# INDIANA SILVER JACKETS
# NORTH BRANCH ELKHART RIVER, WEST LAKES TASK TEAM

## *CHAPTER 6 – Conceptual Review of Locally Suggested Activities and Structural Projects*

### Introduction

The Flood Focus Committee of the Elkhart River Alliance spoke with the ISJ Elkhart River, West Lakes Task Team (Task Team) about several activities and structural concepts that have been mentioned locally as potential projects that by themselves or in combination might help reduce seasonal flooding or larger flood risk in the West Lakes Chain.

To assist in developing the scope of the analysis for each activity, the Task Team grouped the list of concepts into two main groups: 1) Activities that should be studied for impacts on the more seasonal, higher frequency flood events, and 2) Activities that should be studied for impacts on the larger, lower frequency flood events. The conceptual activities and projects included:

Seasonal flood event impacts:

- Opening of a gate at the Benton Dam located on the Elkhart River at Benton, Elkhart County.
- Increasing the size of the opening below the county road bridge over the North Branch Elkhart River (NBR Elkhart River) at Cosperville.
- Managing in-channel aquatic vegetation.
- Fallen tree and obstruction removal in the NBR Elkhart River, downstream of West Lakes.

Larger flood event impacts:

- Raising selected access roads to existing residential areas.
- Construction of a bypass channel in the NBR Elkhart River, downstream of West Lakes.
- Creation of additional flood water storage basins upstream of the West Lakes Chain.
- Lowering the water level of Sylvan Lake 1-2 feet in the fall or winter to allow for additional spring flood storage.

At a conceptual/feasibility study level, these concepts were reviewed technically for this report with respect to their potential to affect flooding on the West Lakes Chain. Other project considerations were also identified. This analysis is a cursory review of the concepts and was not intended to be a final engineering analysis or a design. The levels of hydrologic and hydraulic calculations performed for the review of these projects were limited by the existing available data and existing stream modeling. While several older stream flow models exist, they do not have the ability to provide a detailed analysis of possible changes in watershed / drainage basin development and storage changes.

If these or any other potential projects are pursued in the future by the Flood Focus Committee of the Elkhart River Alliance, more in-depth data gathering, analysis, computer modeling, plan development, cost estimating procedures, and pre-permit agency coordination will be needed as part of normal engineering feasibility, design, and then permitting processes. Any such studies should be conducted by a multi-professional team, with a member being a professional engineer experienced in detailed water resource modeling.

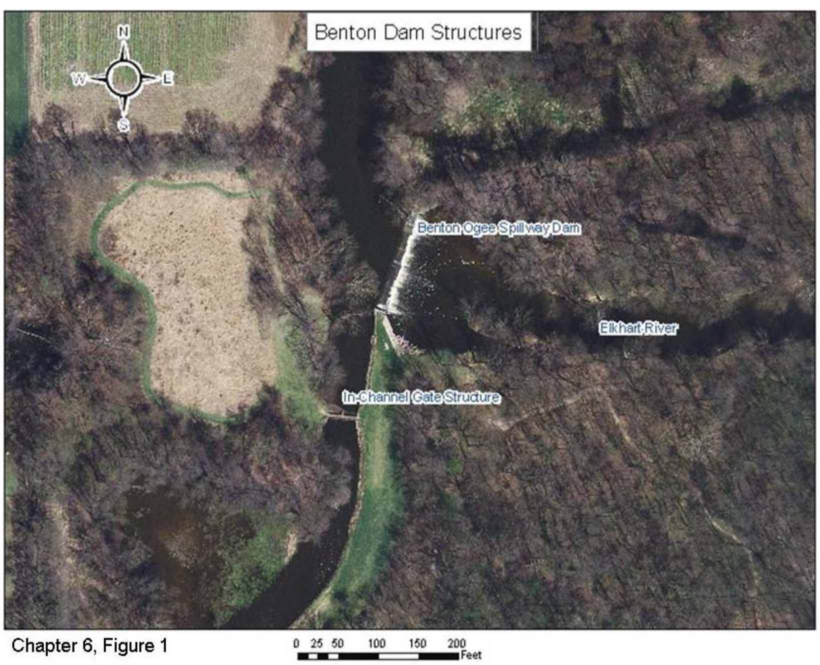
The development of a future basin-wide, detailed, timing based, modeling approach is recommended to get a comprehensive view of the NBR Elkhart River system. This will be beneficial in evaluating future development and land use changes. Due to the extensive existing wetlands and storage areas in the basin, a modeling approach referred to as "unsteady" is recommended. This modeling approach can properly account for the impacts and timing of storage areas during flood events and how they impact the flood elevations.

## ACTIVITIES REVIEWED FOR SEASONAL FLOOD EVENT IMPACTS

### Opening of the Gate at the Benton Dam Located on the Elkhart River at Benton, Elkhart County

A concept has been discussed locally that assumes if the gate at the downstream Benton Dam is opened, water will flow faster in the NBR Elkhart River system and possibly lower water levels in Waldron Lake.

The dam at Benton in Elkhart County is composed of a fixed concrete spillway in the river and an in-channel gate structure in the adjoining man-made canal (see Figure 1). The ogee spillway dam is a 4-foot-high concrete broad crest weir structure approximately 130 feet across. The man-made canal branches off the river. About 135 feet downstream of the beginning of the canal is an in-channel gate structure, which is a walking bridge approximately 35 feet across. Under the structure are six openings about 5-feet across. (See Figures 2 and 3.)




Chapter 6, Figure 1

The structures at Benton are 29.5 miles downstream of Waldron Lake. With the legal lake level of Waldron at 885.55 feet, and the crest of the diversion dam at 820.9 feet, there is a 64.6-foot vertical elevation change between the two sites.

