GLMRIS

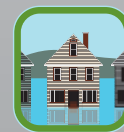
Great Lakes and Mississippi River Interbasin Study


Aquatic Nuisance Species


Ecosystems


Navigation


Recreation


Flood Risk Management


Water Use

Aquatic Nuisance Species Controls Report

Wabash-Maumee Basin Connection

Fort Wayne, Indiana

Appendix D Value Engineering Study

US Army Corps of Engineers®

BUILDING STRONG®

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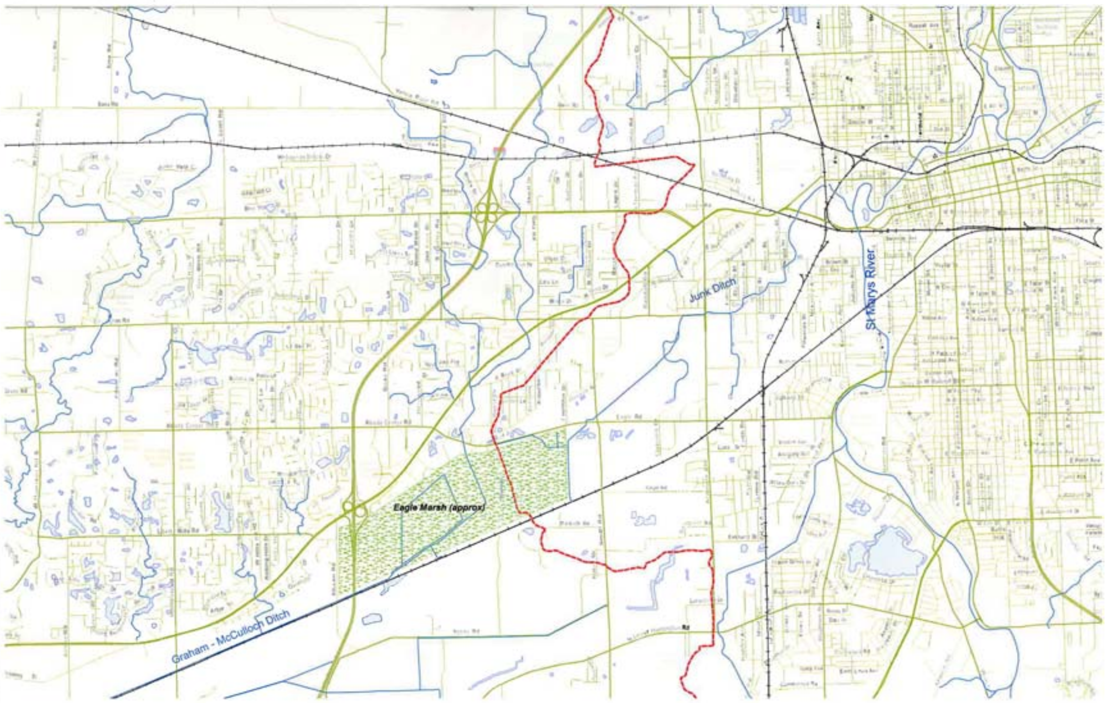
Value Engineering Study

US Army Corps
of Engineers®

Louisville District

Final Report



Wabash-Maumee River Basin Connection Study

Fort Wayne, IN

February 2011

Strategic Value Solutions, Inc.

Value Improvement Specialists

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Final

Value Engineering Study Report

for

Wabash-Maumee River Basin Connection Study

Fort Wayne, IN

February 2011

Prepared for:

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ACKNOWLEDGEMENTS

Strategic Value Solutions, Inc. would like to express our appreciation to the Louisville District USACE staff members who assisted us in the review of this project. Particular thanks go to David Nance, PG for providing valuable insights into project issues and to Ben Robertson, AVS for assisting in the coordination and management of this study.

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SECTION 1

EXECUTIVE SUMMARY

SECTION 1
EXECUTIVE SUMMARY

This report presents the results of a Value Study conducted by Strategic Value Solutions, Inc. (SVS) on the plan of the Wabash-Maumee River Basin Connection Study project for the US Army Corps of Engineers, Louisville (the District).

P2 Number:	114597
Design/Construction Strategy:	Design-Bid-Build
Level of Project Development:	Planning
Design Firm:	In-house design

The Value Study included a 3-day (24-hour) value methodology workshop that was conducted with a multidisciplinary team in Louisville, KY on January 19-21, 2011.

