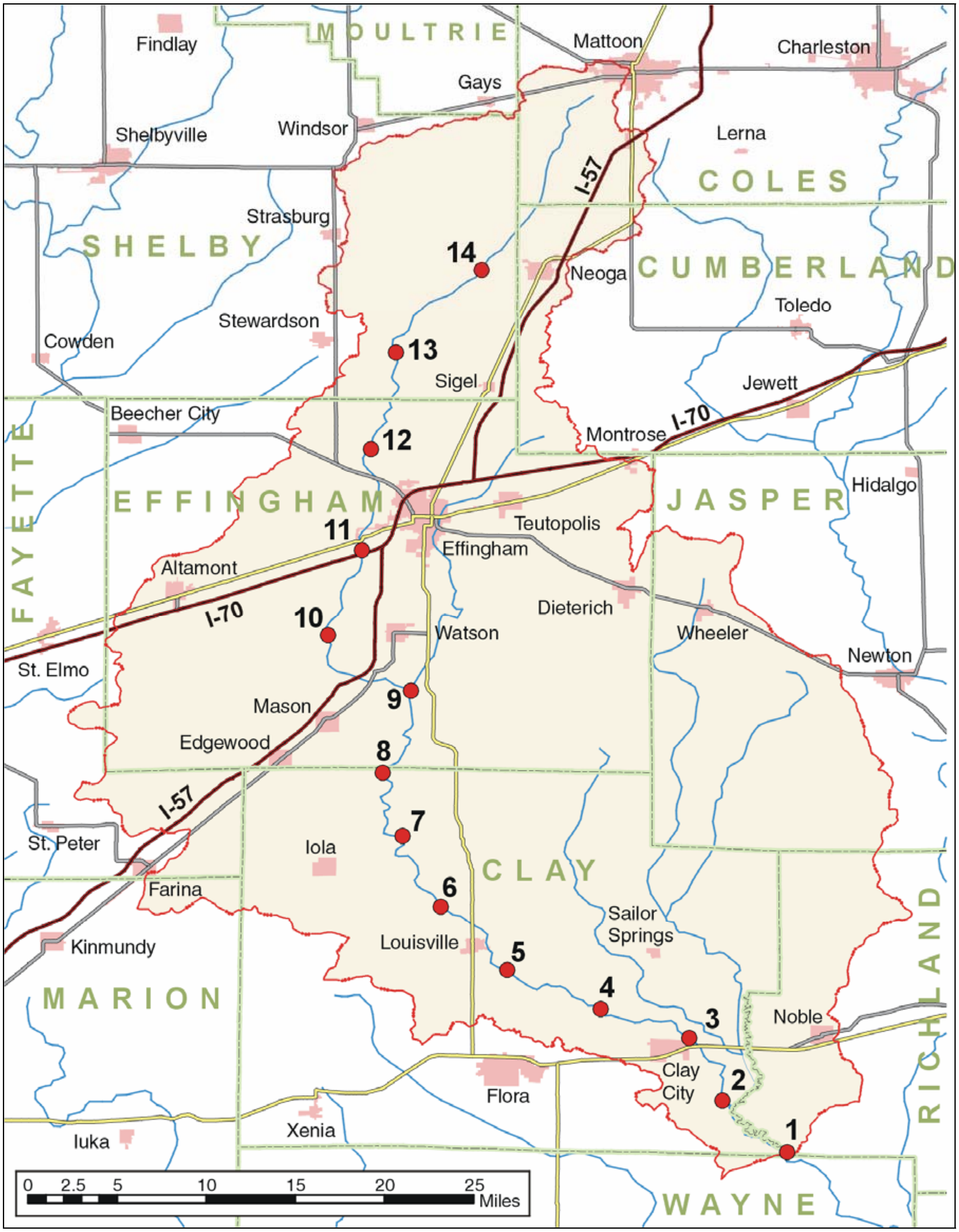


Figure 2. Little Wabash Aerial Assessment Chapter Divisions

The Chapter on the DVD's can be located using the following chart:

| DVD Disc | Chapter on DVD | Chapter on Map (fig. 2) |
|---|---|---|
| 1 | 2 | 1 |
| 1 | 3 | 2 |
| 1 | 4 | 3 |
| 1 | 5 | 4 |
| 2 | 2 | 5 |
| 2 | 3 | 6 |
| 2 | 4 | 7 |
| 2 | 5 | 8 |
| 2 | 6 | 9 |
| 3 | 2 | 10 |
| 3 | 3 | 11 |
| 3 | 4 | 12 |
| 3 | 5 | 13 |
| 3 | 6 | 14 |

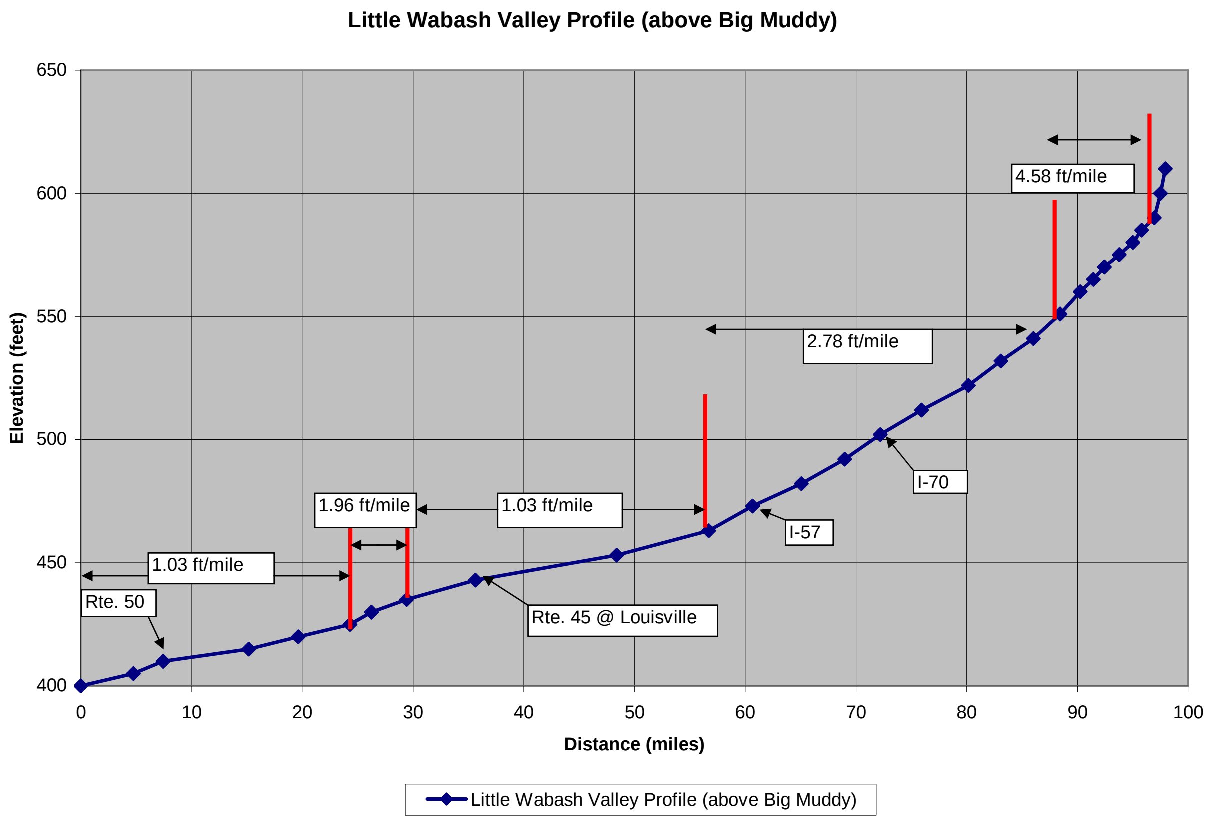


Figure 3. Valley Slope Little Wabash River

The Little Wabash is joined by the Big Muddy Creek at approx. 400 MSL and has a gradient of 1.03 ft/mile for approx. 20 miles. The USGS topographical maps then show an increase in gradient to 1.96 ft/mile for approx. 7 miles before returning to a gradient of 1.03 ft/mile for an additional 30 miles. The increased gradient in this 7 mile reach is disregarded for this study as this reach contains an existing dam on the Little Wabash and a pumping station for the Clay City water supply. Without an accurate channel profile it is assumed that this change in gradient is simply a result of the difference in water surface elevation found above and below the dam. (see Figure 3)
Approximately 57 miles above the Big Muddy Creek confluence and 4 miles below Interstate 57 the gradient increases to an average of 2.78 ft/mile for approx. 32 miles before again increasing to 4.58 ft/mile for 8 miles before reaching Lake Mattoon. There is also a dam on the Little Wabash just below U.S. Rte. 40 that creates a reservoir that the City of Effingham pumps for a portion of its water supply. Curiously there is no change in gradient found on the valley profile created from the USGS topographic maps as there is near the Clay City dam. Further evaluation of the gradient below the Clay City dam may be warranted to determine if there is an actual increase in gradient within this reach.

The major factors indicating channel condition identified from the aerial assessment have been totaled by DVD chapter in Table 1 below. This tabulation allows a general comparison of the relative dominance of features found in each chapter and provides a means of comparing stream characteristic between chapters. A discussion of the major differences will follow later in this report.

**Features Identified by Aerial Assessment in The Little Wabash**

| Chapter | Severe Erosion | Erosion | Geotech Failure | Deposition | Log Jam | Breakpoint | Rock Outcrop |
|---|---|---|---|---|---|---|---|
| **1** | 6 | 30 | 10 | 0 | 1 | 0 | 0 |
| **2** | 0 | 36 | 2 | 0 | 4 | 0 | 0 |
| **3** | 0 | 59 | 19 | 2 | 0 | 0 | 0 |
| **4** | 0 | 14 | 72 | 1 | 1 | 0 | 0 |
| **5** | 0 | 6 | 67 | 1 | 2 | 0 | 6 |
| **6** | 0 | 5 | 79 | 0 | 2 | 0 | 2 |
| **7** | 0 | 2 | 97 | 0 | 1 | 0 | 4 |
| **8** | 0 | 1 | 131 | 2 | 5 | 0 | 4 |
| **9** | 0 | 8 | 90 | 0 | 4 | 0 | 11 |
| **10** | 0 | 94 | 12 | 0 | 8 | 0 | 2 |
| **11** | 2 | 66 | 6 | 10 | 4 | 2 | 4 |
| **12** | 0 | 107 | 0 | 16 | 1 | 1 | 7 |
| **13** | 3 | 71 | 1 | 11 | 4 | 9 | 16 |
| **14** | 0 | 5 | 0 | 0 | 0 | 2 | 2 |

Table 1. Features by Chapter on Aerial Assessment

Eleven cross sections were taken at selected locations on the Little Wabash after viewing the DVD’s. The cross sections are located at “riffle” locations to best represent the channel characteristics and to allow for comparison of width, depth, x-sec. area, etc. along the channel at similar geometric locations. The results of the hydraulic analysis at each site is presented in summary form in Table 2 and each cross section is provided in more detail in Appendix A. Aerial views of cross sections locations are shown in Figs. 6-10. Exact locations as Eastings and Northings can be found in Appendix A

**CROSS SECTION SUMMARY --LITTLE WABASH RIVER**

| X-sec | ADA | Q2 cfs | BKF cfs | BKF/sq.mi. | BKF Width | Max D | Vel. FPS | W/D | Top Bk. Depth | BKF X- Area | Top Bk X- Area | BKF cfs/ Q2 cfs | Top Bk/ BKF area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 72.34 | 2839 | 1567 | 21.66 | 94 | 9 | 3.1 | 17.5 | 9 | 504 | 504 | 0.55 | 1.00 |
| 2 | 110.7 | 3773 | 2240 | 20.24 | 102 | 7.5 | 3.7 | 17.2 | 12 | 605 | 1108 | 0.59 | 1.83 |
| 3 | 125.4 | 3794 | 2547 | 20.31 | 68 | 11.9 | 3.9 | 7 | 13.4 | 657 | 773 | 0.67 | 1.18 |
| 4 | 216.1 | 4800 | 3398 | 15.72 | 110 | 13.6 | 3.4 | 12.1 | 16.2 | 1009 | 1382 | 0.71 | 1.37 |
| 5 | 250 | 4695 | 3298 | 13.19 | 92 | 13 | 3.7 | 9.6 | 13 | 880 | 1030 | 0.70 | 1.17 |
| 6 | 372 | 6221 | 5091 | 13.69 | 128 | 15.5 | 3.8 | 10.4 | 19.2 | 1330 | 1846 | 0.82 | 1.39 |
| 7 | 376 | 6273 | 5180 | 13.78 | 104 | 15.4 | 4.2 | 8.7 | 15.4 | 1248 | 1387 | 0.83 | 1.11 |
| 8 | 556 | 9533 | 1999 | 3.60 | 172 | 12 | 1.8 | 26.4 | 12 | 1120 | 1120 | 0.21 | 1.00 |
| 9 | 602 | 9524 | 2089 | 3.47 | 105 | 16.1 | 2 | 10.7 | 16.1 | 1033 | 1033 | 0.22 | 1.00 |
| 10 | 756 | 11682 | 3388 | 4.48 | 138 | 15.5 | 2.4 | 13.7 | 15.5 | 1392 | 1392 | 0.29 | 1.00 |
| 11 | 791 | 10199 | 3896 | 4.93 | 130 | 15 | 2.7 | 11.5 | 15 | 1470 | 1470 | 0.38 | 1.00 |