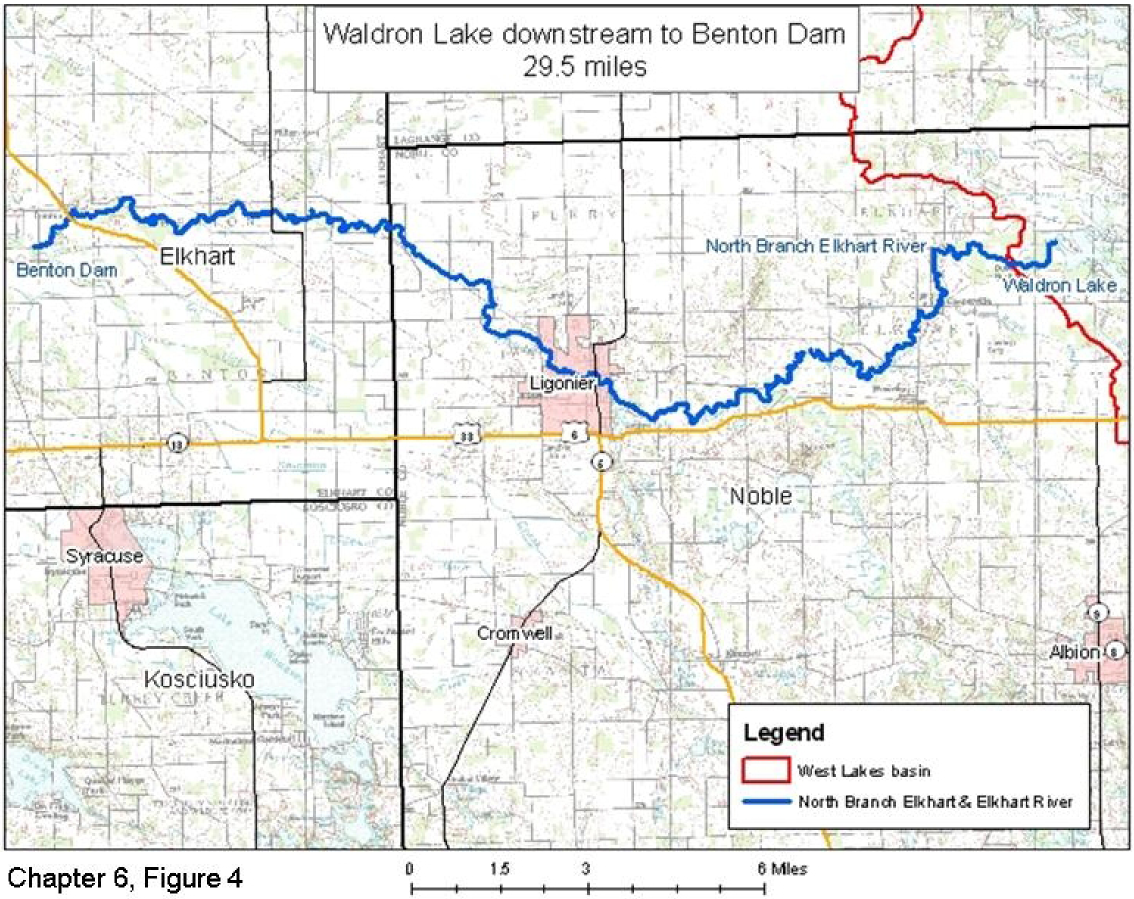
This slope, while not obvious to an observer on the ground along the river, over the course of 29.5 miles stream miles (see Figure 4) is a significant elevation change in the landscape.

Chapter 6, Figure 2


Chapter 6, Figure 3

Based on information from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Elkhart County, the Benton structure does not increase flood elevations in the Elkhart River. (See Appendix G for Flood Profile Panels) Panel 28P shows the Benton structure labeled as "Diversion Dam" located in a steep portion of the river. During flood events the 4-foot-tall Benton Dam is overtopped by nearly two feet of water.

Certainly during lower flows, the dam does impound water upstream of the structure in the pool area. However, the flood insurance profile predictions and historic flood event profiles show the Benton Dam effects are limited and do not extend beyond the typical pool area upstream of the structure. Physically, the impact of the Benton spillway or canal in-channel gate structure cannot propagate 29.5 miles (or 64.6 feet vertically) upstream to the West Lakes Chain.



Chapter 6, Figure 4

As a comparison, other structures can be seen on the profiles showing an increase in the flood depth in the River for a short distance. Profiles 25P- 32P show the Elkhart River in Elkhart County, and profiles 52P - 55P show the NBR Elkhart River in Noble County. Restrictive structures can cause the flood profile to jump higher for a short distance on the upstream side compared to the downstream side. How far an increase can propagate upstream is dependent on how high the restriction is and how quickly the increasing slope of the channel negates the pool behind the restriction.

So, while structure can have various amounts of restriction, the Benton Dam structure shown on the profile 27P causes impacts only a minimal distance upstream and does not increase flood depths upstream to West Lakes Chain. The profile shows flood depths of roughly six feet both upstream of the NIPSCO Dam and downstream of the Benton Dam.

Activities associated with operational changes or reconstruction of either of the dams would not reduce large predicted flood flows, flood depths, or duration of floods in the West Lakes Chain.

## Increase the Size of the Opening Below the County Road Bridge Over the North Branch Elkhart River at Cosperville

Another project identified as an activity that might help reduce flood risk was to increase the size of the opening below County Road 900 North over the NBR Elkhart River at Cosperville. The cross-sectional opening available to pass flow under the bridge is reviewed in this section.

As is typical for most bridges, the current waterway opening at this bridge is smaller than the combined channel and flood plain flow cross-sectional areas that adjoin the bridge. This is true looking either upstream or downstream of the bridge. Some small localized flood height reduction could be expected for a small distance upstream, if the bridge opening were increased (or the bridge deck raised). Increasing the bridge opening size may also slightly increase the volume of water passing downstream at any time. This may produce some slight increased flood depths downstream of the bridge.

Detailed computer modeling calculations could be used to predict specific benefits and/or downstream risks associated with various bridge size and dimension changes. A hydraulic study to evaluate alternative bridge sizes or dimensions for their affects was not conducted for this report.

Increasing the bridge's waterway opening could be accomplished in at least three ways.

- Years of accumulated debris and sediment appear to have been deposited under the bridge near the bridge abutments outside of the low flow channel. The current waterway area could be increased by removing this build up and maintaining the maximum opening configuration that was available when the bridge was originally constructed.
- Immediately downstream of the bridge opening an apparent sewer outfall pipe has been constructed and covered with a protective rock mound. This pipe and rock mound run in the same east-to-west direction of the road and block a portion of the bridge's waterway flow area. The pipe and its rock fill could be shortened, or reconfigured, in such a way as to not block the bridge waterway area.
- If the bridge becomes slated for a county rehabilitation or reconstruction project, providing a longer bridge span with a larger waterway area could be considered and analyzed to predict specific benefits or downstream risks associated with various bridge dimension improvements.

### Managing In-Channel Aquatic Vegetation (Transition Area)

An issue previously mentioned in this report and during local site visits is the concept of managing in-channel aquatic vegetation in the area defined as the “transition area” in Chapter 2. Vegetative growth, under the right conditions, can be very extensive in this portion of the channel.