PROJECT DESCRIPTION SUMMARY

The Asian Carp, *Hypophthalmichthys* spp. is within 20 miles of Eagle Marsh, the natural intersection of the Wabash and Maumee River basins. The marsh is shallow, generally less than 18 inches deep and receives backwater flows from both basins under flood conditions. The carp is moving towards the marsh from the Wabash basin and has the potential to cross into the Great Lakes basin. Should the fish succeed, it has the potential to cause material harm to the region's $7 billion commercial fishery and create long-term ecological and economic damage to interests in the US and Canada. The fish multiply rapidly and consume the aquatic plants, phytoplankton, zooplankton and small mollusks forming the base of the food chain which supports the Great Lakes ecosystem.

According to Doug Keller of IDNR Division of Fish and Wildlife, the carp can swim in as little as one foot of water and can jump 10 ft vertically and about 20 ft horizontally. It is highly adaptable to varying flow conditions and water chemistry. The fish were seen attempting to jump over Williams Dam on the East Fork of the White River, a 20-ft high concrete dam .

As a temporary measure, Indiana DNR in cooperation with Little River Wetland Project and the NRCS has constructed a fence across Eagle Marsh. The fence post is embedded five feet into the marsh and reinforced against debris and ice flows from the Maumee River. It also has panels that can be removed in case of major flows to protect Fort Wayne, IN from a flood rise associated with the barrier. The barrier is robust but poses minimal impediment to flood flows. The fence will prevent adult Asian Carp from crossing the watershed divide. The fence is placed across a part of the marsh where water flows are too slow to maintain buoyancy of the eggs, so that even if the carp spawn next to the fence, the eggs will likely not survive.

By agreement with NRCS and IDNR the fence is permitted for five years after which it must be removed or its status will need to be revised . Replacement with another barrier is not out of the question but specific features would have to be negotiated.

Critical information regarding the actual risk of carp migration across the watershed boundary is not yet available nor is detailed, quantitative data concerning the minimum size of tributary up which the carp will migrate, their flow preferences as well as triggers for migration, parameters for egg viability, and other information vital to an effective design.

The Project Design Team is gathering data and formulating a set of alternatives.

VALUE STUDY TEAM

The team members that comprised this multidisciplinary Value Team are listed on the introductory pages of this report. In this instance, the value study team members are predominantly members of the Project Development Team. This is a Value Planning Study and early in project development.

All other participants of the study are provided in Appendix A.

VALUE METHODOLOGY

This Value Study used the international standard Value Methodology established by SAVE International, the Value Society. The Value Methodology (VM) uses a six-phase process executed in a workshop format with a multidisciplinary team. Value is expressed as the relationship between functions and resources where function is measured by the performance requirements of the customer and resources are measured in materials, labor, price, time, etc. required to accomplish that function. VM focuses on improving Value by identifying the most resource efficient way to reliably accomplish a function that meets the performance expectations of the customer.

With this process, the Value Team identifies the essential project functions and alternative ways to achieve those functions, and then selects the best alternatives to develop into workable solutions for value improvements.

Additional information about the Value Study processes used in the generation of the results presented is provided in Section 3 of this report.

STUDY CONSIDERATIONS

This section describes some of the key considerations identified during the Value Study.

Action Items

The following were identified as action items for the Value Team. These are aspects of the project or specific issues that the District project development team (PDT) or other stakeholders have asked the Value Team to review for validation of the current concept or to offer alternative solutions.

- None were identified

Key Agreements

There are typically a number of agreements, formal and informal, which affect the decision-making throughout the planning and design process. The following were identified as key agreements for the Value Team to consider when identifying alternative solutions.

- If the project is to be constructed under Section 206, Ecosystem Reconstruction, a $7.5 million cap applies. However, a 65%-35% cost share is required. So far no cost share partner has been identified. If a suitable project and partner are identified, it could be built in 18 months. A stakeholder entity could be created by a collaboration of Great Lakes entities to cost share on this project.

- The project could be constructed under Section 506 also Ecosystem Restoration which has no defined project limit. Congressional authorization would be required to construct a specific project.

- Little River Wetlands Project is the private not-for-profit owner of the Eagle Marsh project. Little River owns 50% of the land and provides routine maintenance. IDNR owns the rest of the 1100 acres site. The cooperation of both groups was crucial in getting the fence built. The site has a NRCS easement which required a cooperative use agreement that has a 5-year term after which time the fence must be removed if other arrangements are not in place.

- NRCS has been approached by several nearby landowners interested in joining the Wetland Reserve Program. If successful this may generate additional acerage for flood storage. Collaboration with NRCS may increase the viability of some proposed approaches.