Table 2. Summary of Cross Section Data

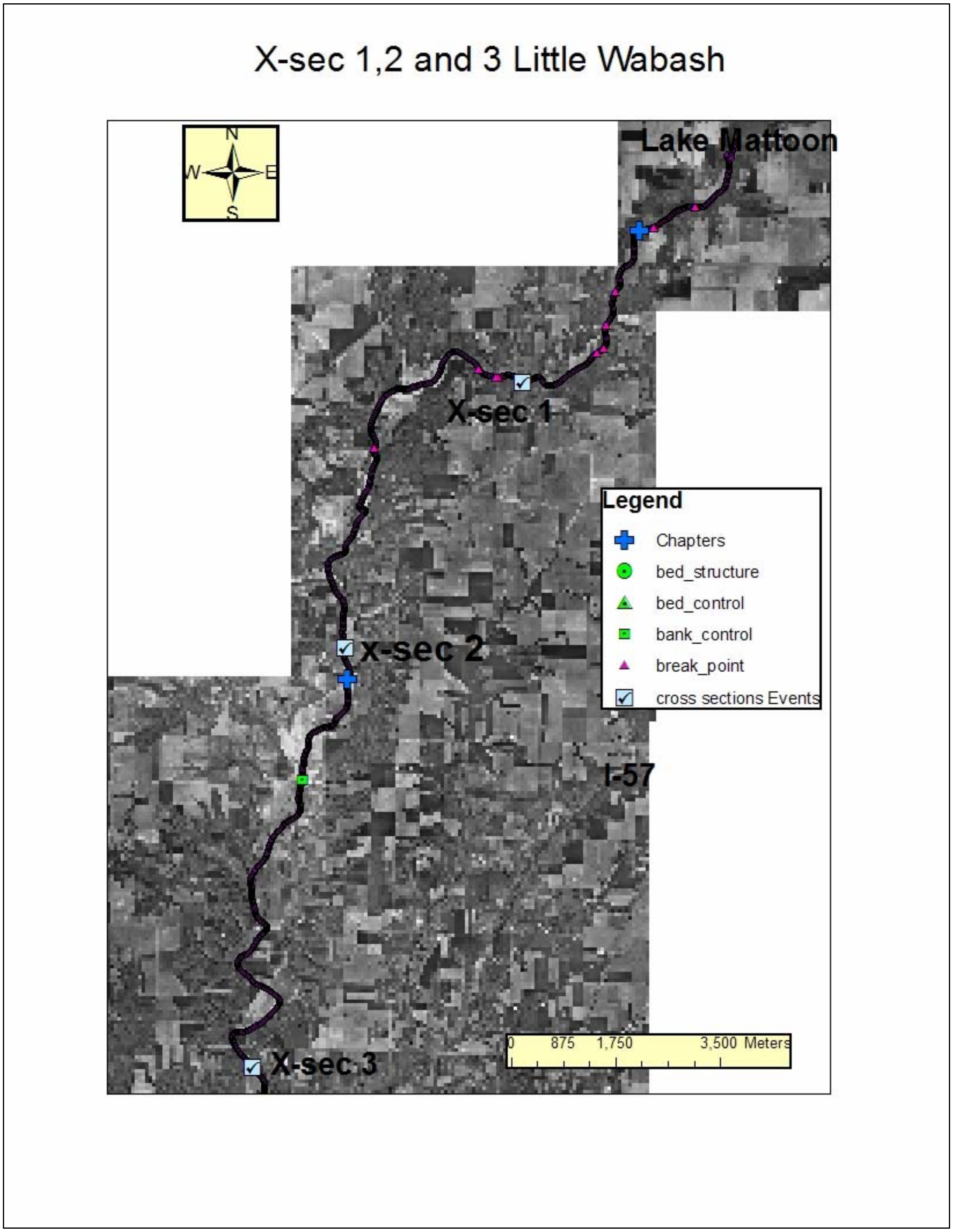


Fig. 6 Cross Section 1,2 and 3 Locations

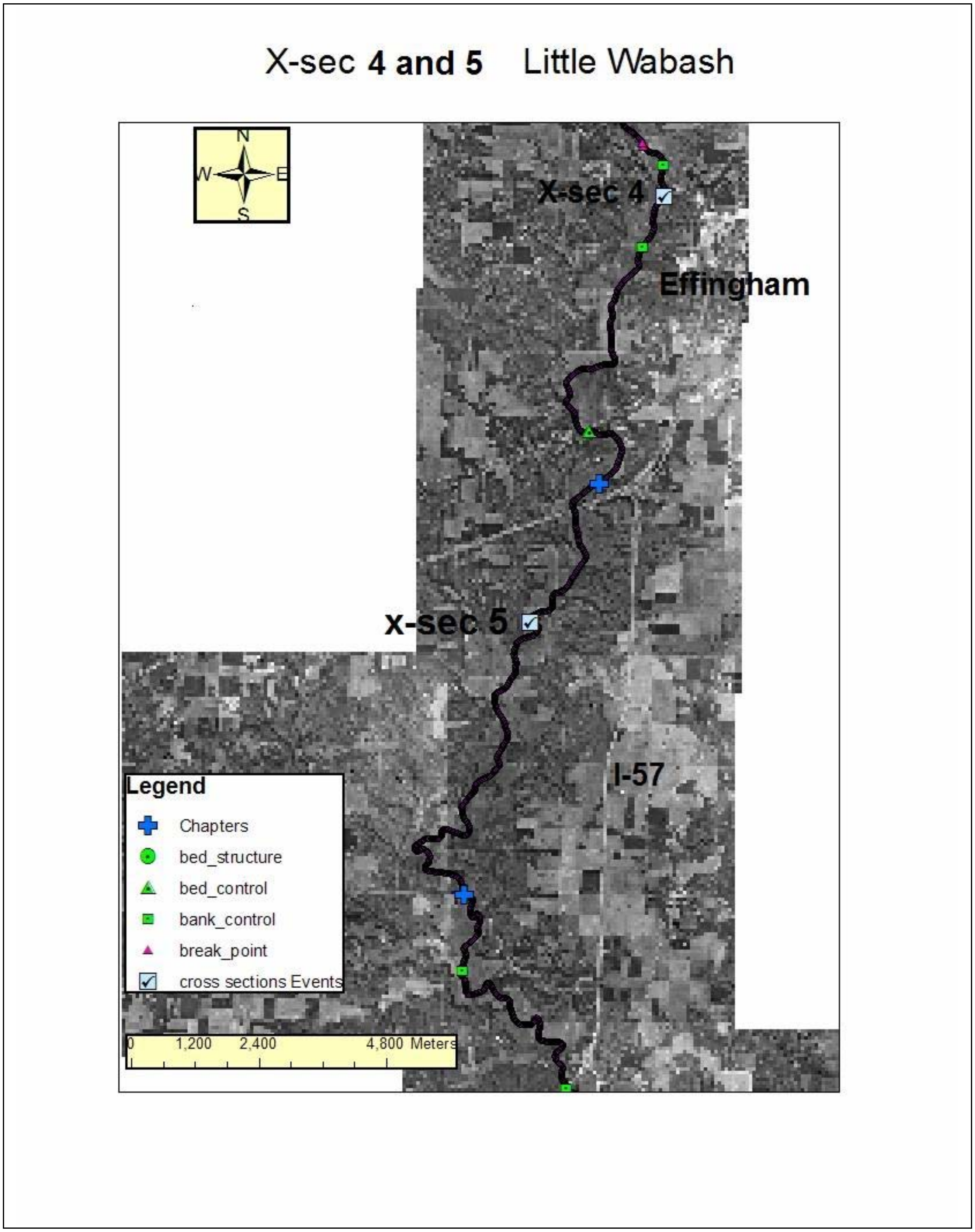


Fig. 7 Cross section 4 and 5 Locations

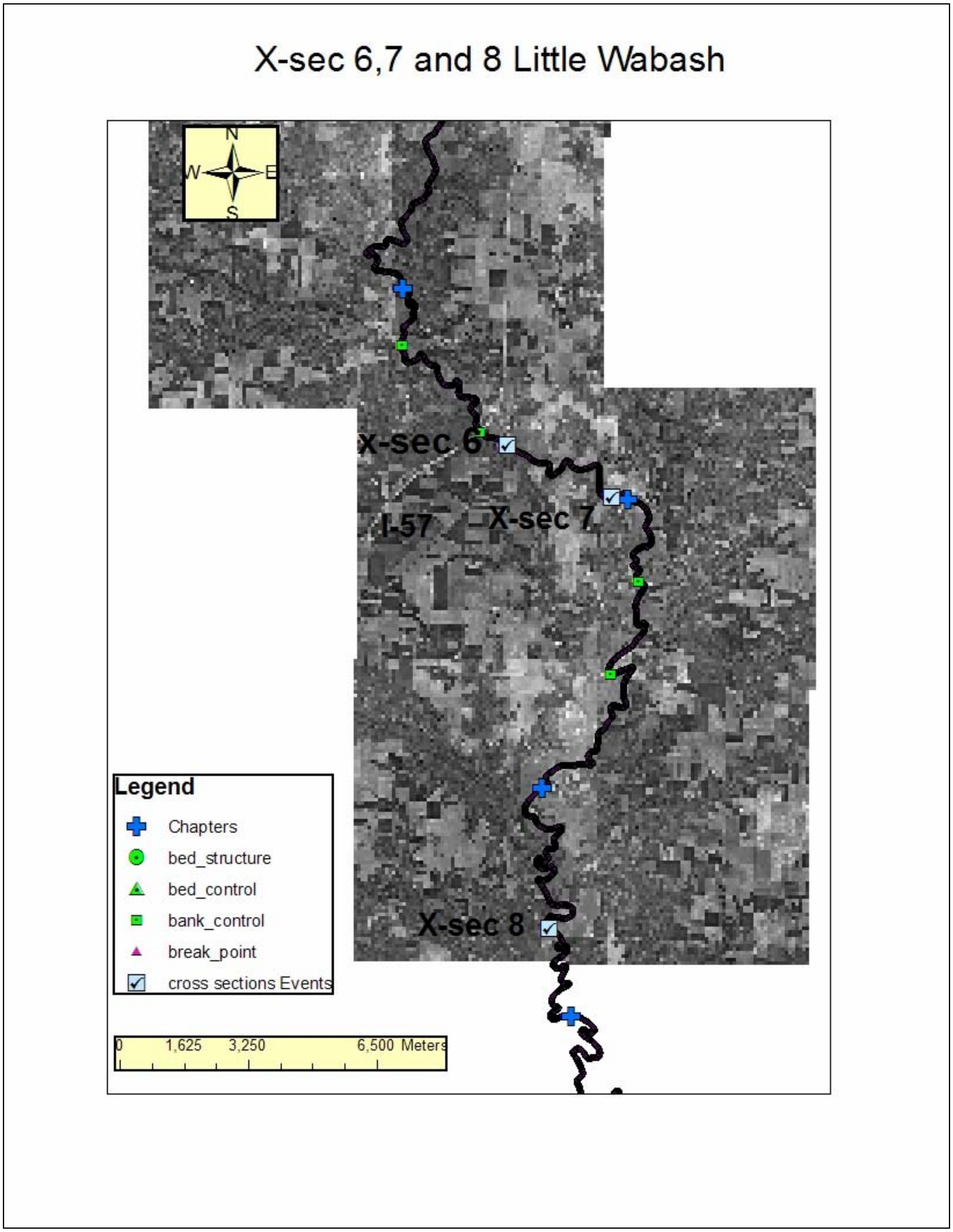


Fig. 8 Cross Section 6, 7 and 8 Locations

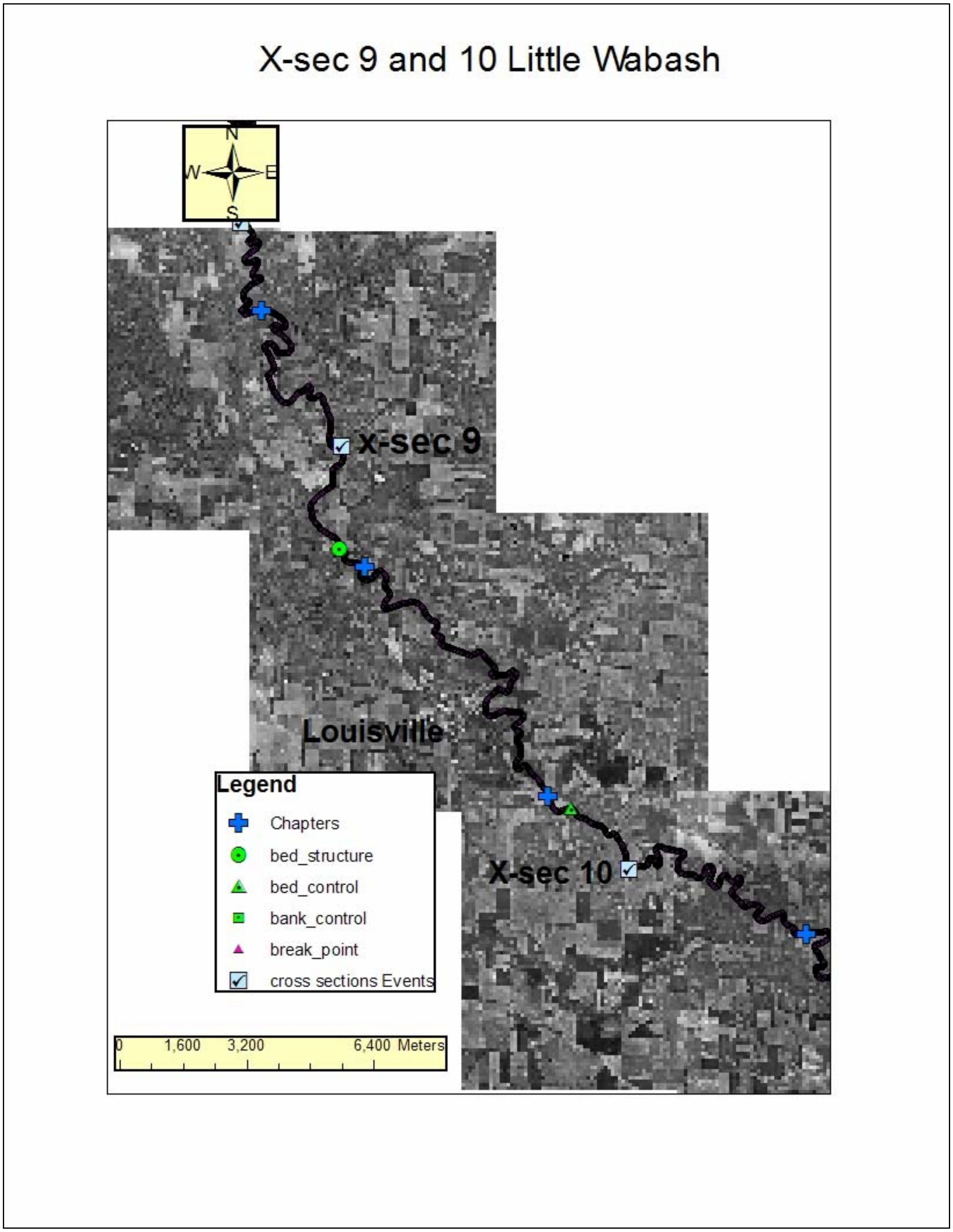


Fig. 9 Cross Section 9 and 10 Locations

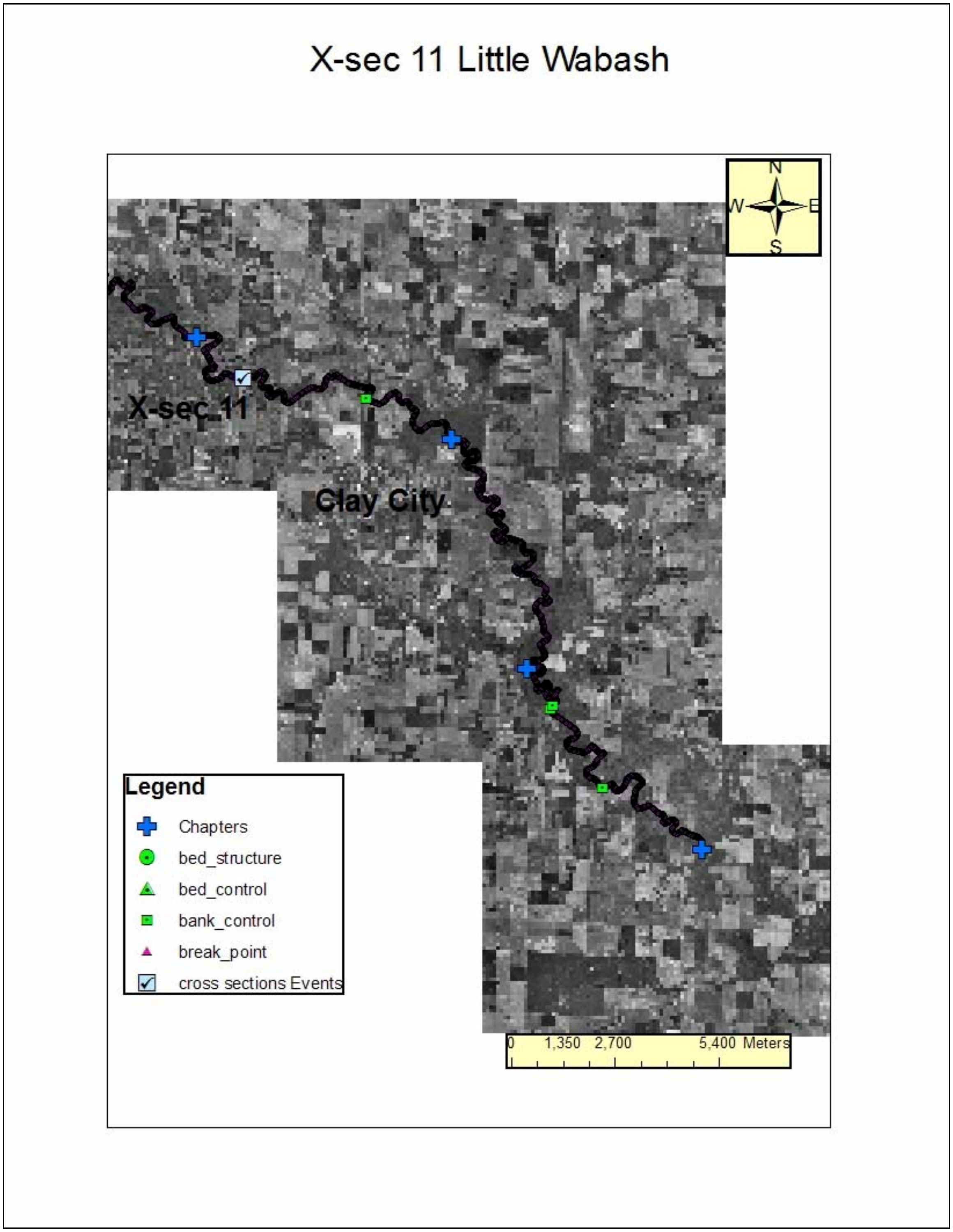


Fig. 10 Cross Section 11 Location

**General Observations**

1. Erosion on the middle section of the study area in Chapters 4 thru 9 is classified as primarily "geotechnical failures" caused by soils and geology found in the bank material and statigraphy. Erosion on the upper and lower portion of the study area however is primarily classified as "bank erosion" caused by channel flows. If the study is divided in three sections, middle, lower and upper reaches with the middle section being chapters 4 thru 9 a very significant change is noted. The lower and upper reaches have "bank erosion" occurring at a ratio of nearly 10 to 1 over geotechnical failures (479 to 50) while the lower reach has geotechnical failures occurring at nearly 15 to 1 over "bank erosion" (536 to 36). (see Fig. 5)

Fig. 4 Geotech Failure near X-sec 6 below Interstate 57.

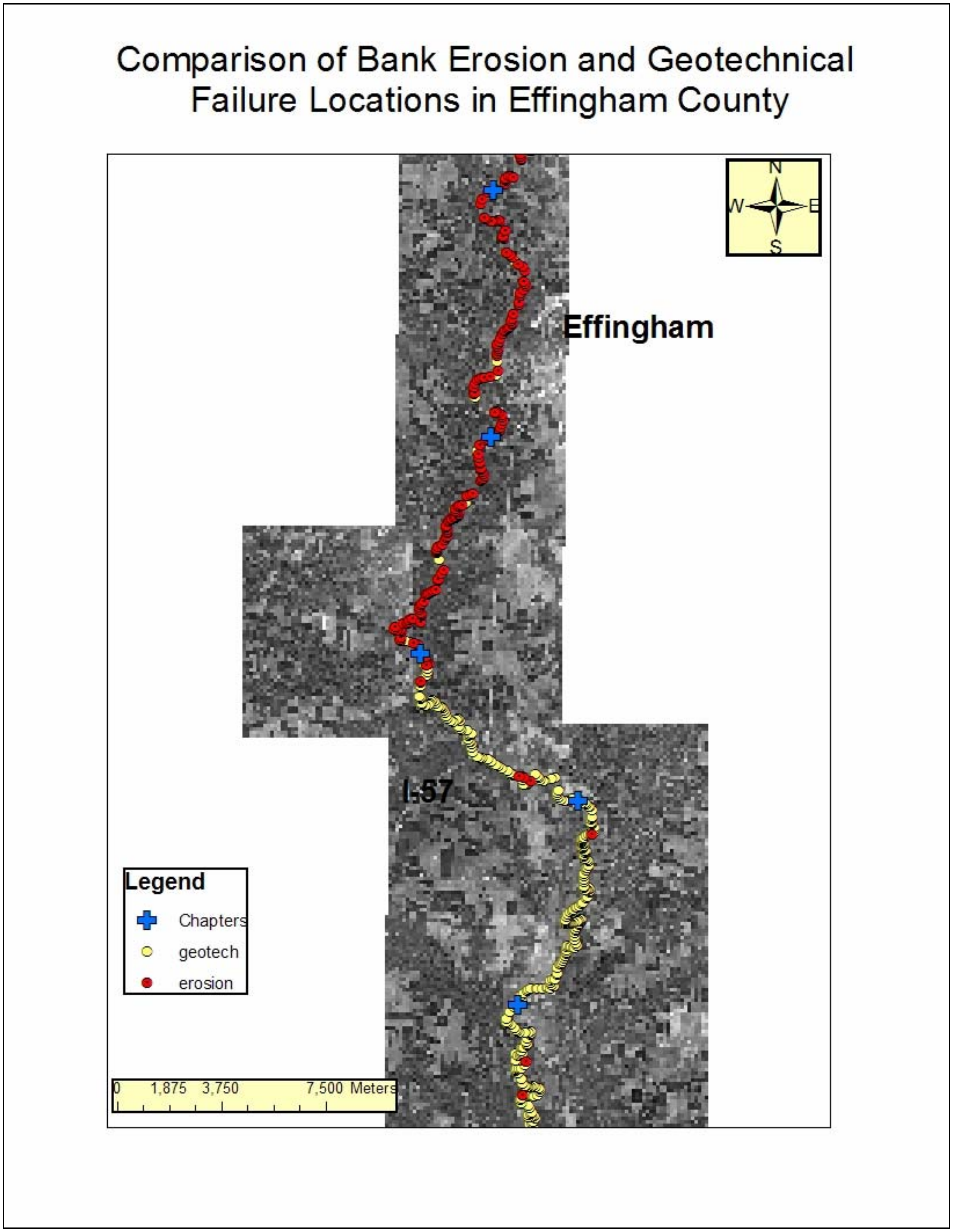


Figure 5. Comparison of Bank Failure Mode: Change in mode occurs abruptly just above Interstate 57. Another abrupt change occurs northwest of Clay City between chapters 3and 4.

2. The valley slope changes very near the change in bank failure mode (between chapters 8 and 9 and near x-sec 6) from 1.03 ft/mi. in the lower reaches to 2.78 ft/mi. in the upper reaches. (see Fig. 3)
3. Below x-sec 7 the velocity drops from 4.2 ft/sec. to around 2.0 ft/sec.