Aquatic vegetation typically is seen as excellent habitat for fish and other aquatic life, so any project to remove this type of vegetation should be carefully planned and strategically implemented. Aquatic vegetation control information and permitting requirements can be found on the Department of Natural Resources, Division of Fish & Wildlife’s website *www.in.gov/dnr/fishwild/files/fw-Aquatic_Vegetation_Control_Permit_Information.pdf.*

While this activity would not reduce large predicted flood flows, or flood depths, this activity, if done correctly only in the transition area, seems to have some merit as it might slightly lower seasonal high water levels that often run a little above normal lake level. It appears the aquatic vegetation in the transition area lies down during higher and faster flood flows and does not seem to be a restriction to passing these larger events. During the dry times of summer, especially during lower and slower flow times, the vegetation in the transition appears to remain standing and may be slowing water flow. This summer slow flow caused by vegetative growth, may be a contributing factor to keeping the lakes from returning to their legal average level over the past few wetter than normal years. A more detailed discussion of the aquatic vegetation growth can be found in Chapter 2 of this report.

### Fallen Tree and Obstruction Removal in the North Branch Elkhart River, Downstream of Waldron Lake

Various levels of minimalist or more aggressive fallen tree and obstruction removal projects have been implemented in this watershed. In summary:

- Traditional clearing and snagging projects (as practiced in the past) which can be environmentally destructive to the channel and the overbank areas often do not appear to provide significant, long-term benefit in flood reduction. These large-scale projects, as they typically open the channel up to sunlight, may cause an extensive growth of in-channel vegetation, thus being more harmful to flow capacity than what previously existed. These large-scale projects also often have the unintended consequence of making channel banks and remaining trees more unstable and more prone to erosion than previously existed.

- Minimal stream maintenance activities (removal of isolated fallen trees) also likely will not reduce large predicted flood flows or flood depths, but when done properly may provide some small benefit in passing lower and slower in-channel flows. This is specifically apparent in the area immediately downstream of the lakes and upstream of County Road 300 West. This activity would also be beneficial in improving boating and canoeing recreational opportunities along the NBR Elkhart River, and tourism opportunities in the community.

- As analyzed in a 1983 US Army Corps of Engineers study for this area, typically, for these projects, costs exceed any benefits achieved, especially when the primary purpose is to alleviate flooding.

**Traditional Clearing and Snagging:**

Removal of at-risk and fallen trees, obstructions, and significant vegetation removal along the overbanks, sometimes known as "Clearing and Snagging" is described in engineering literature from various sources. Haestad Methods, Inc., a publisher of stream modeling engineering computer software and literature, describes it as:

> Removing vegetation from the channel sides and along the bank and removing trees, debris, and stumps from the channel. The channel geometry and alignment usually remains unchanged with this solution, and the construction modifications simply result in slightly lowering the resistance presented to the flow of water.

Typically, computer modeling estimations of before and after project conditions will predict slight increases of flow velocities and slight decreases in stream flooding depths along the areas where this type of work is proposed. These slight changes, while potentially helpful during low flow (typically summer time) conditions, will not translate into meaningful decreases in lake levels during significant flooding events.

These removal activities also typically provide only minimal short-lived results, as much of the fallen trees, obstructions, and vegetation will reestablish within several seasonal cycles.

Studies by Wilson (1973), Pickles (1931), and Burkham (1976) for streams in Mississippi, Illinois, and Arizona, respectively, found the resistance to flow returning to previous levels and beyond, with increases ranging from 50 percent to more than 300 percent in the next few years following removal operations. This increase in resistance in a short timeframe is evidence of a large re-growth in vegetation along and in the stream. To perpetuate the results of removal activities, they need to be repeated on a fairly frequent cycle.

While permitting expectations often vary between federal laws, state laws, and local ordinances, significant detrimental environmental and cumulative effect may often result from this solution. Fish habitat and cover are removed, the shade given by vegetation is lost, increased bank erosion could occur, and bottom sediments are resuspended by clearing and snagging activities.

Of particular note in this watershed, the loss of shade and the increase in sunlight often has the adverse impact of increasing thick aquatic weed vegetation growth in the stream channel. During the summer, thick aquatic vegetation in the channel is already noted in the stream/lake transition area in the NBR Elkhart River below West Lakes.

**Stream Maintenance, Best Management Practices:**
The 1996 Indiana Drainage Handbook (Handbook) is a valuable resource for evaluating and implementing appropriate stream maintenance activities. The Handbook can be found at the DNR, Division of Water's website at www.in.gov/dnr/water/4892. The handbook is intended to be used by state and federal regulatory agencies as well as those performing local drainage work.

The Handbook: (1) explains and clarifies federal, state, and local laws and regulations affecting drainage improvement activities within Indiana (in place in 1996 when it was written, specific citations should be reviewed for current wording); (2) provides descriptions of specific "Best Management Practices," which define how work should be performed with a minimum of adverse environmental impact; and (3) explains procedures for timely access to agencies' drainage-related personnel.

The Handbook states that localized removal projects are preferred over full-scale (clearing and snagging) projects as shown below:

> "Effectiveness of large-scale river restoration projects in reducing flooding is limited only to small annual floods. Often times, the effect of these activities on reducing flood stages of larger, less frequent floods, is negligible or at best limited to 2 to 3 inches of stage reduction. In most cases, similar hydraulic benefits may be achieved by following the American Fisheries Society Stream Obstruction Removal Guide, i.e., removing only localized logjams, at a fraction of cost and time."

In order to appropriately identify, plan and direct an effective removal project, the Handbook uses an obstruction classification system based on the "American Fisheries Society Stream Obstruction Removal Guidelines." Five conditions are described along with management techniques based on each category: Condition 1 is the least severe, Condition 4 is the most obstructive, and Condition 5 describes a special case. (See Appendix A for descriptions of each condition from the Drainage Handbook).

The cumulative benefits of removal projects do not necessarily, or simply, result in improved flow at some distance upstream of the obstruction. A review of local stream gradient (slope) is important when identifying and evaluating the location and expected benefits of a particular removal project. In this area, partially based on the stream gradients, removal of an obstruction identified as a condition 1 or 2 obstruction in the Handbook, downstream of approximately County Road 300W, likely would have little, if any, impact on discharges (improved flows) from West Lakes Chain.