Critical Assumptions

Through the planning and design process, many assumptions have to be made in order to advance the project. The following were identified as some of the critical assumptions affecting the decision-making on this project.

- Per IDNR regulation, any construction within the floodplain cannot induce stages for the 1% chance exceedence event greater than 0.14 feet on other properties.

- Asian carp poses the most credible near-term threat, although tubenose goby and northern snake-head present a long-term threat.

- Any incorporation of the berms along Graham McCulloch Ditch into an Asian Carp barrier may trigger a requirement for these berms to be upgraded to current USACE levee standards. The berms on this project are not designed as flood control projects and do not function as flood control projects. They more closely resemble spoil pile berms constructed to train flow from the Graham McCulloch Ditch to the west.

- As a contingent value, the team is using 0.65 cfs as the lower boundary for flow necessary for a successful spawning run. Where the wetland widens and the velocity drops, the operating assumption is that the eggs die. The eggs need about 2 feet per second.

- Primary flood risks are assumed to arise from backwater from the St. Mary's and Maumee Rivers and some risk from headwaters flows but little risk from the western side.

- Because headwater flooding is very flashy the carp risk may largely associated with the fish being already in the Graham-McCulloch Ditch at the time a flood occurs.
- The current assumption is that a potential pathway between the edge of the landfill and the railroad has been blocked. The 2009 FIS indicates the area near former landfill is at a higher elevation.

Critical Constraints

Constraints or limits on the Value Study are used to define the boundaries between project aspects that the project stakeholders will consider changing and those that cannot be changed. These constraints may result from a variety of political, technical, schedule, or environmental causes. Excessive constraints tend to inhibit the team's ability to identify creative opportunities for value improvement. Inadequately defined constraints can result in the team's effort being wasted in areas where there is no possibility of change.

Constraints identified for this study were:

- Roger Setters (USACE) noted that there are legal and institutional barriers because the primary benefits are accrued by out of state parties. Congress did not give USACE any dispensation to not have cost share or refrain from placing management burden on a local entity.
- Must not cause flooding in the neighboring communities. Local flooding at 10% recurrence intervals is a major problem for some parts of Ft. Wayne near Junk Ditch.
- The neighboring communities are skeptical of flood risk assurances and will likely require demonstrable proof such as real-time monitoring before accepting any barrier approach
- Project is limited to engineering solutions and does not address approaches such as public education. The project team noted that this is a potential shortcoming because the team perceives a real risk in deliberate or accidental introduction of carp across the wetland divide.

Management Strategy Risks

From the Value Team's understanding of the project management plan, the following risks and opportunities were identified.

- Risk assessment is not yet completed. Other invasive species that may be relevant to this study are *hydrilla* and possibly goby however very unlikely because of the physical factors for their movement. The snakehead, currently in Arkansas, is of concern over the longer term.
- USACE is unwilling to pay for and maintain a directional flow meter because they believe that a short term project will be built before the meter provides valuable data. As Dave Nance, PG of IDNR noted invasive species migration is a larger problem with far reaching consequences and that we need much more data to better manage this and

other invasive species. He urges a more long-term approach and argues that this is a good site for a study area.

- The hydraulic and hydrologic information are incomplete. The development team does not yet know what flood frequency on the St. Mary's will flood Eagle Marsh via Junk Ditch. There are stage and flow gages in the downtown Ft. Wayne area on the Maumee and St. Josephs but they are relatively new.

Quality Objectives

Often, the District project development team or other stakeholders have specific quality objectives for the project. For this project, none were identified by the PDT.

WORKSHOP RESULTS

The purpose of the workshop is to identify and develop alternative concepts that will improve the overall value of the project. In order to be successful at identifying alternatives, it is essential that the Value Team first understand the project objectives and the problems that must be solved. For this reason, the workshop began with presentations by the District's project management to define the project objectives and to provide background information on the project. This was followed by a more detailed presentation of the project plan by the project development team on how the plan will accomplish the project's objectives. This was followed by a more detailed presentation of the existing barrier by Dave Nance, PG of IDNR describing the design parameters and strategies chosen to meet the project's objectives.This Information Phase of the workshop was followed by an in-depth analysis of the functional requirements of the project. A complete understanding of the basic functions that must be accomplished in order to successfully achieve the mission of the project is essential for the team to identify feasible alternatives to the current concept.