4. Cross section 1 (chapter 13)carries 55% of predicted Q2 discharge at top low bank elevation. A Probability Curve plotted for Gage #03378635 (Fig. 11.--1981 to 2004 data) shows the 1.5 yr. return interval storm to be about 78% of the 2 yr. maximum peak discharge. The 55% figure at X-sec 1 then equates to an approx. return interval of less than 1.05 R.I. and by definition makes top bank the “geomorphic bankfull”.
5. Cross sections 2,3,4 and 6 have lower “geomorphic bankfull depths” than low top bank, they are, by definition incised channels. However the bankfull flow calculations maintain 59% to 82% of the predicted Q2 flow at each site. These figures compare very well with the 78% of Q2 at x-sec 1 and support the field determined bankfull elevations to have a R.I. in the acceptable range near 1.5 yr.
6. The channel capacity in the downstream reach (chapter 1-7 and x-sec 8-11) is only approx. 21% to 38% of the predicted Q2 discharge compared to 55% to 82% in the upper reach. This represents a R.I. of much less than 1 and indicates a channel capacity that is undersized and floods very frequently.
7. Soils adjacent to the stream in chapters 9 thru 12 (x-sec 2-7) are Horton silt loam and Wirt loam. Both are formed in loamy and sandy alluvium and have very low shear strength and play a significant role in the bank erosion found in this reach. Permeability is 0.6 to 2.0 in/hr and can be as high as 20 in/hr on Wirt soil type.
8. Chapters 9 thru 12 show very significant movement of bedload in the form of “sand waves” during low flow. Under high flow events the channel dimension may change significantly depending on the amount of “bedload” that becomes “wash load” (Fig.17).
9. Probability curves of the gages at Effingham and Clay City on the Little Wabash show the 1.5 yr. R.I. discharge to equal 21.67 and 12.38 cfs/sq. mile of drainage respectively. However the channel capacity determined from cross sections decreases steadily from 21.66 cfs/sq. mile at X-sec. 1 to less than 5 cfs per sq. mile at cross sections 8 thru 11. This data suggests that the channel is undersized and maybe adjusting to changing flow regimes.