Over the years, several downed tree removal operations have occurred along this stream. They include:

1982 (local effort)
1986 (State-sponsored $55,313 to address 12.5 river miles),
(several years following this project were drier than normal)
1999 (State-sponsored $119,000 to address 7.4 river miles),
(several years following this project were drier than normal)

2007 (Noble County performed work, State contributed $10,000)
2009 (Noble County performed work, State contributed $10,000)
Additional volunteer efforts at cutting recreation obstructions (reportedly done by local canoeists), have been noted at various points and times along the stream.

Local testimony has indicated each of these efforts has seemed to provide some flood reduction benefit. However, some of the benefits may have been attributed to drier than normal years following the projects. Regardless, after a few years, the activities needed to be repeated.

In summary, the practice of obstruction removal can be beneficial, especially if the stream is significantly blocked; however, the benefits are typically only experienced for a few years. Particularly with traditional clearing and snagging projects, the regrowth is more restrictive, due in part to additional sunlight in the stream corridor allowed by removing the tree canopy. This practice often has significant negative impacts to the fish and wildlife dependent on the stream. It also requires frequent expenditures of funds and resources for maintenance for minimal benefit during flood events.

All local, state, and federal permit requirements should be followed, and appropriate access rights secured, if this practice is used.

## ACTIVITIES REVIEWED FOR LARGER FLOOD EVENT IMPACTS

### Raising Selected Access Roads to Residential Areas

A structural concept mentioned locally as a potential project is raising selected county and local access roads to residential areas that have been isolated during recent flooding events.

While this concept would not reduce predicted flood flows, flood depths, or the duration of flooding events, it seems to have some merit as it may increase the time property owners have access to their homes. It also would increase the time people have to evacuate their homes when large flooding events are anticipated.

This concept has not been studied for costs or to identify potential project areas in this report, but could be analyzed and considered by the various county engineers and community highway departments.

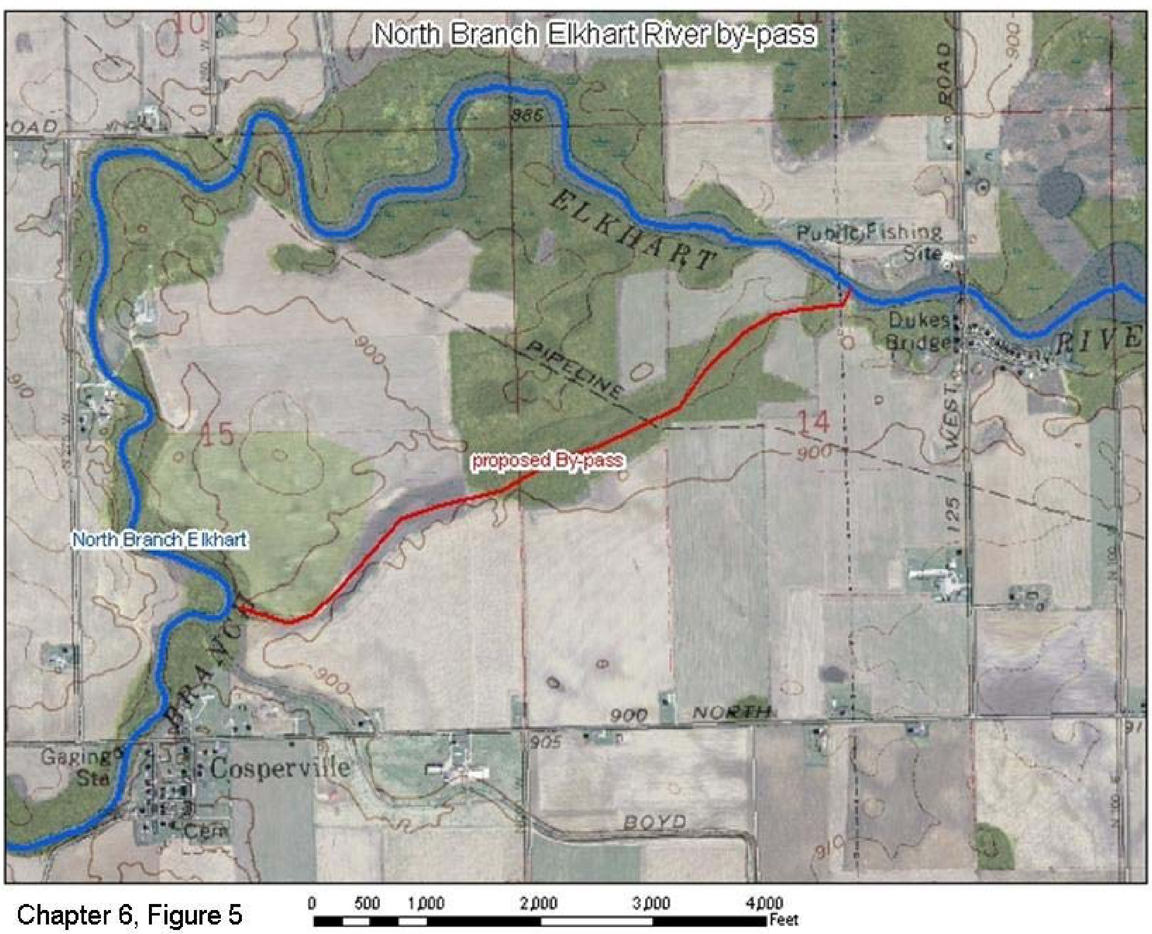
### Construction of a Bypass Channel in the North Branch Elkhart River, Downstream of Waldron Lake

Building a bypass channel downstream of West Lakes to improve drainage during flood events and lower lake levels more quickly also has been identified as a potential local project.

Although a bypass channel can increase the rate of flow out of a lake during flooding events, a valid concern is that flow rates in the channel and floodplain downstream of the bypass channel will also increase. Depending on the specifics of the configuration and the precise timing of the flood flows, increased flood heights downstream of the by-pass channel may also increase for some distance. Extensive detailed hydrologic and hydraulic computer modeling would be required to evaluate and predict the changes to flood flow timing, flood flow rates, duration of flood events, and heights of flooding events for any specific proposed project of this type.

This chapter reviews a bypass channel configuration and location based upon a concept discussed locally, and confirmed by review of the natural topography, primarily to minimize excavation needs and cost. The conceptual by-pass channel evaluated in this report pulls water from near Dukes Bridge and discharges the lake water into the NBR Elkhart River upstream of Cosperville (see Figure 5).