Using function analysis and Function Analysis System Technique (FAST) diagramming, the team defined the basic functions of this project as *Block Path.* Key secondary functions that supported this basic function(s) included *Trap Fish, Create Barrier, Separate Basins and Handle Ice*. Analysis of the functions intended to be performed by the project, helped the team focus on the mission of the project and, consequently, how to identify alternative concepts that would still meet the mission while exploring opportunities for value enhancement.

Analyzing the functions of this project gave the team the following key insights:

- The project could be designed to counter the threat of a single species or could include deterrents to multiple invasive species.

- Ice management poses significant design and maintenance challenges for barrier-type projects.

- Trapping fish may be viable as parameters are developed on what inititates movement.

With an understanding of the functional requirements, the Value Team transitioned to the Creative Phase of the workshop and brainstormed on all of the possible ways to accomplish each of those functions. The team generated 111 ideas for potential approaches to achieve the project's goals which included the 19 ideas previous generated by the project development team.

Based on the team members' professional judgment and input from the District representatives, 11 of these ideas were selected for developing into Value Alternatives. Two of these were from 19 ideas proposed by the development team before the workshop. Furthermore, the team selected Alternative Prev. B-4 as the baseline, and organized the remaining alternatives into 9 scenarios. Prev. B-4 was selected since it was proposed by the development team prior to the workshop.

Value Alternatives

Table 1-1, at the end of this section, includes a complete list of all the Value Alternatives developed. This table shows the number and title of each alternative as well as a summary of the cost savings. The cost savings shown are the capital or first cost savings only.

It should be noted that Value Studies are working sessions for the purpose of developing and recommending alternative approaches to the current plan. As such, the results presented are of a conceptual nature and are not intended as a final design. Detailed feasibility assessment and final design development of any of the alternatives or suggestions presented herein, should they be accepted, remain the responsibility of the District.

Some alternatives presented in this report are variations of a common concept and others are alternatives to a specific aspect of the plan. Thus, not necessarily all alternatives in this report can be implemented as selection of some may preclude or limit the use of others.

These potential savings do not reflect any costs for redesign, which must be considered. Moreover, the full benefit and impact of many of the alternatives goes beyond the cost savings to include improved project performance of required functions.

Optimum Combination of Alternatives

After completing the development of the Value Alternatives, the team reviewed the composite list of alternatives to identify what they believed to be the optimum combination of alternatives. This combination represents the best value solution for the project in the opinion of the Value Team. The review concluded that the maximum project benefits would be realized by combining the alternatives as detailed in Table 1-2 – Optimum Combination.

This combination results in the following potential cost savings:

CB-2 First Cost	$493,000
CB-28 First Cost	$1,023,000
Cost Savings compared to Prev B-4	$2,757,000

The savings from some of the individual Value Alternatives have been adjusted to account for overlapping savings when combined with other Value Alternatives. The calculations for these savings can be found in the Cost Information Appendix to this report.

Design Suggestions

In addition to the Value Alternatives, the team also identified 5 design suggestions. These are suggestions for changes or clarifications to the project documents that did not have an identifiable or quantifiable cost impact that could be determined within the scope of the workshop. The design suggestions from this study are included in Section 5 of this report.

Additional Benefits

A Value Study typically results in benefits beyond cost savings. These benefits are generated as a part of an alternative, design suggestion, or from an observation made by the team or one of the other participants during the workshop. Below are some of the benefits realized from this study, in addition to the cost savings discussed above.

- A more detailed understanding of the risks posed by each of the target species (carp, goby and snakehead) particularly the Asian carp was generated in the workshop and prepared in a summary report, Design Suggestion G-10.

CONCLUSIONS

While a comprehensive effort to separate the Wabash and Maumee River basins provides the most complete solution to blocking the path to Lake Erie, the team concluded that it is not feasible given the time and budget constraints of the current project. The team also acknowledged the insufficient information and, possibly insufficient time to acquire measurements and develop data necessary to inform an optimum solution.

In the near term, the team has elected to focus on a straightforward barrier with the primary purpose of blocking adult carp. The study revealed more complete strategies for blocking carp at Huntington dam as well as in Eagle Marsh. The alternatives nominated as optimum combinations address debris and ice flows, flood protection, protection of Eagle Marsh and potentially barriers for other invasive species. These alternatives also allow adaptive management and can be monitored and modified as the threats are better defined.

The team had not considered contacting colleagues in the Northwest on how to manage fish with jumping and shallow-water slithering capacity. Although much of this expertise is expended protecting salmon and other desirable species by diverting them from intake structures or otherwise directing their path, the same knowledge may be invaluable in deterring invasive fish. This avenue should be pursued.