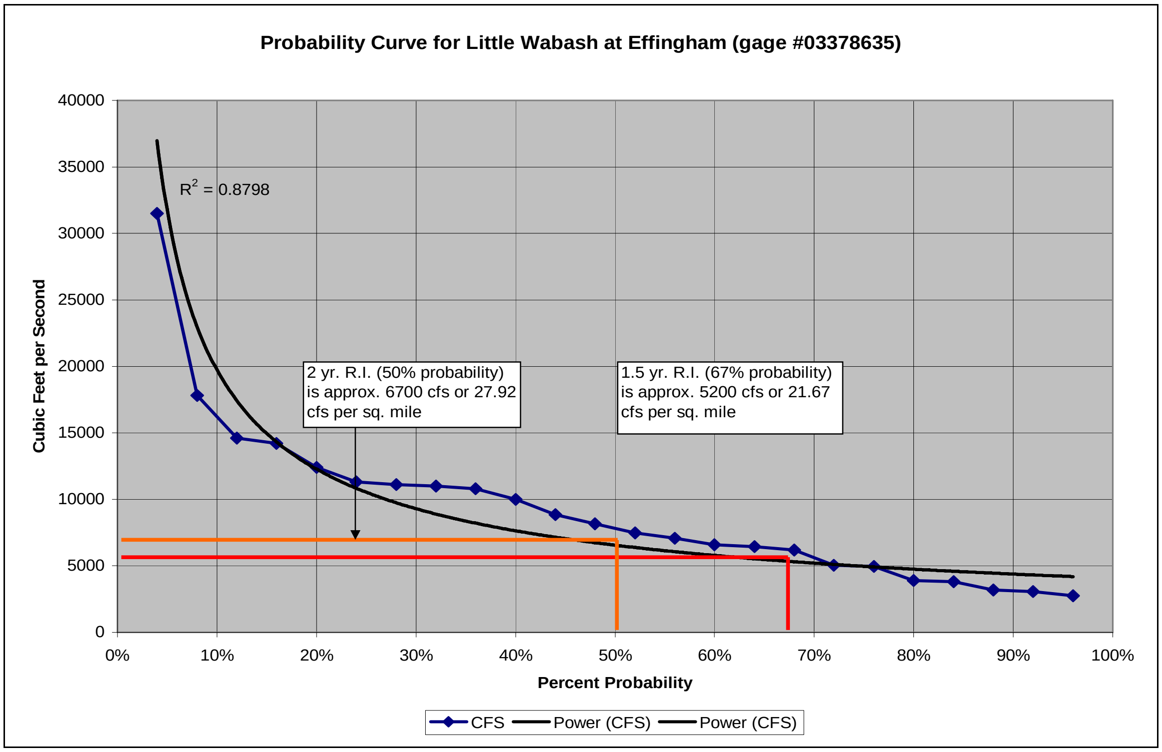


Fig. 11 Probability curve for Maximum Annual Peak Discharge USGS Gage #03378635

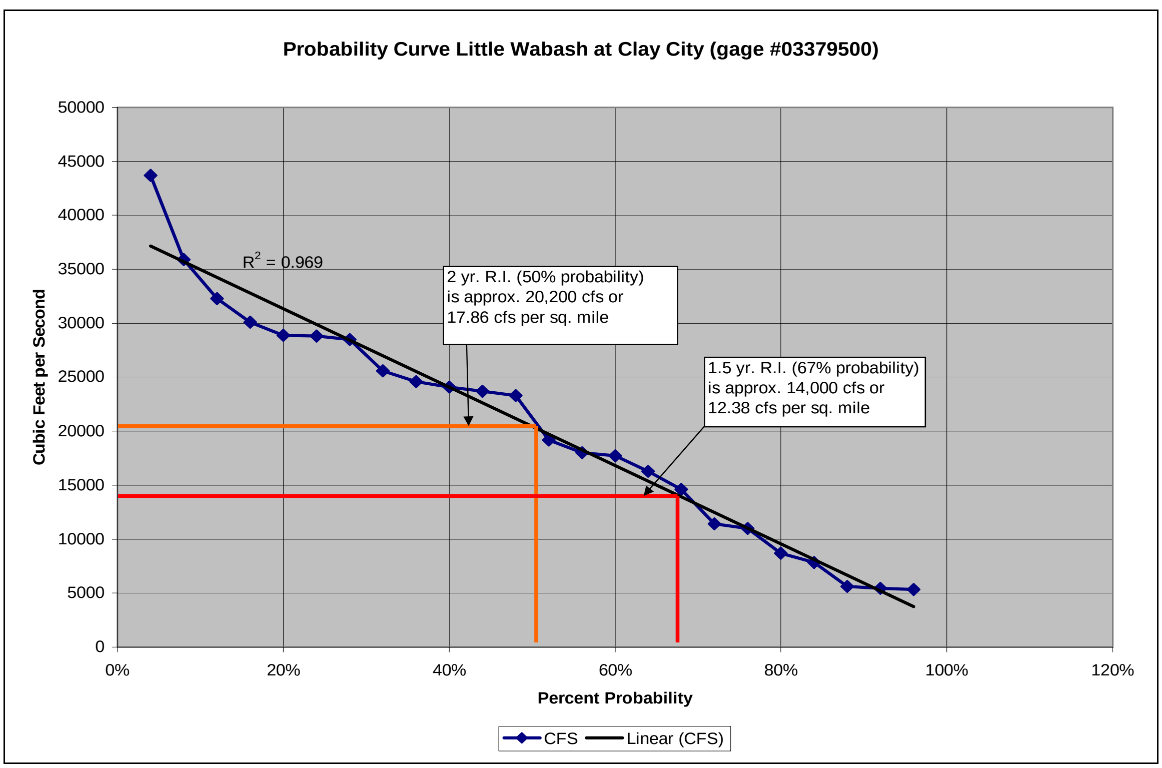


Fig. 12 Probability Curve: Annual Maximum Peak Discharge, USGS Gage #03379500

10. A second plot of the Annual Maximum Peak Discharges at both gages indicates an upward trend in peak flows of approx. 225% since records have been collected at Effingham beginning in 1967(Fig. 13). A plot of the Annual maximum Peaks at Clay City indicate an increase of 47% over the same time period (Fig. 14).

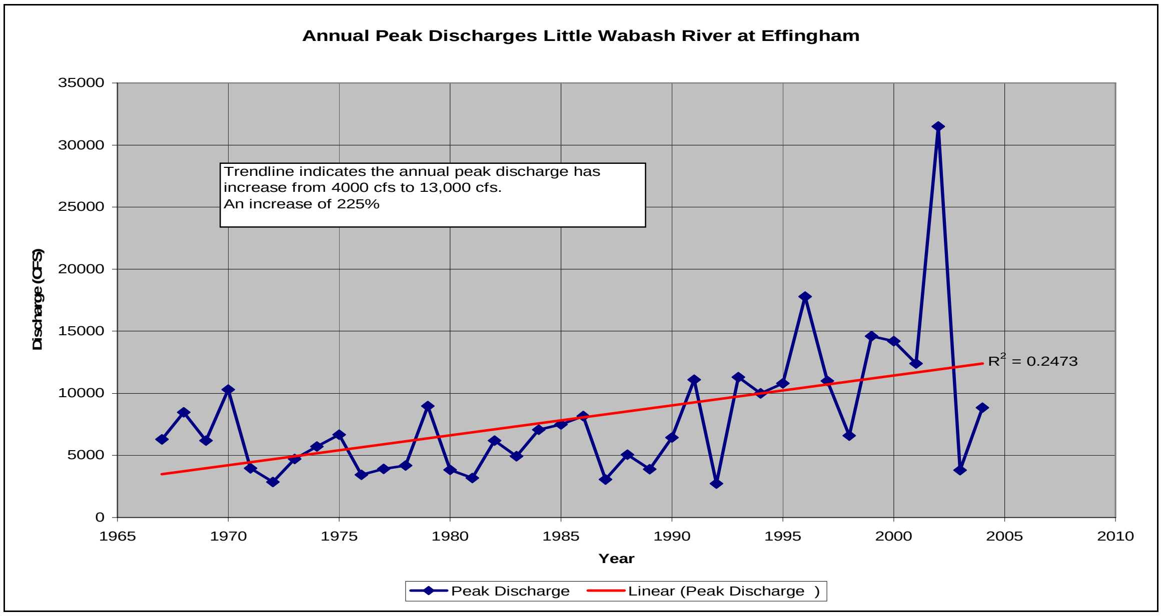


Fig. 13 Linear Trendline for Annual Maximum Peak Discharges USGS Gage #03378635 from 1967 thru 2004.

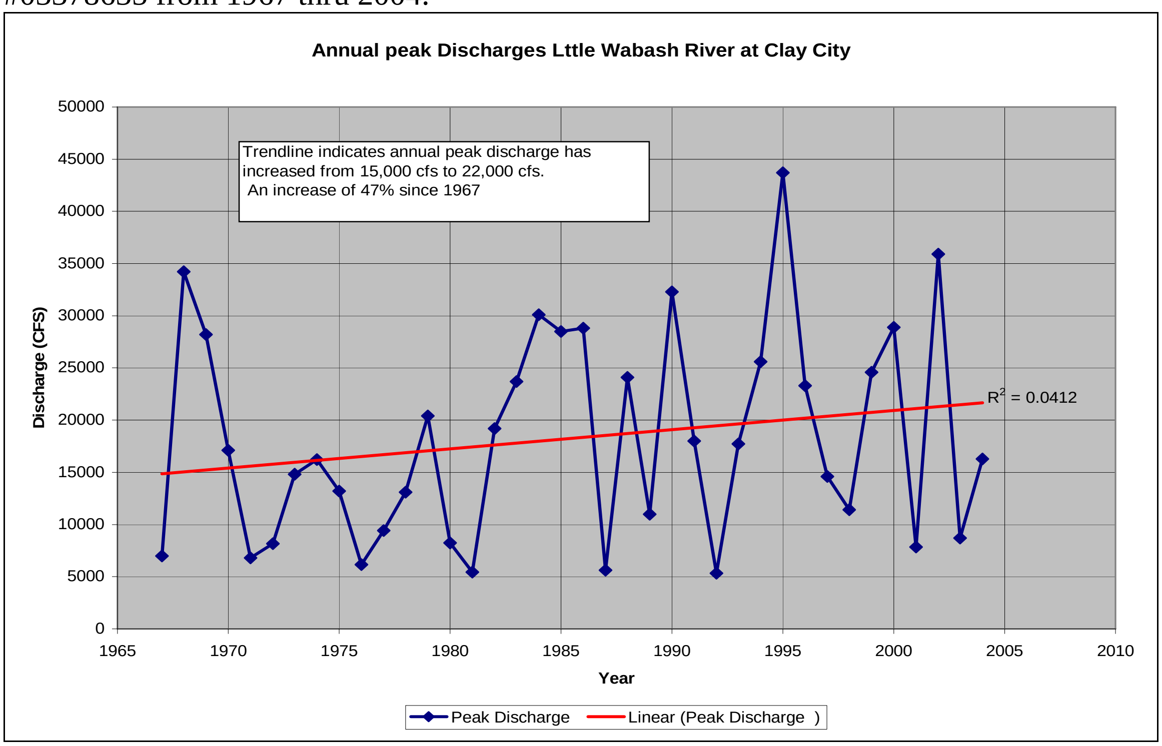


Fig. 14 Linear Trendline for Annual Maximum Peak Discharges for USGS Gage # 03379500 from 1967 thru 2004

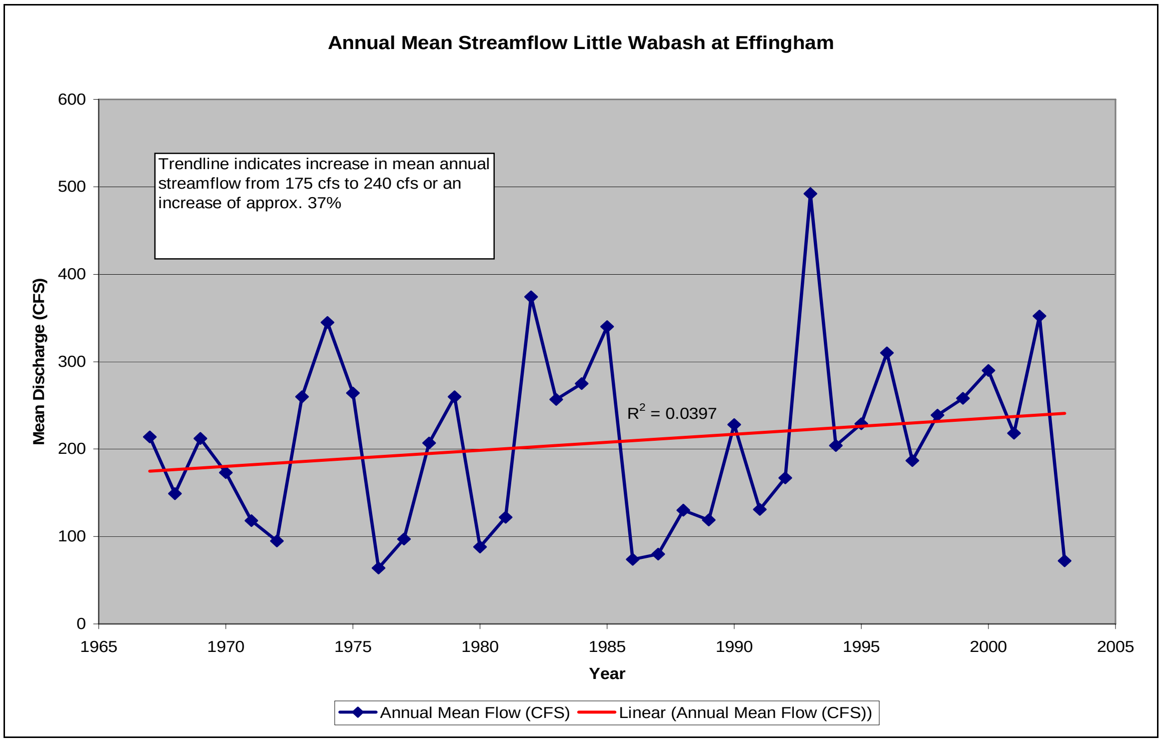


Fig. 15 Linear Trendline for Annual Mean Flow, USGS Gage #03378635 for 1967 thru 2003

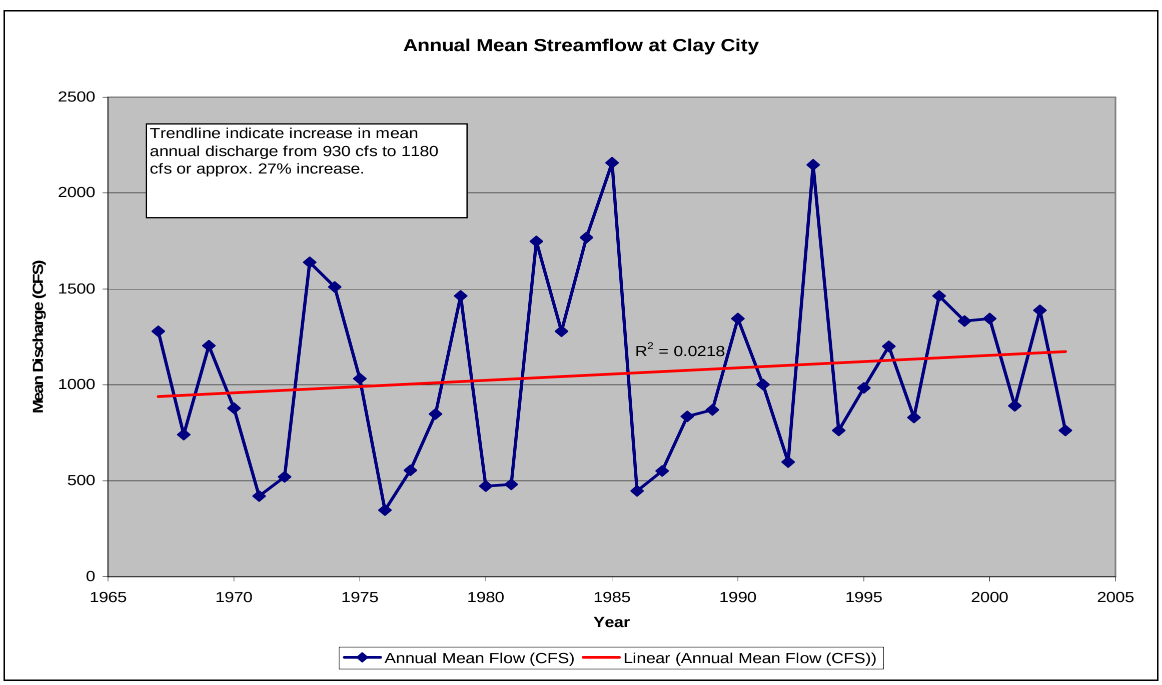


Fig. 16 Linear Trendline for Annual Mean Flow for USGS Gage # 03379500 for 1967 thru 2003.