- The flood event considered for reduction was a 1 percent annual chance flood event (100-year).
- Under current conditions, a 1 percent annual chance flood event (100-year) out of West Lakes into the NBR Elkhart River at Cosperville has a flow rate of 1,000 cubic feet per second (cfs).
- During a 1 percent annual chance event (100-year), the proposed by-pass channel




Chapter 6, Figure 5

would need to have the capacity to carry about 770 cfs to lower lake levels 1.1 feet.
- The March 2009 flood was about 0.8 feet lower than the expected 1 percent chance flood elevation of 890.5 feet.
- To achieve the lowering of the lake level 1.1 foot, under this scenario, the flow rate at Cosperville would need to increase from 1,000 cfs to 1,770 cfs.
- In order to be effective, the 6,500-foot-long by-pass channel was sized to be 160-feet wide and 5-feet deep, with 3:1 side slopes.
- The large top width is needed to have the channel capacity in this reach due to a low natural slope.
- An additional weir structure at the edge of the lake, with a crest width of at least 74 feet, would be needed to prevent the lake from lowering below normal level during dry seasons, but still allowing the design flow of 770 cfs to enter the by-pass channel.

The increase in flow from this conceptual by-pass channel when it re-enters the stream was shown, by basic hydraulic modeling, to increase flood stages in the NBR Elkhart River.
- While the by-pass channel could physically be constructed, the current 1 percent annual chance (100-year) level of 890.5 feet would only be reduced to 889.4 feet (1.1 feet).
- Homes would still be subject to flooding and access may still be an issue to many homes.

The increased discharge capacity from the by-pass channel would also significantly increase flood stages in the NBR Elkhart River downstream of the by-pass outlet.
- The total flow in the river during the March 2009 event was around 807 cfs, so the additional by-pass channel flow of 770 cfs needed to lower the lake 1.1 feet would almost double the total flow during flood events.
- The results of this increased flow produced flood stage surcharges of 1.5 ft more than three miles downstream of the outlet near Cosperville.
- Regulatory complexities could become expensive and timely to adequately address. The purchase of flood easements, habitat and/or wetland mitigation, and archeological reviews likely would be required.
- Additionally, the increased flood stages would require the Federal Emergency Management Agency (FEMA), Flood Insurance Study and maps to be updated to reflect the increased flood potential.
- FEMA charges this expense for remapping to the party requesting the project.
- The requesting party would be responsible for any flooding mitigation needed for increased elevations
- Many areas downstream of this potential by-pass channel would be included in the areas requiring the purchase of flood insurance that were not previously included.

A significant concern is that if constructed, a by-pass project sets a precedent for the other many lakes upstream of West Lakes to follow.

- If a by-pass channel is built, other upstream lake communities could assume they have the right to initiate and complete their own drainage projects to reduce their flood elevations.
- The upstream flood problem would then be passed downstream again to West Lakes, potentially cumulatively negating any benefits from this project, and potentially setting the stage for much worse flooding at West Lakes.

This was a simplified conceptual look at a by-pass channel's impacts. This was only the first step of an iterative design process. The above information should not be used for the basis of a construction project without further detailed study, modeling, analysis and permitting.

### Creation of Additional Flood Water Storage / Detention Basins Upstream of West Lakes Chain

Many possible approaches to increase flood storage in the upper portions of the drainage basin could be conceived and studied. Depending on the timing of when stored or detained water eventually flows downstream, there is the opportunity to both reduce or increase flood discharges and flood levels, but there is also the possibility that the duration of minor flooding levels will be extended at West Lakes due to delayed release from detention basins. This option has some merit as it mimics and increases the current extensive naturally ongoing flood reduction process that this basin's unique geography provides.

To understand the magnitude of additional water storage discussed in this report, several terms need to be explained. While it is easy to understand how much volume is meant by a gallon of water, a unit of measurement more often used for volume of water is a cubic foot. A cubic foot of water contains 7.5 gallons of water.

The unit of measurement more often used for large volumes of water, the acre foot, also needs explanation.  An acre-foot of water is:

- one acre of land covered by water one foot deep, or
- about a football field covered with water one foot deep, or
- contains about 325,900 gallons of water.
- one square mile (640 acres) covered by water one foot deep would be a volume of 640 acre-feet of water.

### **Storage of a Volume of Water** (Without Considering the Refilling Affect of an Ongoing Flood)

One storage concept considered in this chapter:

- Assumes a volume of water in the West Lakes Chain, at a specific lake level, is transferred away from the lakes into some previously constructed but dry storage area.
- It also assumes waters could be drained into the new storage area faster than flood waters currently entering the lakes.
- It was further evaluated based on a specific volume of water that currently would be in the West Lakes Chain between specific lake level elevations.

- This concept does not consider that inflow and outflow during extended periods of high lake levels often extends for days (as during the spring 2009 event when the lakes were at or above 888 feet for periods of up to 15 days).
- This concept does not recognize that the continuing storm event runoff will quickly refill the one-time volume of water moved from the lakes to a storage facility.

Figure 6 is a table that lists the additional storage required in acre-feet for a one-time lowering of the lakes down to the elevation of 886 feet (5.4 inches above the Legal Level of 885.55 feet). It is being assumed that no additional flood flow comes into the lakes after the one time lowering

| Storage Volume for one-time lowering to 886 ft | | | | |
|---|---|---|---|---|
| **Lake level** | **Staff Gage** | **Surface Area at lake level** | **Storage above normal lake level** | **Pond size for one-time lowering** |
| (ft) NGVD | (ft) NGVD | Acres | Acre-ft | Acre-ft |
| 885.55 | 5.55 | established normal lake level | | |
| 886 | 6.0 | 864 | 223 | |
| 888 | 8.0 | 1567 | 2653 | 2430.5 |
| 889 | 9.0 | 1918 | 4396 | 4172.6 |
| 890 | 10.0 | 2269 | 6489 | 6266.0 |
| 891 | 11.0 | 2496 | 8871 | 8648.5 |
| 892 | 12.0 | 2723 | 11481 | 11258.0 |
| | | | | |

**Chapter 6, Figure 6**

For example:

If the flood waters rose to 888 ft (or 8.0 on the USGS staff gage), which is a 50 percent annual chance flood event (2-year) elevation, and were lowered by a transfer to dry storage, only two feet to 886 ft (or 6.0 on the USGS staff gage),

- water would need to be transferred into a 2,430 acre-feet storage pond, or
- 243 acres flooded with 10 feet of water (similar to purchasing an average family farm to excavate and flood), or
- 243 football fields flooded with 10 feet of water, or
- 1 (one) square mile of land covered with about 3.8 feet of water.

To lower the West Lakes Chain only four inches (from 886 feet to the crest of the control structure), it would require an area of about 223 acre-feet of storage.