Table 1-1
Summary of Alternatives

Scenario No.	Alt. Included	Description	First Cost	First Cost Savings
BASELINE	Prev-B-4	Rock/sand berm parallel to I-69 combined with realignment of Graham McCulloch Ditch - variations include sand core berm w/ rock cover; excavation of ditch realignment material used for berm; one or series of innovative release structures **FIRST COST $4,273,000**	$4,273,000	
1				
	CB-2	Create a vertical drop structure	$493,000	
	CB-28	Berm (permeable) with underdrains	$1,023,000	
				$2,757,000
2				
	CB-3	Enhance the fence	$1,780,000	**$2,493,000**
3				
	CB-4	Create a fence berm combination	$332,000	**$3,941,000**
4				
	CB-2	Create a vertical drop structure	$493,000	
	CB-9	Build a permeable barrier (riprap)	$531,000	
				$3,249,000
5				
	CB-25	Build structure and pump around	$863,500	**$3,409,500**
6				
	CB-31	Reroute Graham-McCulloch Ditch to Junk ditch and create barrier downstream floodwall	$5,027,000	**($748,000)**
7				
	CB-35	Build barrier for the longest economic crest for lowest flow depth	No costs developed	

Scenario No.	Alt. Included	Description	First Cost	First Cost Savings
8				
	SB-2	Create storage in both basins	$2,361,000	**$1,911,500**
	Prev B-12	Create a fence or barrier at Huntington Dam	No costs developed	

Table 1-2
Optimum Combination of Alternatives

Alt. No.	Description	First Cost Savings
Combination 1		
Prev B-12	Create a fence or barrier at Huntington Dam	No costs developed
Combination 2		
CB-2	Create a vertical drop structure	$493,000
CB-28	Berm (permeable) with underdrains	$1,023,000
	Total	**$2,757,000**

SECTION 2

PROJECT DESCRIPTION

SECTION 2
PROJECT DESCRIPTION

The Wabash-Maumee River Basin Connection Study is a planning level study whose purpose is to prevent the Asian Carp and secondarily, other invasive fish species from crossing the basin divide at Eagle Marsh and entering the Maumee watershed draining to Lake Erie. The marsh is near Fort Wayne, Indiana and is the saddle point between the Wabash Basin and the St. Mary's River. The St. Mary's and the St. Joseph's rivers form the Maumee River. (see map on next page)

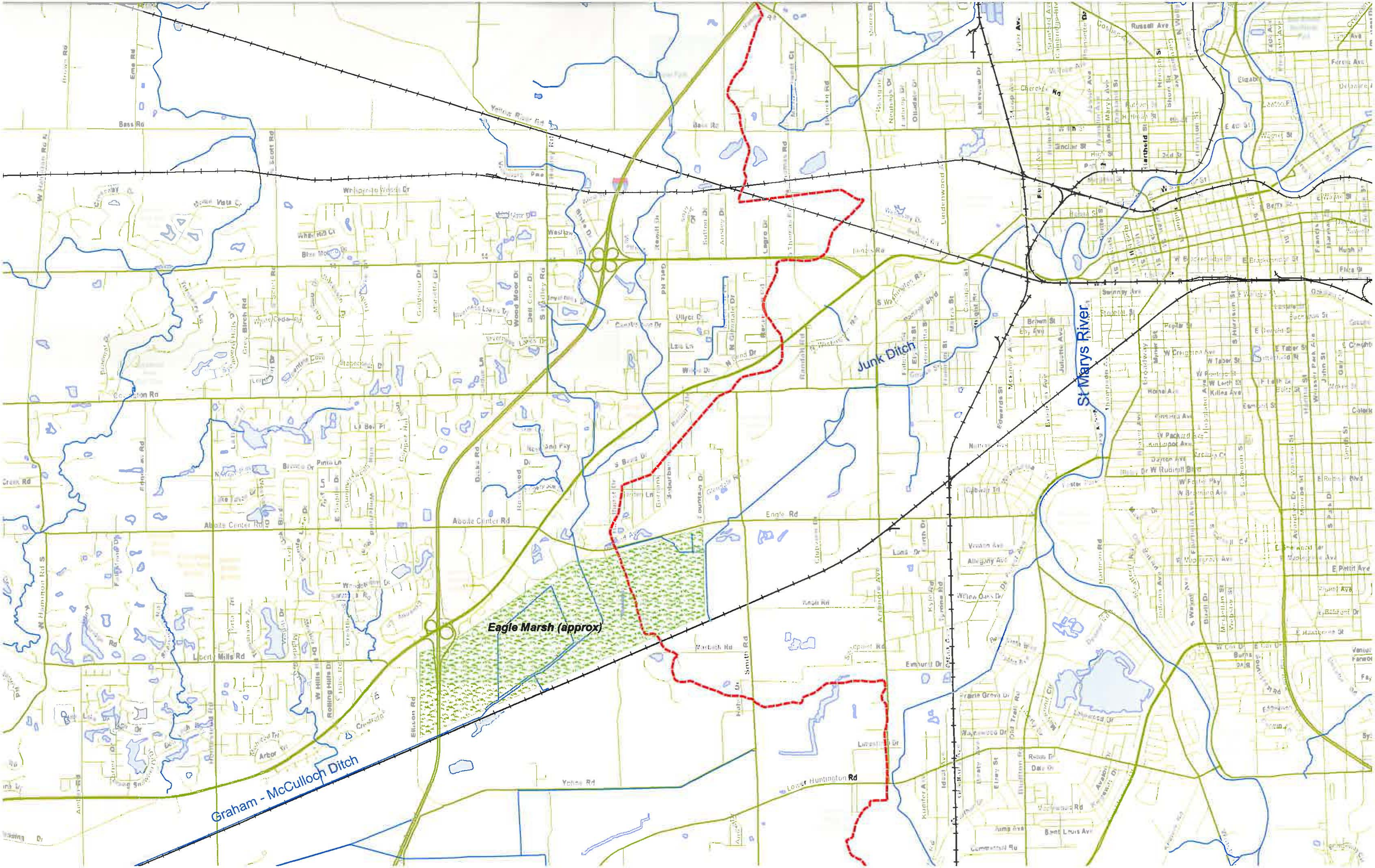
Although 53 invasive species threaten the region, the most imminent threat is posed by the members of the Asian Carp family particularly bighead and silver carp. These fish have expanded their range into the Wabash basin and were sighted attempting to jump the low-head dam at Williams Dam on the East Fork of the White River.