11. A third plot of the Annual Mean Streamflow records over the same period at the same gages shows an increase of 37% at Effingham(Fig. 15) and 27% at Clay City(Fig. 16).
12. Erosion in all of the Little Wabash is likely driven by the increase in annual peak flows recorded at USGS gages at Effingham and Clay City. Both gages show increases in annual peak flows when a linear trendline is established. Since the widely accepted "channel forming" flows occur between the 1 and 2 yr. return interval discharge, this increase in annual discharge necessitates some major channel changes as the stream adjust to the new higher flows. What is unknown is the exact causes of the new discharge levels and if the flows will remain at these higher discharges.
13. In general the erosion failure mode in the Little Wabash in Chapters 8-12 occurs due to a combination of highly permeable soils with low shear strength often overlaying low permeability subsoils. Where the low permeability soils are above the channel bed, seeps occur and geotechnical failures are dominant. Where the highly permeable soils comprise the entire bank height, bank erosion occurs as bank caving or mass failures and has not been classified as "geotechnical" although primarily soils related due to low shear strength.
14. The bank failure in the Little Wabash is a **system wide failure** caused by a combination of easily eroded soils and increased discharges. There are no readily available treatment options other than a holistic approach of stream restoration, or the "no action" alternative which will allow the channel evolution process to continue until the channel reaches a new equilibrium under the current and future flow regime. There are reaches that are incised and therefore disconnected to the floodplain (x-sec. 2, 3, 4 and 6) where use of a riffle-pool sequence could be a means to encourage the establishment of a more stable channel.

Fig. 17 Typical "Sand Wave" found in Chapters 9 thru 12

# Aerial Views of Stream Chapters and Features Identified by Aerial Assessment

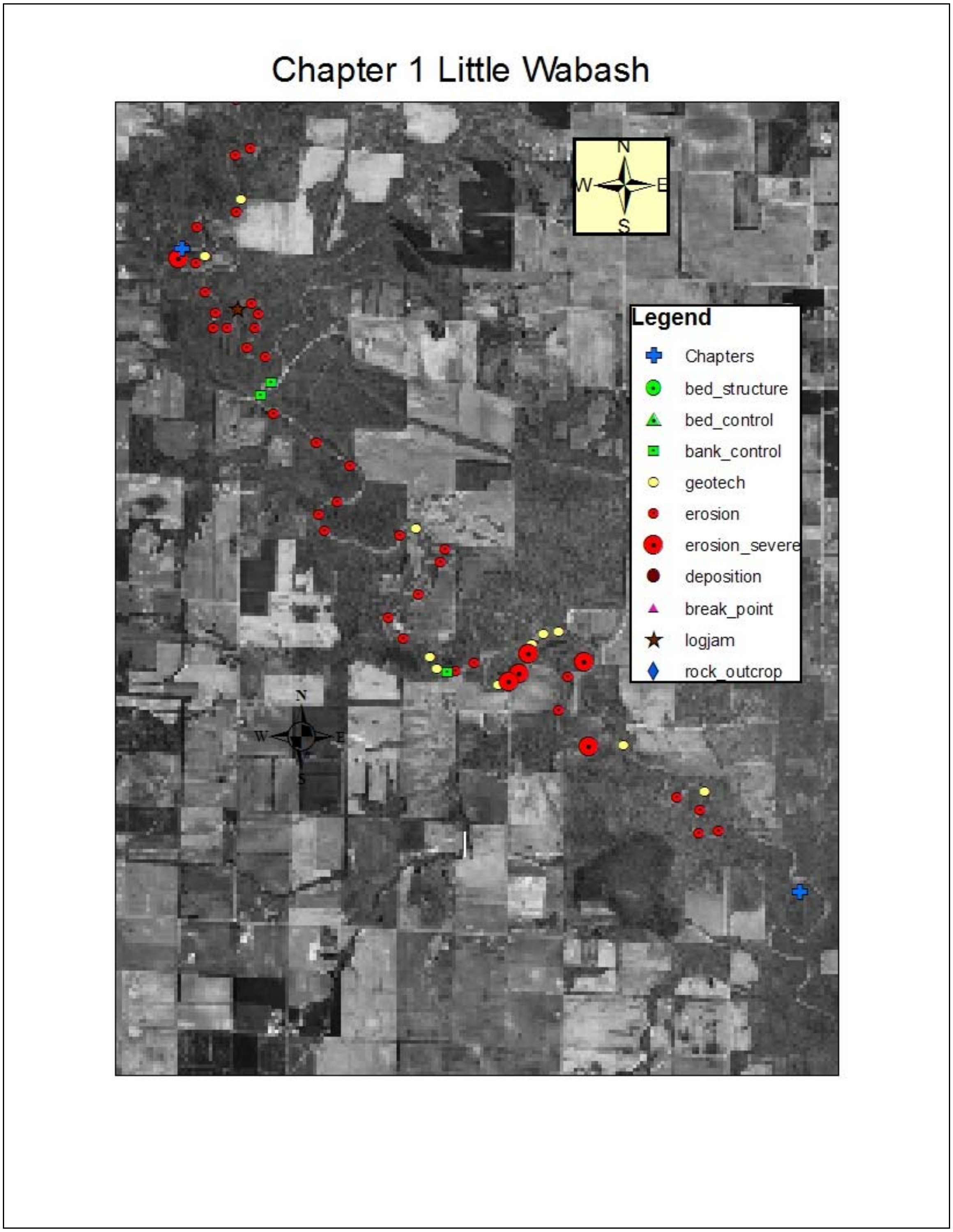


Fig. 18  Chapter 1 Little Wabash River (most downstream reach of study)