- This would be roughly 22 football fields flooded with 10 feet of water.

Even for modest and short-lived benefits, this option would require massive amounts of property acquisition and excavation.

The extensive area needed for storage is evidence of the existing extensive floodplain acreage around the lakes where flood water now spreads. The West Lakes Chain has significant existing storage volume capacity due the wetland areas surrounding the lakes. Without the storage area that already exists, the flood heights would likely be even higher. Thus, the flood storage pond size required to produce any benefit is extremely large.

### Storage of a Volume of Water, During an Ongoing Flood Event

To discuss the potential benefits of additional water storage during an ongoing flood event, it is important to understand both:

- the existing ability of the system to pass flood water downstream, and
- the magnitude of how much flood water continues to enter into Waldron Lake throughout the many weeks it takes for a storm event to pass out of the entire drainage basin.

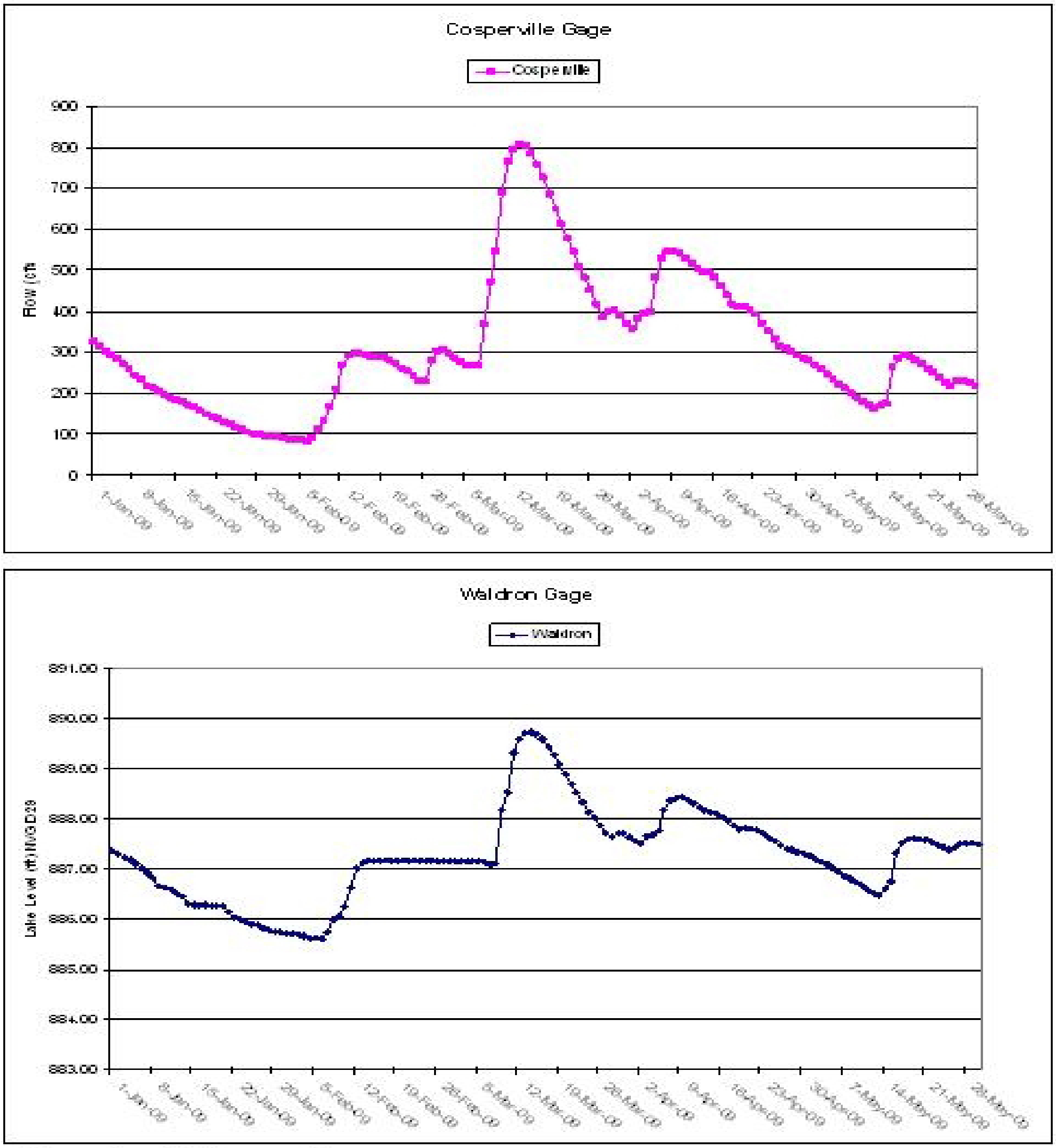
### Existing Ability to Pass Flood Water:

It is understandable that during extended high lake levels one might assume significant flow is not occurring through the lake's natural outlet. When standing on a bridge observing stream flow, it is almost impossible to visually grasp the cumulative amount of water passing in any day.

For Waldron Lake and its natural outlet stream, the NBR Elkhart River through Cosperville, it is fortunate that both a USGS stream gaging station and a lake level recording station have been funded and have existed for many years. These two USGS stations provide a true time-based record of the existing ability of the system to pass flood water downstream, and the associated time-based response of the lake level. These gaging and level recording stations provide the ability to look beyond theoretical calculations, to an actual measured system response to a flooding event.

The measurements of rate of flood flow over time at the NBR Elkhart River at Cosperville USGS gaging station, for an actual flooding event, Jan. 1 to May 30, 2009, are shown in Figure 7 (see next page). The lake level over the same time for Waldron Lake is also shown on Figure 7.

- During the March 2009 flood event, water level and flood flow were recorded by both of these USGS gaging and recording stations.
- Based on the measurements, the NBR Elkhart River flow rate response to high lake levels in the West Lakes Chain is very consistent, with changes being shown within the day.
- When lake levels increase, the downstream flow rates in the river also increase to a very high rate.
- When lake levels decrease, the downstream flow rates in the river also decrease.
- On March 14, (at the time of the highest lake level and the highest downstream flow rate), the flow going out of West Lakes past the Cosperville gage was 807 cfs.
- This rate of flow out of West Lakes during this flood is equivalent to a 5,500 gallon tanker truck pumped full of lake water passing under the Cosperville bridge every second. This is 86,400 trucks per day.
- This rate of flow 807 cfs, is also equal to about 1,600 acre-feet of water in a day (which is about 160 football fields flooded with 10 feet of water in a day).