Figure 1. Eagle Marsh – Photo courtesy of TetraTech

They are presently about 20 miles downstream of Eagle Marsh.

Figure 2. Graham-McCulloch Ditch – Photo courtesy of TetraTech

The fish multiply rapidly and consume the aquatic plants, phytoplankton, zooplankton and small mollusks forming the base of the food chain which supports the Great Lakes ecosystem. If the fish establish breeding populations in the Lakes, the economic and ecological implications are serious. US Fish and Wildlife estimates the economic value of the sport and commercial industries in the Great Lakes at between $4.5 and $7 billion and the economic value of waterfowl hunting at $2.6 billion. The damage that these fish would do to hunting, fishing and recreational boating is a source of considerable debate but the desirability of denying carp access to the Great Lakes is not. The primary access route is through the Chicago Sanitary and Ship Channel and much of the national effort is focused on blocking that route. The present project seeks to deny access through the minor route between the Junk Ditch and Graham-McCulloch Ditch through the Eagle Marsh.


Eagle Marsh (approx)
Junk Ditch
St Marys River
Graham - McCulloch Ditch
Bass Rd
Covington Rd
Aboite Center Rd
Engle Rd
Liberty Mills Rd
Lower Huntington Rd
Yohne Rd

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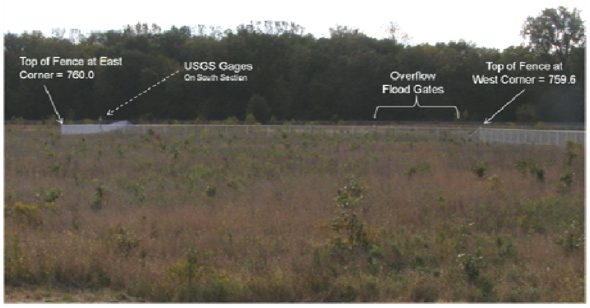
There are several constraints that form the project approach. The marsh receives flows from several sources many of which contribute to frequent flooding in either Ft. Wayne or Huntington, IN. Any physical barrier must be designed to avoid exacerbating this problem. Moreover, in the design team's estimation, any such barrier must include demonstrable proof that flood levels are not increased. A hydraulic model demonstrating no-net-rise would likely not be sufficient while on-site, real-time monitoring of water depth would be. Alterations to Junk Ditch or Graham McCollouch Ditch are particularly influenced by this constraint. A physical barrier in the marsh will most likely include some combination of a highly permeable barrier that does not restrict water flow, construction of regional storage sufficient to lower flood elevations in both the Wabash and Maumee basins and prevent trans-basin mixing, or diversion of flows away from the marsh in such a manner as to avoid additional flooding.