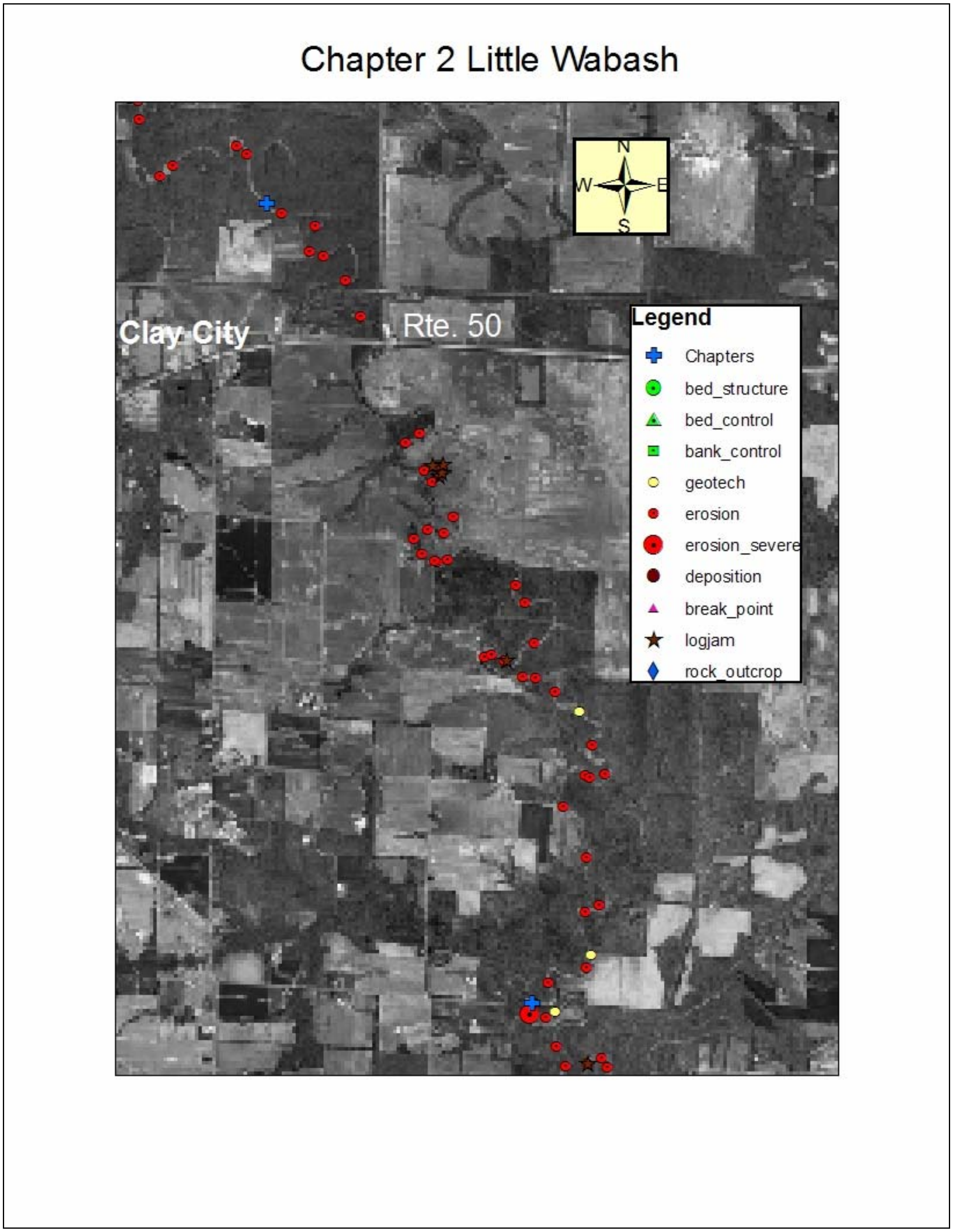


Fig. 19 Chapter 2 Little Wabash River

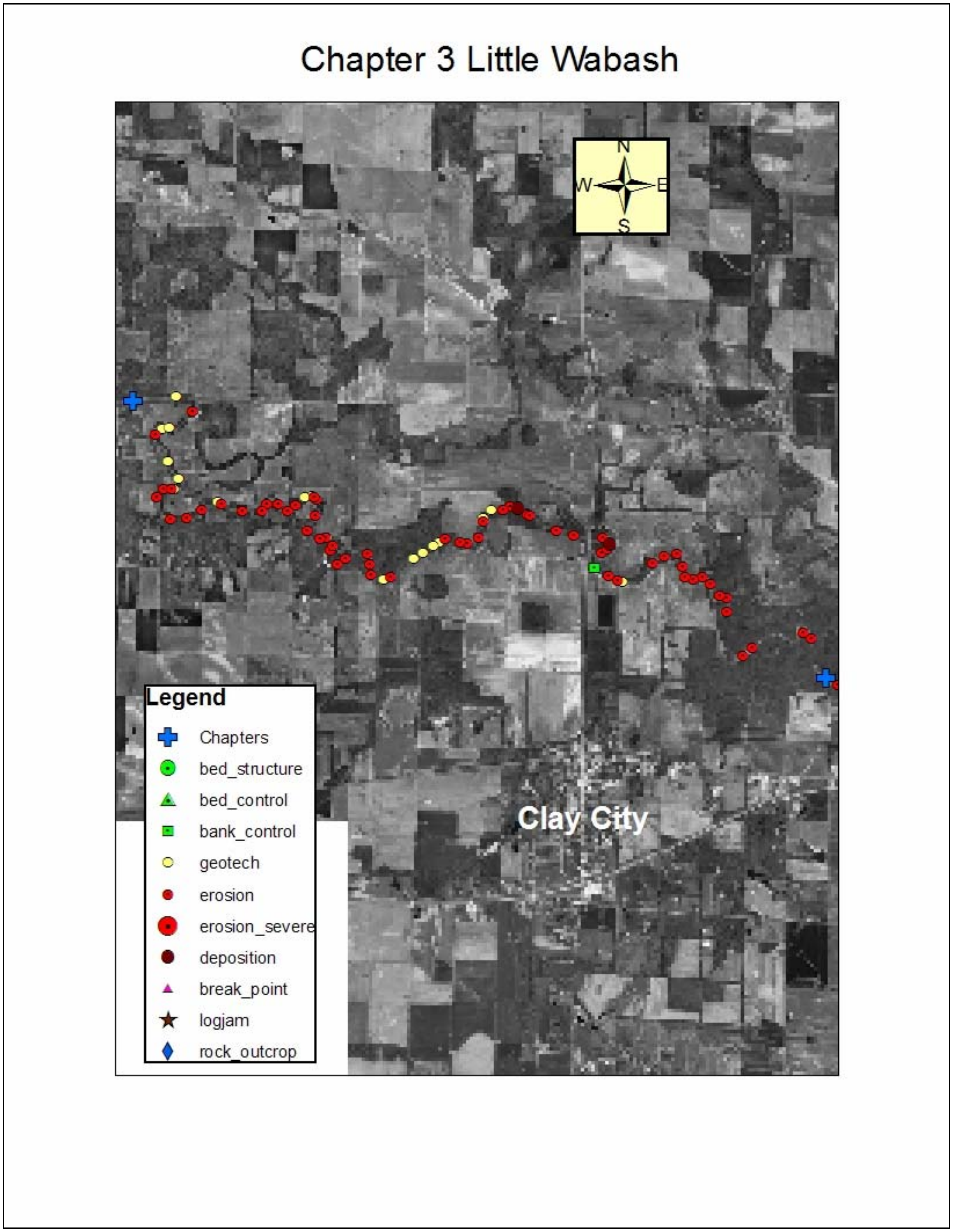


Fig. 20 Chapter 3 Little Wabash River

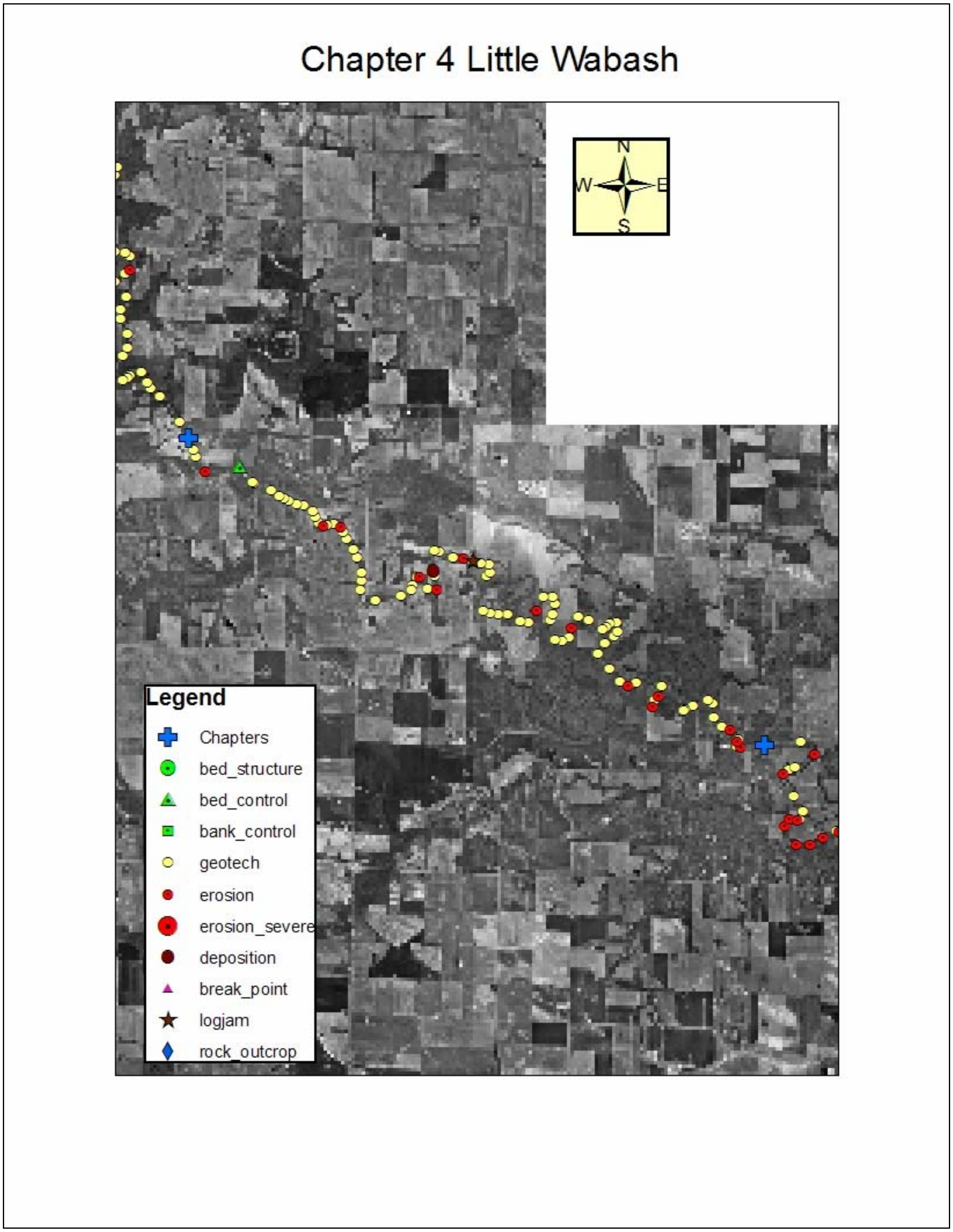


Fig. 21 Chapter 4 Little Wabash River

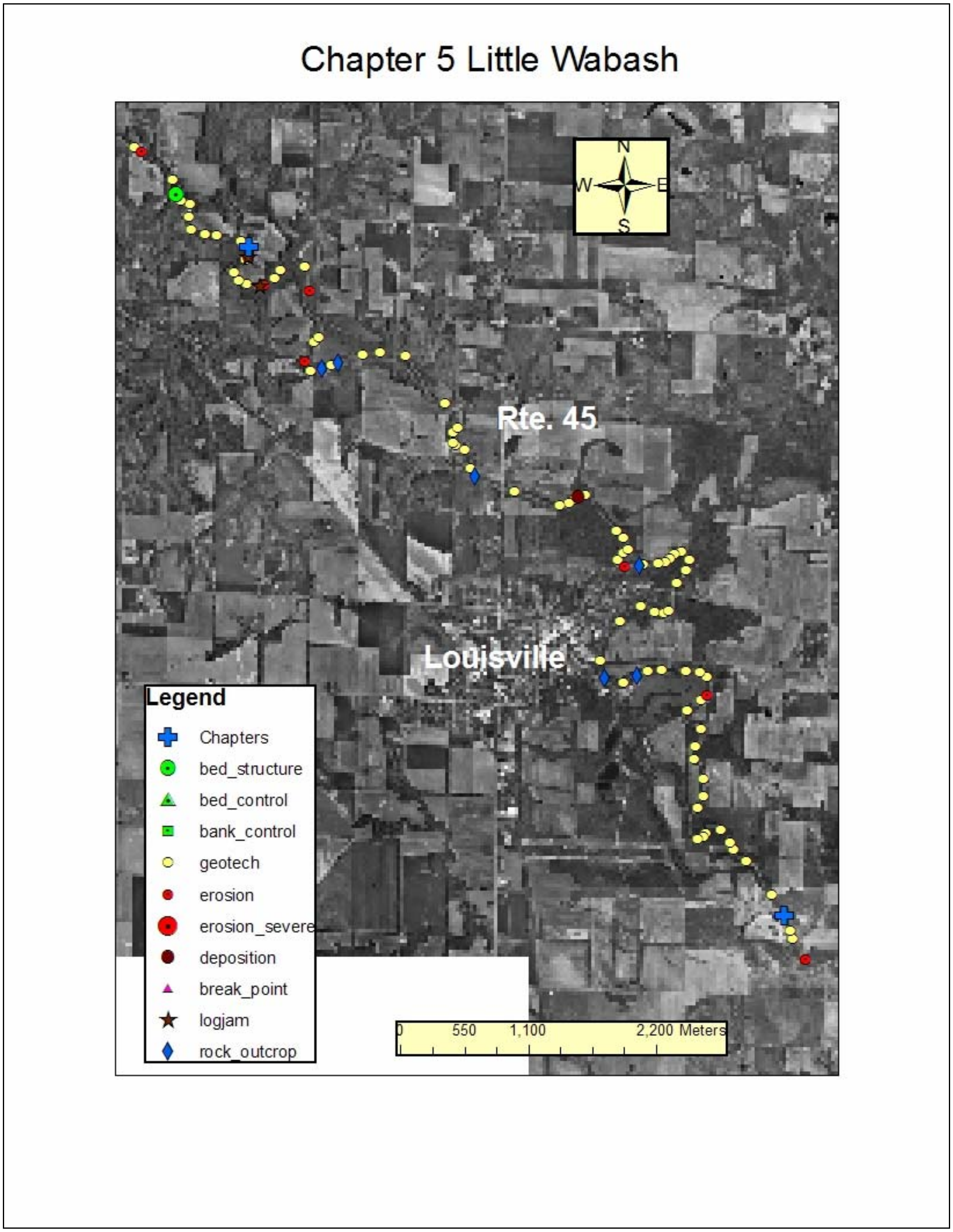


Fig. 22  Chapter 5 Little Wabash River

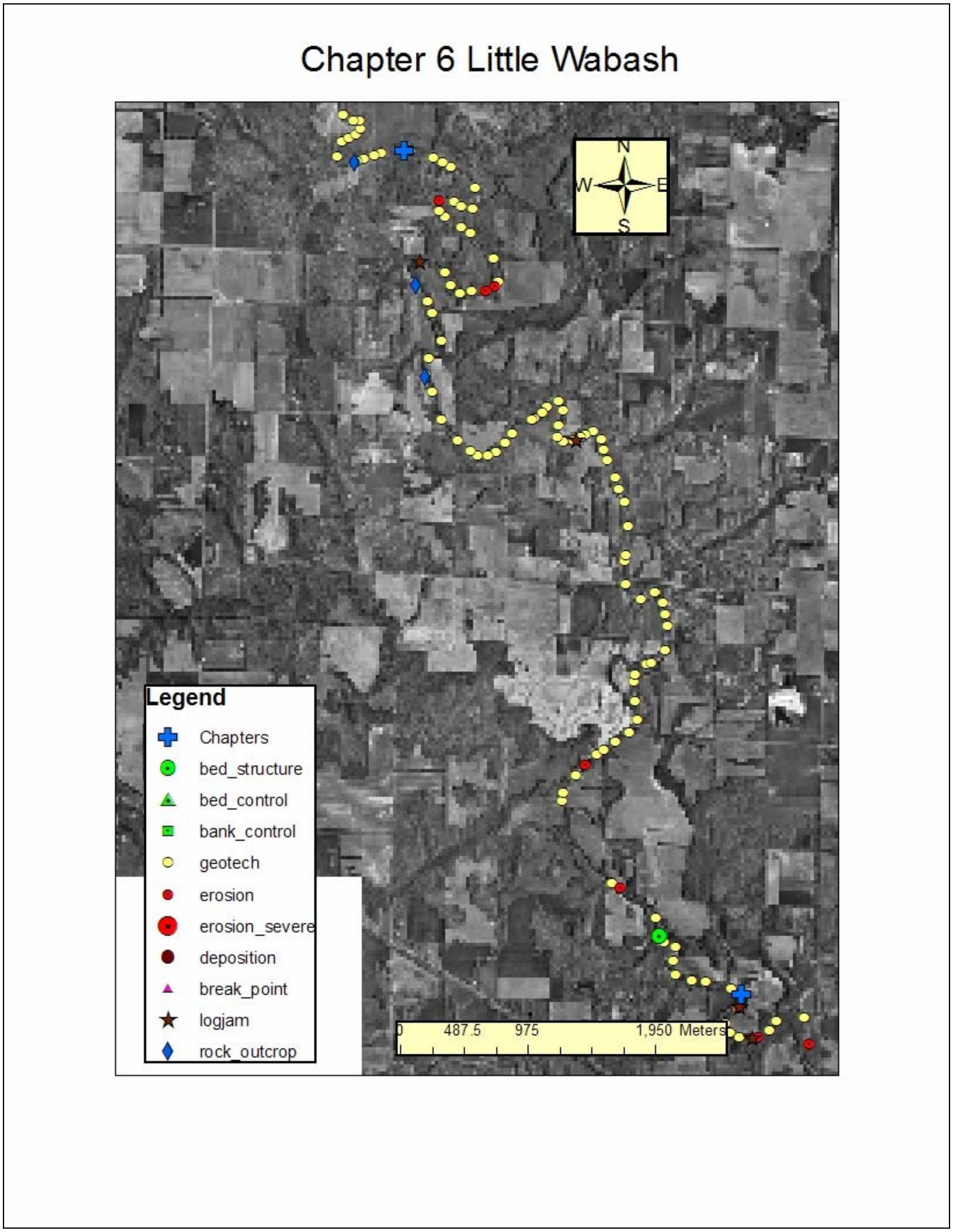


Fig. 23 Chapter 6 Little Wabash River

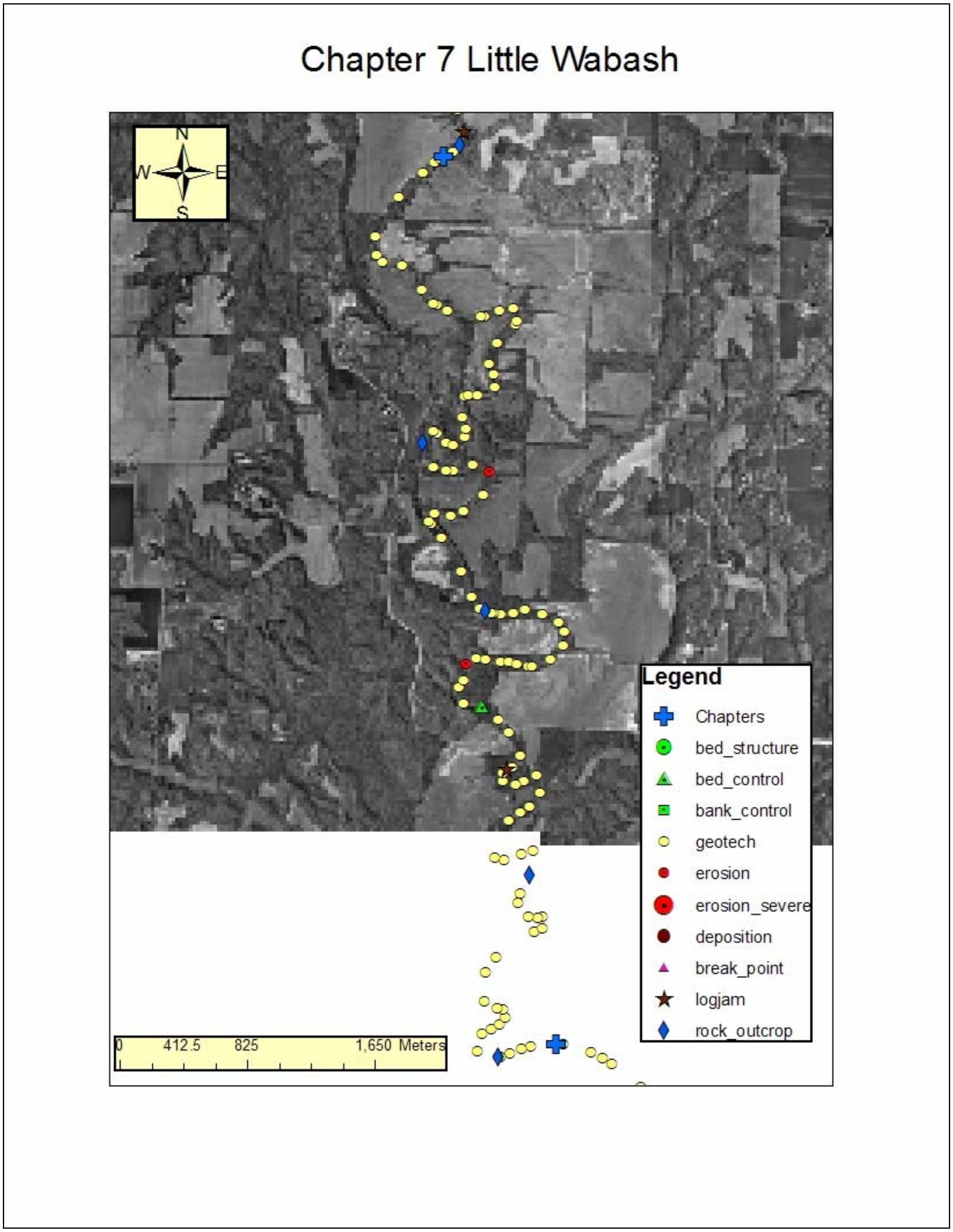


Fig. 24  Chapter 7 Little Wabash River

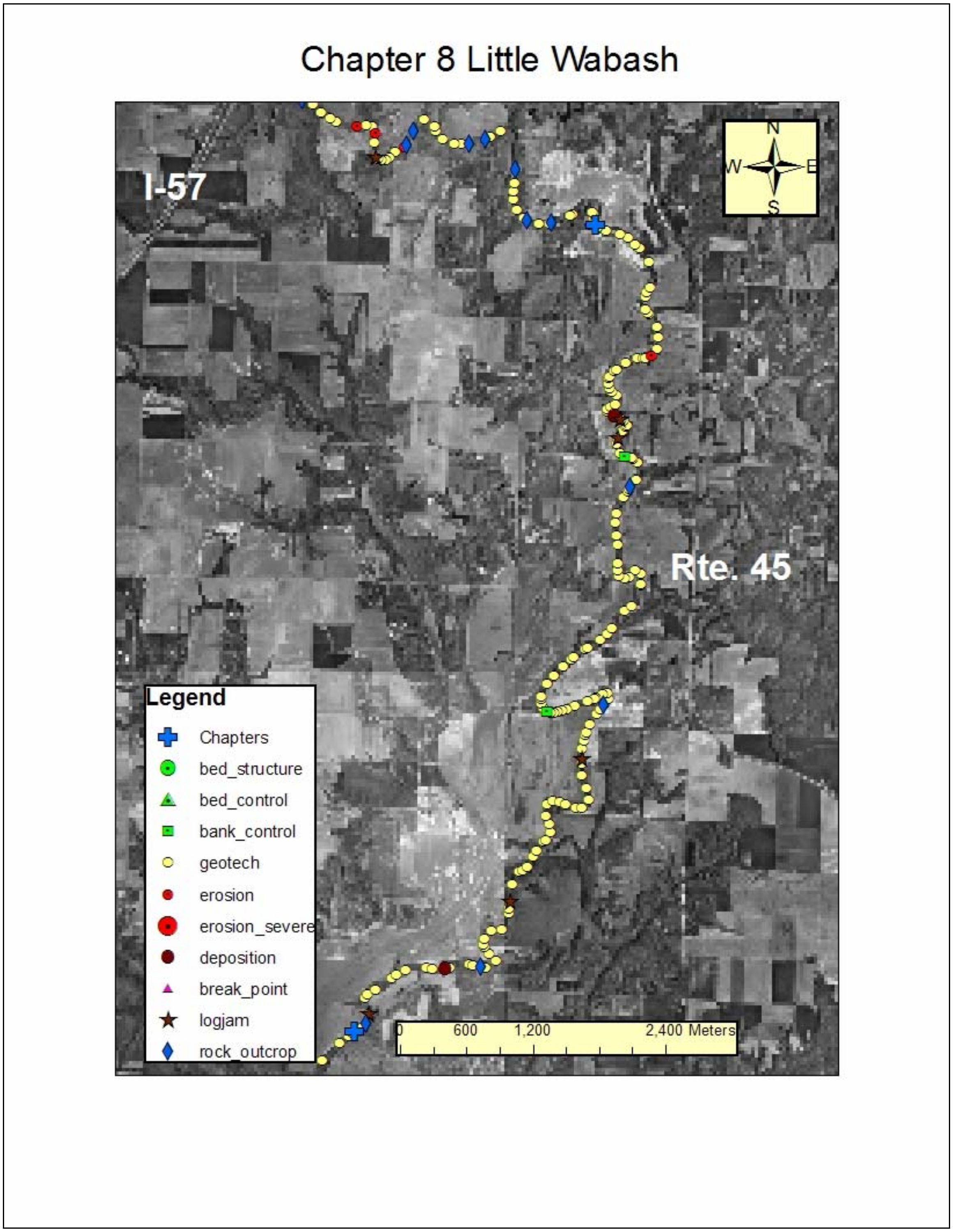


Fig. 25 Chapter 8 Little Wabash River

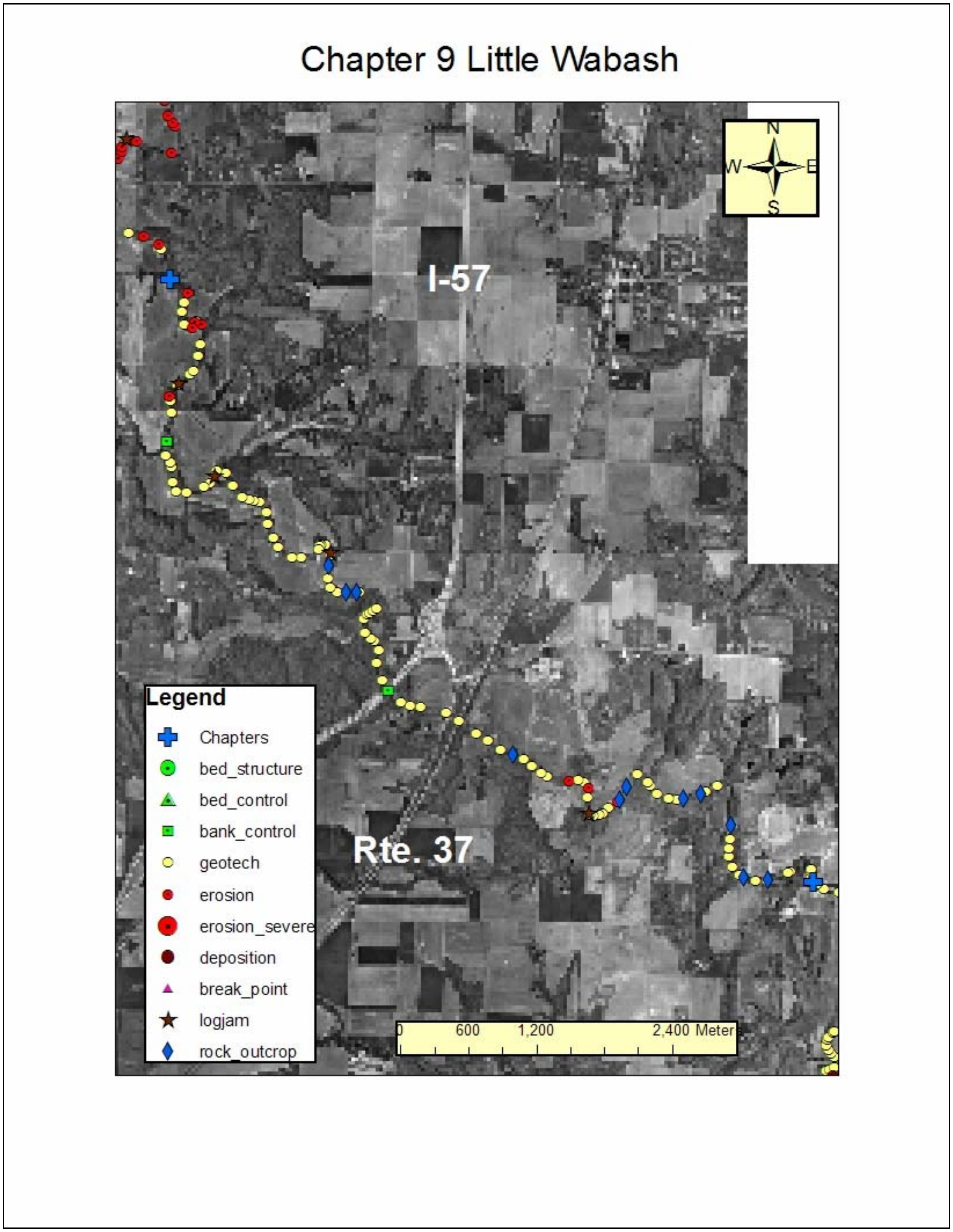


Fig. 26  Chapter 9 Little Wabash River

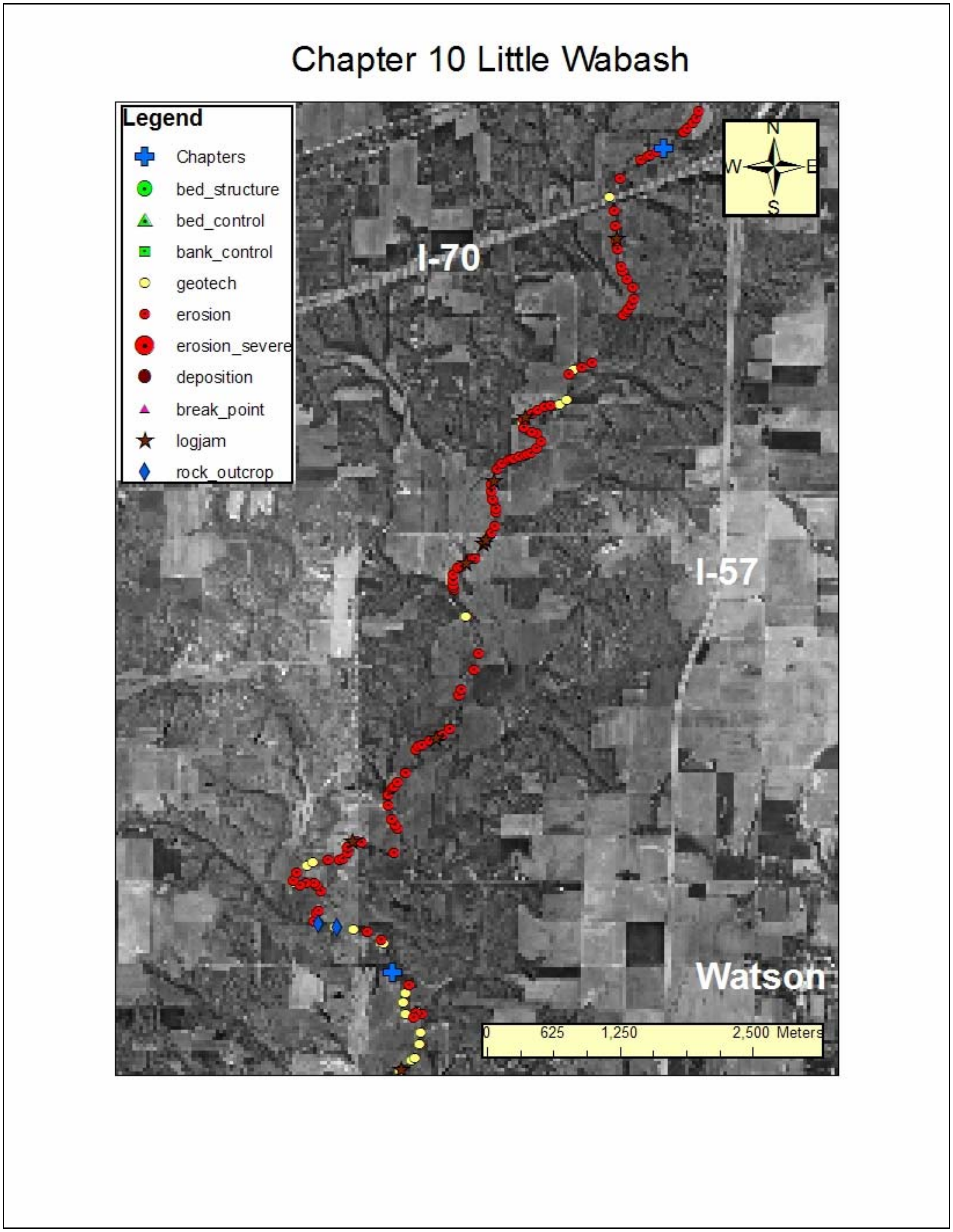


Fig. 27  Chapter 10 Little Wabash River

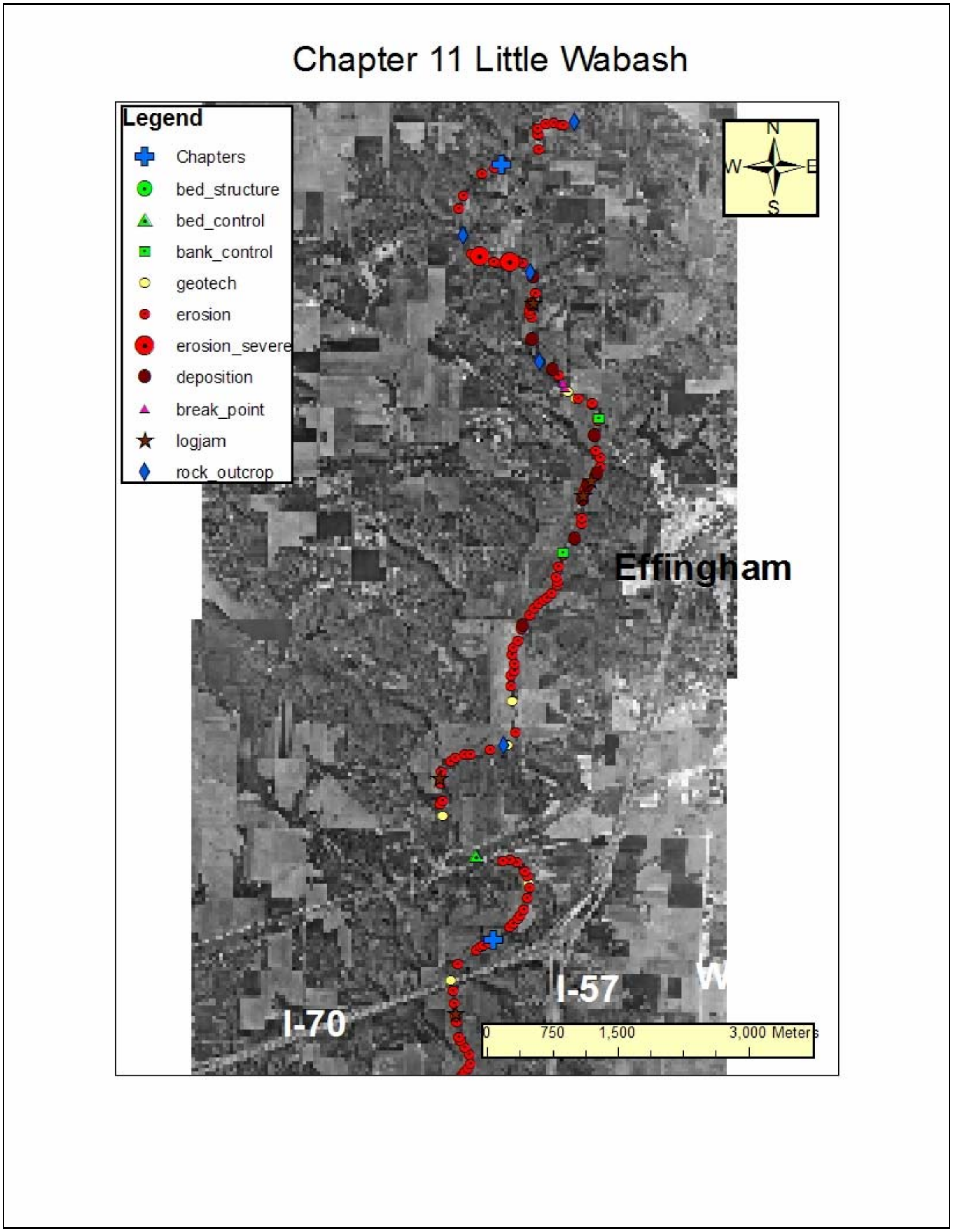