**Chapter 6, Figure 7**

- During the March 2009 flood event, the river was passing significant amounts of flood water downstream; however, equally larger volumes of flood water are entering the lakes during the flood event, causing extended periods of time with higher than normal lake levels.

### The magnitude of water that enters Waldron Lake throughout the many weeks that it takes for a storm event to pass:

A way to view the magnitude of water entering Waldron Lake during the weeks it often takes a storm event to pass is to look at the additional storage needed to sustain a lowering of the level of Waldron Lake during an ongoing flood event.

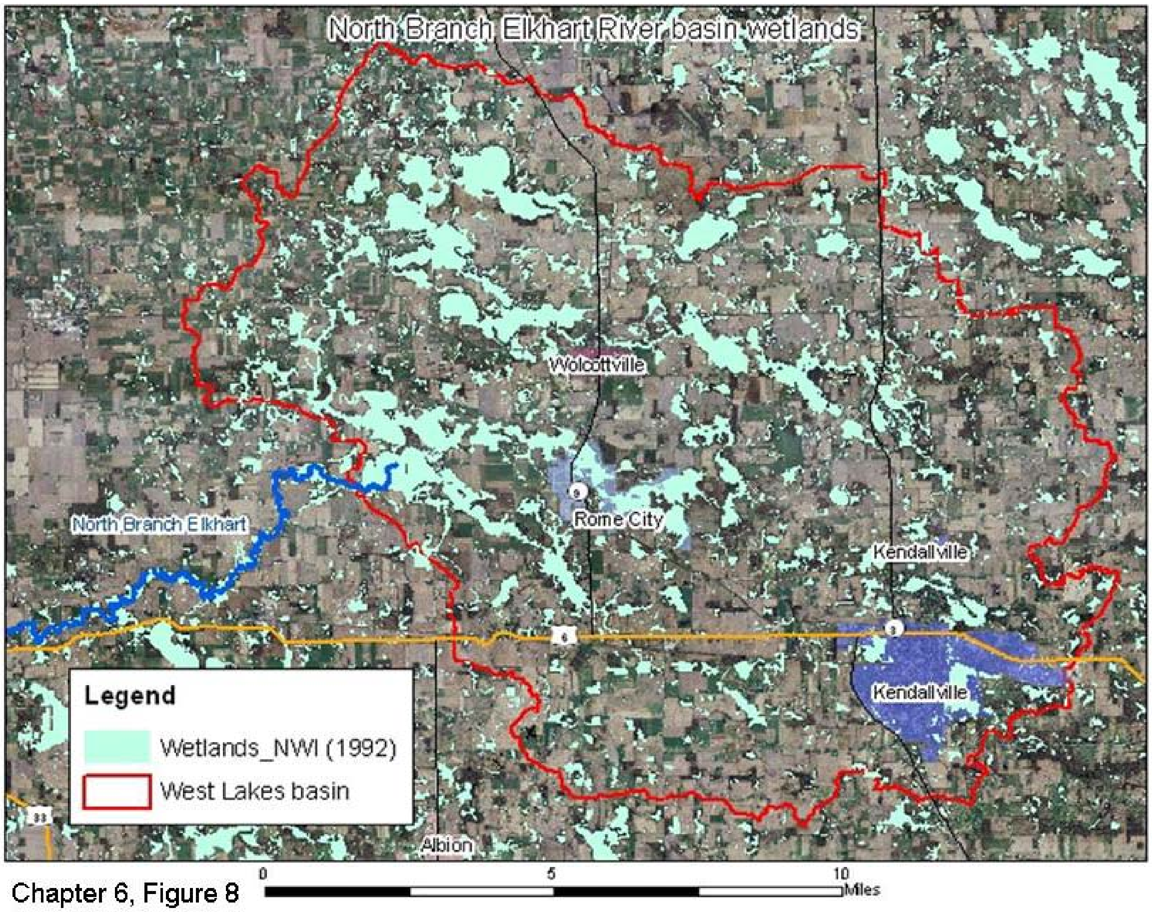
- With the West Lakes Chain at 888 feet, there are 1,567 acres of water surface. This includes surrounding land below an 888-feet elevation that would be covered by high water.
- To create and maintain only a one-inch lowering of water level over that water surface in a single day, for the entire 24-hour period the river would need to pass into storage an additional 65 cfs (cubic feet per second) more than the inflow to the lake, an additional 8 percent higher flow rate than would normally be occuring.
- For every 24-hour period of a flood event, to create and maintain only a one-inch lowering of water level, an additonal storage area holding about 5,600,000 cubic feet would be needed.
- This additional storage area is about 130 acre-feet per day. So an additional 13 football fields would need to be flooded with 10 feet of water per day to sustain lowering West Lakes Chain one inch.
- And the March 2009 event saw lake levels at or above 888 feet for a total of 26 days, which would mean 13 additional football fields 10 feet deep each day for 26 days, or 338 additional football fields for that flood event, for a one-inch benefit.

Even a 2,430 acre-feet pond could be filled in several days with the rate and volume of flood flow into the NBR Elkhart River from West Lakes during high water events as experienced in March 2009. Once the conceptual storage pond is filled, the waters in the lake would once again rise.

Another way to view the size requirements for additional on-going flood storage at West Lakes is to view storage capacity needed in terms of the volume of a totally dry Sylvan Lake. If the flood flows over and above the historical mean monthly flow for March were diverted to storage during the period Jan. 1 to May 30, 2009, how much could Sylvan Lake store? Below normal pool level, Sylvan has a storage capacity of 5,986 acre-feet. Based on the gage data, to keep the lake level of the West Lakes Chain at 886.5 feet, (one foot above Legal Level), it would require the filling of more than five dry lakes the size of Sylvan Lake.

Efforts to preserve existing wetland, flood plain, and ground water storage areas upstream and throughout the drainage basin, provides a more attainable way to ensure upstream storage and beneficial reduction in flood peaks. Returning previously existing natural storage areas to service is a further viable option to provide some benefit. All efforts to limit increased runoff from future development should be encouraged. Finding or building massive new storage areas seems unlikely, but should not be discouraged.