The absence of a suitable sponsor also presents a challenge. This project is not exempt from the 65% federal-35% local sponsor requirement. The primary beneficiaries of a successful project are commercial and recreational interests near Lake Erie. Neither Indiana state agencies nor the City of Ft. Wayne have expressed a strong interest in the necessary cost sharing agreement. The protection of Eagle Marsh and urban flood control are understandably higher priorities. Development of a Great Lakes-based public-private compact to agree to the cost-share requirement is one alternative. Designing the project to include sufficient local benefits to attract a local sponsor is another. Presently $7.5 million including sponsor cost share is authorized under Ecosystem Restoration can be expended to design and build the project. If the estimated cost exceeds $7.5 million the project must then go through the more typical feasibility process. The absence of a compelling reason for local sponsorship coupled with the agreement to remove the temporary fence within five years constitutes significant constraints on the project.

The absence of rigorous technical information regarding both the local hydraulics and the necessary conditions for carp migration further complicate this project. The precise conditions in which backwater effects produce flows across the wetland of sufficient depth and velocity are not well defined. At present, it appears that successful migration of the carp across the wetland requires that the fish be in the Wabash headwaters steam during or within a few hours of backwater incursion from the Maumee basin. The area does not have a sufficient stage or flow gauge history to construct a thorough risk assessment of this occurrence. The triggers for carp spawning runs are broadly defined. It is clear that this fish is highly adaptable; it is less clear how to create a sufficiently inhospitable environment to serve as an effective carp deterrent without serious harm to native species.

Adult carp are temporarily excluded by a reinforced chain-link fence across Eagle Marsh. IDNR was the lead agency responsible for the design and construction of the 1,177-foot main fence and 494-foot supplemental debris fence. The marsh is an NRCS wetland restoration site and is jointly owned and maintained by the Little River Wetlands Project and IDNR.

Center Section of the Fence
with Debris Fence



Above photos courtesy of Dave Nance

The schedule for the project is not yet developed but given the operating constraints, the time frame is between 18 months and 5 years.

SECTION 3

VALUE STUDY PROCESS

SECTION 3
VALUE STUDY PROCESS

This section describes the process used to conduct this Value Study and the significant findings of the Value Team. This Value Study used the international standard Value Methodology established by SAVE International, the Value Society. The standard establishes the specific 6-Phase, sequential process, and the objectives of each of those phases, but does not standardize the specific activities in each phase.

Value Methodology (VM) is the general term that describes the structure and process for executing the Value Workshop. This systematic process was used with a multidisciplinary team to improve the value of the project through the analysis of functions and the identification of targets of opportunity for value improvement.

The **VM Job Plan** provides the structure for the activities associated with the Value Study. These activities are further organized into three major stages:

1. Pre-Workshop preparation
2. VM Workshop
3. Post-Workshop documentation and implementation

Figure 3-2 at the end of this section shows a diagram of the VM Job Plan used for this Value Study.

DEFINING VALUE

Within the context of VM, Value is commonly represented by the following relationship:

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

In this expression, functions are measured by the performance requirements of the customer, such as mission objectives, risk reduction and quality improvements. Resources are measured in materials, labor, price, time, etc. required to accomplish the specific function. VM focuses on improving Value by identifying the most resource efficient way to reliably accomplish a function that meets the performance expectations of the customer.