Fig. 28  Chapter 11 Little Wabash River

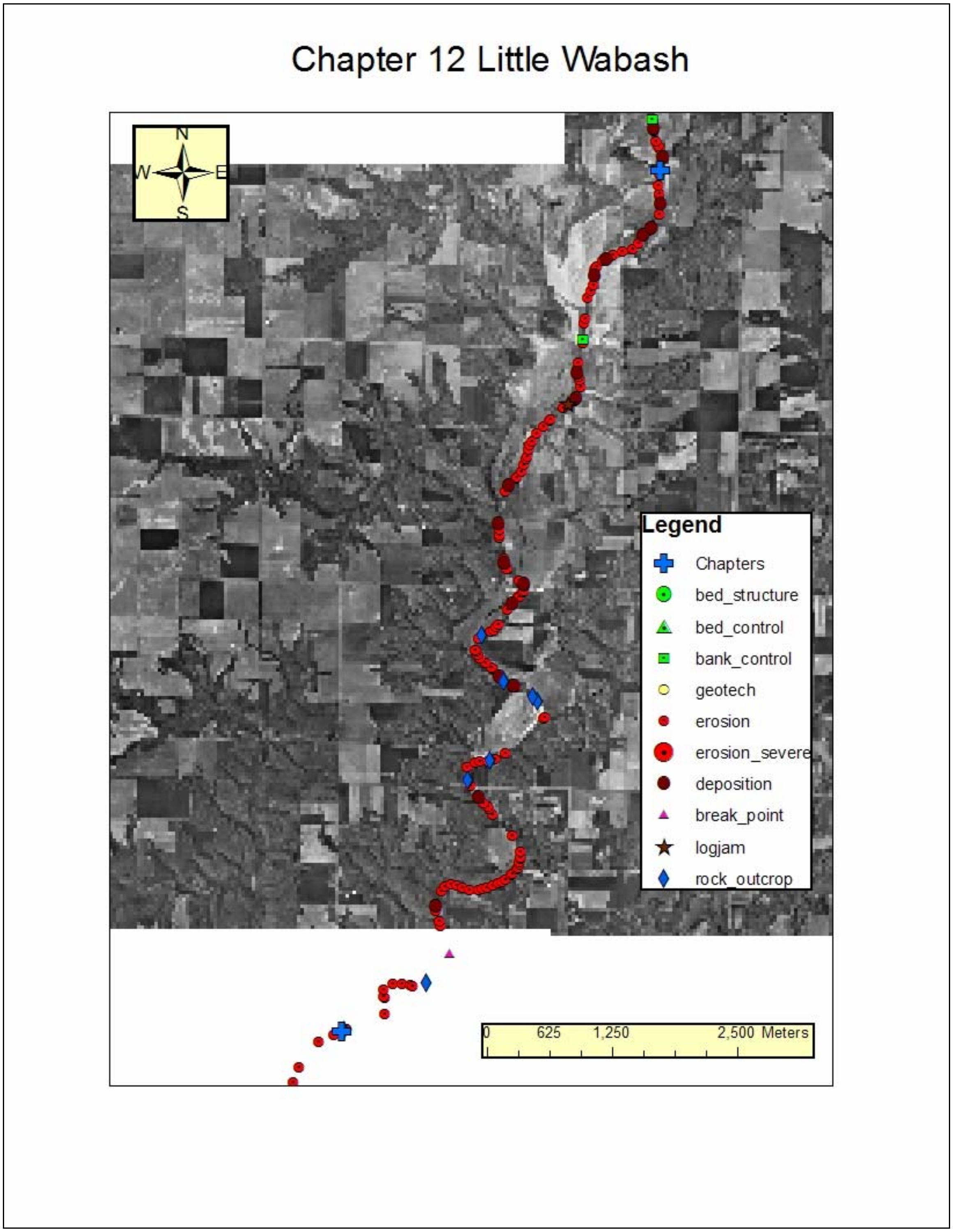


Fig. 29 Chapter 12 Little Wabash River

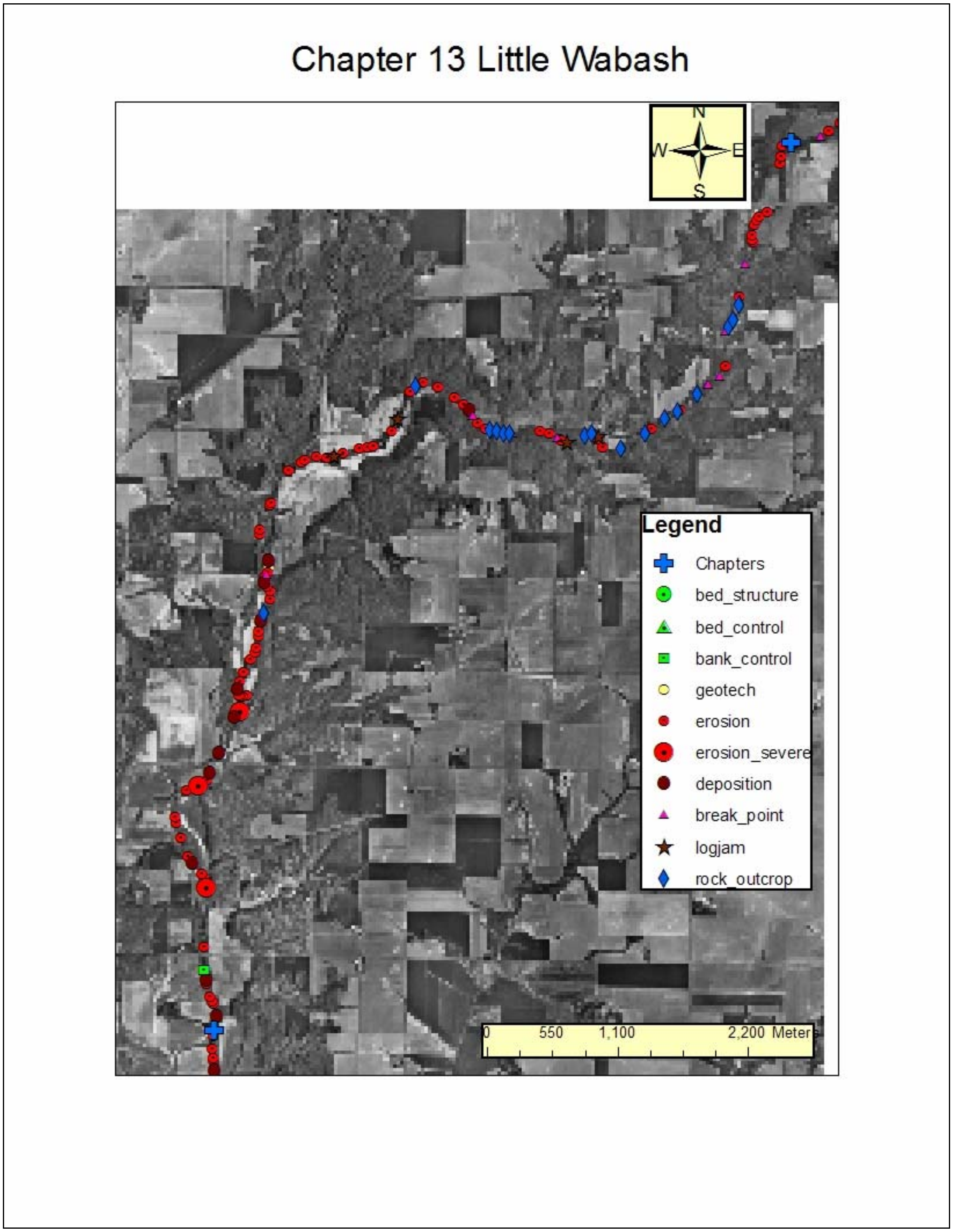


Fig. 30 Chapter 13 Little Wabash River

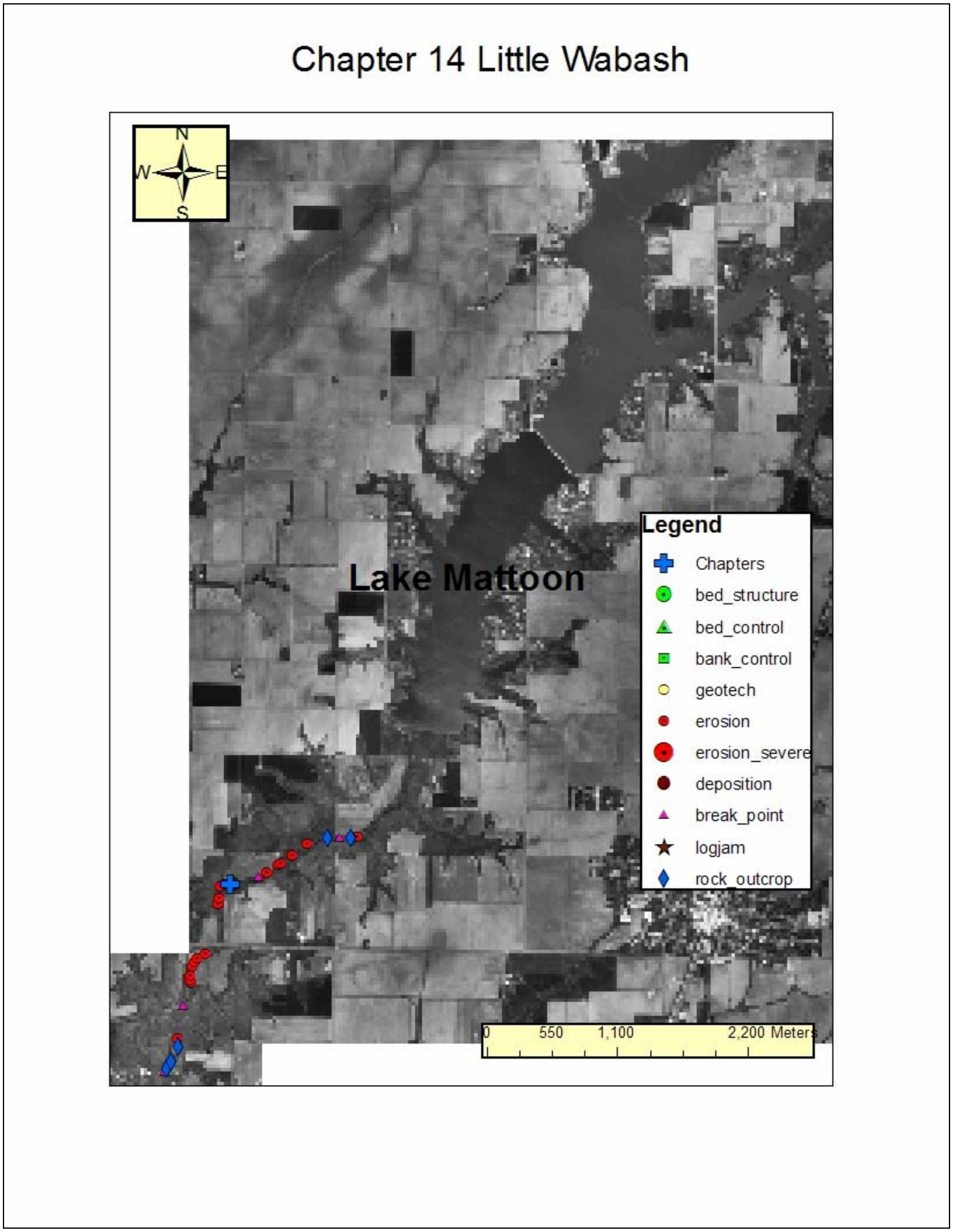


Fig. 31 Chapter 14 Little Wabash River

**Stream Condition and Treatment Alternatives by Chapter**

The conclusion of the aerial assessment is that the system wide failure and adjustment process of the magnitude found in the Little Wabash River will require more in depth study and data collection prior to making any specific recommendations. In general terms the channel appears undersized for the current flow regime. Therefore channel improvements proposed would need to take into account the channel dimensions needed for the current flow regime and include the needed increase in cross sectional area as well as a stable planform and gradient required to reach equilibrium.

The confidence level of individual site treatments applied to streambank erosion along Little Wabash River in its current state is low to very low. Attempts to treat streambank erosion problems should be limited to protecting high value property and infrastructure at this time on an as needed basis only and can be expected to require high levels of maintenance and inspection.

Treatment to the Little Wabash in this study reach should be of a holistic nature undertaken after additional study and design by a competent multidisciplinary team.

# APPENDIX A

# CROSS SECTION DATA