The NBR Elkhart River and associated lakes within the watershed/drainage basin function as a long system of linked lakes and wetlands that act as “rest areas” (see Figure 8, next page). If any of the upstream “speed bump” features such as wetlands and flood plains become filled or reduced in capacity, the bump is removed and water continues downstream faster and with a higher flow rate. When too much water gets to the same place at the same time it becomes a flooding situation.  The “rest area” features inherent in the NBR Elkhart River and West Lakes systems currently store flood waters upstream and reduce the high flood peak events in the lower reaches of the system. This type of watershed/drainage basin still experiences flooding; however, without the "rest areas" of extensive upstream storage through out the watershed/drainage basin; the peak flood levels would be much higher. Where possible, previously existing upland wetland, flood plain, and natural depressional storage areas should be identified and restored, to provide their pre-development benefits.




Chapter 6, Figure 8

In summary, additional dry storage, while beneficial, would require vast new areas of storage to provide anything more than a minimal decrease in lake levels, and a brief shortening of the time span that higher flooding lake levels are experienced (lower levels of flooding may actually be experienced over longer time frames depending upon the timing of the release of the stored water). Eliminating high flood levels through new dry storage appears prohibitive due to cost and sheer size.

### Lowering the Water Level of Sylvan Lake in the Fall or Winter to Allow for Additional Spring Flood Storage

A concept locally mentioned as a potential project is lowering Sylvan Lake during the winter months anywhere from six inches to several feet. This is expected to create storage for flood waters to fill back up to Sylvan Lake's legally established average level, thus reducing water moving downstream through the West Lakes Chain.

For this analysis, the one-time seasonal lowering of the lake two feet from the legal level of approximately 916 feet down to 914 feet was considered. Sylvan Lake has an increase in storage capacity of about 1,400 acre-feet between these lake levels, (see Figure 9 next page). Above 917 feet, flood damages around Sylvan Lake begin.

| Sylvan Lake Storage at varying Lake level | | | |
|---|---|---|---|
| Lake Level | Total Storage | Storage Increase | Note |
| (ft) | (Acre-ft) | (Acre-ft) | |
| 914 | 4520 | | |
| 914 to 916.1 | 5920 | 1400 | 916.2 ft Sylvan Legal Level |
| 916.1 to 917.1 | 6600 | 680 | |
| 917.1 to 918 | 7250 | 650 | flooding on Sylvan Lake |

**Chapter 6, Figure 9**

While Sylvan Lake does have storage capacity if lowered, the flood reduction benefits to the downstream West Lakes Chain has several limitations:

- Of the 134 square miles of total drainage area, the drainage area entering West Lakes chain from the NBR Elkhart River by way of Jones Lake is 67 square miles
- The drainage area entering Waldron and West Lakes Chain from Sylvan Lake is 34 square miles
- Sylvan Lake only represents about one-quarter of the entire drainage area contributing flood waters to the West Lakes Chain
- Sylvan Lake's potential one-time storage area volume of about 1,400 acre-feet equals only 10.7 days of lowering in the one-inch scenario explained above.

In a hypothetical situation, if Sylvan Lake could somehow intercept all the drainage area coming into the West Lakes Chain, its ability to reduce flooding would still be limited.

- During the high-water event experienced in March 2009, the potential Sylvan Lake storage of 1,400 acre-feet made available by lowering the lake two feet would be filled in less than four days.
- The West Lakes system routinely experiences both high-water levels and high outflow for extended periods.
- After four days, downstream flood flows would return to uncontrolled levels.
- Above normal flows were measured downstream of Waldron Lake in the NBR Elkhart River at Cosperville for over a month during the March 2009 event.
- It should also be noted that once Sylvan Lake would return to the legally established average level, either by being intentionally raised for the recreation season, or by a one-time filling from a flood, potential downstream flood reduction ability would no longer exist until such time in the future when Sylvan Lake could again be lowered.

- Lowering the lake level two feet could take weeks to again provide the ability to store any predicted heavy rainfall events.

This option would require funding a modification to the existing dam in order to design and construct a new spillway slide gate feature to allow this type of seasonal water level management. If this option is considered for further action, coordination would need to occur, at least, with the Noble County Circuit Court, the Department of Natural Resources, and the Rome City Conservancy District.  If pursued, the Conservancy District would potentially be asked to provide a benefit outside of current District boundaries, and the District may request an annexation of the benefited downstream property to broaden its current assessment base.

In addition to funding design and construction, the Conservancy District will need to find a way to provide funds for the perpetual maintenance and operation of the new spillway slide gate.

## CONCLUSION

The conceptual level review of the several targeted projects or activities are as follows:

- The Benton Dam located on the Elkhart River at Benton, Elkhart County was found to have no measurable impact (gates open or closed) on flow from West Lakes Chain.
- Increase the size of the opening below the county road bridge over the NBR Elkhart River at Cosperville may be further evaluated with improved hydrologic models, but is believed to only provide marginal benefits at low and moderate flow/stage events.
- Managing in-channel aquatic vegetation in a specific transitional section of the stream between Cosperville and the outlet works for the lake may have some positive impact on stage reduction for some low to moderate stages for seasonal events.
- Fallen tree and obstruction removal in the NBR Elkhart River, downstream of Waldron Lake may have limited benefits upstream of County Road 300W with little or no measurable benefits downstream of this point for Condition 1 or 2 obstructions.
- Raising selected access roads to residential areas would have direct benefits for access at some higher lake stages.
- Construction of a bypass channel in the NBR Elkhart River, downstream of Waldron Lake, likely would not pass a feasibility study review and would cause increased downstream discharges, high construction and maintenance costs, environmental damages, and potentially set an example for further upstream lake drainage bypass projects that would negate any conceivable benefit.
- Creation of additional flood water storage basins upstream of the West Lakes Chain could have some limited positive benefit over time for moderate level events but would require vast storage areas. Protection and expansion of existing storage, and restoration of previous storage areas, may prove more practical.

- Lowering the water level of Sylvan Lake a foot or two in the fall or winter to allow for additional spring flood storage would provide no practical benefit for flood levels at West Lakes Chain.

The results do indicate some items may provide limited help to decrease water levels in the low to moderate flood levels. Some of these items, if cumulatively practiced, could be of measurable benefit. The focus should be on maintaining a natural stream, but one that is relatively open upstream of approximately County Road 300 West to the West Lakes outlet structure. Activities that decreased the impact of aquatic vegetation in the transition area, tree falls, and bridge restrictions may provide some limited benefit. The benefits of these activities at decreasing higher flood stages for the lakes may not be realized. Increasing the elevation of critical structures, including access roads, may provide the best solution for risk management at higher stages.

Protection of the existing storage should be the top priority in the watershed. The area's currently considerable flood storage benefits from wetland storage. Incremental loss of this storage would adversely impact flooding in this watershed.