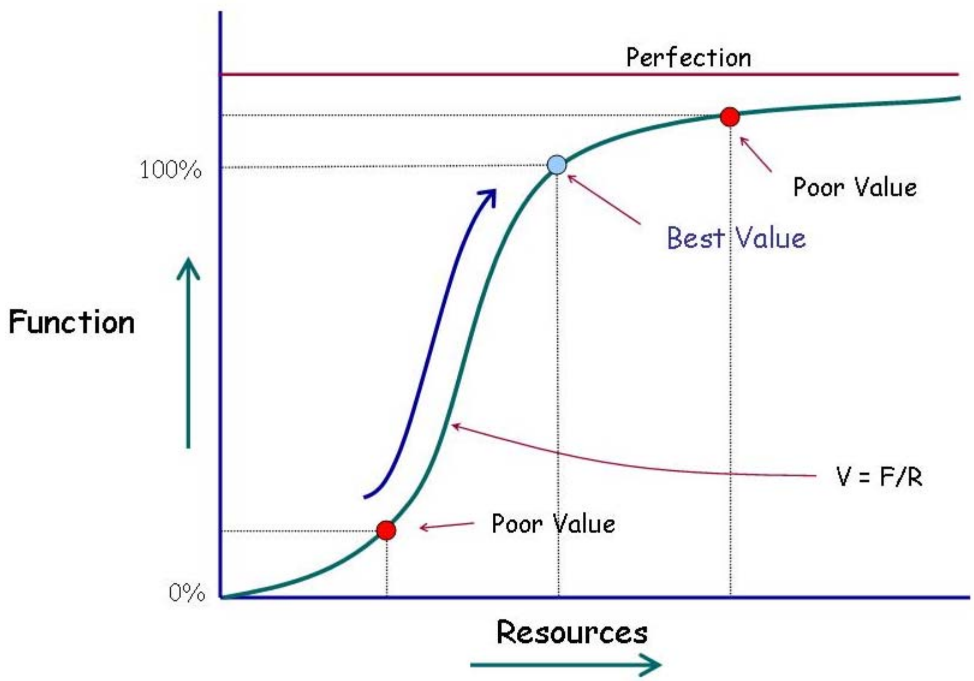
It can be seen from this relationship that Value is improved or increased by:

1. Increasing function without increasing resource consumption. Some increase in resources is acceptable as long as there is a greater increase in function performance.
2. Decreasing resources without decreasing function. Again, some decrease in function may be acceptable if the corresponding decrease in resources is significant enough.

Ideally, the Value Team looks for opportunities to increase function and concurrently decrease resource requirements. This will achieve the best value solution.

This Value concept is illustrated in the Figure 3-1, The Value Curve. This figure shows a hypothetical curve from plotting the value expression above. This curve will asymptotically approach perfection. The best value solution for a given project or project element will be found at the knee of the curve. At this point the required function or functions have been achieved to 100% of the required level with a corresponding minimum resource commitment. To attempt to increase the function performance beyond this level will result in a resource consumption that has a higher worth than the marginal increase in function. This results in a poor value solution. Conversely, a poor value solution can also be the result of not achieving the function to 100% of the requirement. In this case, an incremental increase in resources delivers significant increase in function performance. The Value Methodology is used to identify the poor value decisions in a project and then develop alternative solutions to better align the project along this curve to achieve a best value solution.

Figure 3-1
The Value Curve™



This understanding of how Value is affected by changes in function or resources provides the foundation for all SVS Value Studies. The following paragraphs describe the process we used to understand the functional requirements and how we identified value improvement alternatives.

PRE-WORKSHOP

Prior to the start of the workshop, the team was tasked with reviewing the most current documentation on the project development. This was done to familiarize them with the project plan and to prepare them for asking questions of the project stakeholders during the project presentations at the beginning of the workshop. Much of the background information for this study was generated by the District in-house staff. Other pre-workshop activities included:

- Coordinating workshop logistics and communicating those to the various participants
- Providing guidance to the District on presentation content for the project introduction
- Scheduling workshop participants and assigning tasks to ensure the team is prepared for the workshop
- Gathering necessary background information on the project and making sure project documentation is distributed to the team members

Materials furnished to the team by the District are listed in the Appendix.

VM WORKSHOP

The VM workshop was an intensive session during which the project plan was analyzed to optimize the balance between functional requirements and resource commitments (primarily capital and O&M costs).

The VM Job Plan used by SVS includes the execution of the following phases during the workshop:

1. Information Phase
2. Function Analysis Phase
3. Creative Phase
4. Evaluation Phase
5. Development Phase
6. Presentation Phase

Information Phase

At the beginning of the workshop, it was important to understand the background of the project from which the plan was developed. This background was provided in an oral overview by the District. The overview and subsequent project analysis provided information on the following topics:

- Rationale why this project is necessary

- Project objectives that have governed the proposed plan
- Rationale for the proposed plan configuration
- Explanation of plan features, criteria, and assumptions
- Value Study constraints
- Project cost

The District project management presentation provided the team with an overview of the goals, issues, and expectations for the project. The District and the Value Team also finalized the Value Study constraints. This was followed by the District's project development team's more detailed presentation on the project plan and an explanation of the rationale behind key plan decisions. Further, this gave the project development team an opportunity to share their issues and concerns about the project from their perspective.

From these presentations, the Value Team noted the following key information:

- Asian carp are reported as attempting to jump a dam
- Detailed information as to the stimuli to begin upstream migration is limited
- It is not known how far upstream Asian carp will migrate into headwater streams.
- Threats from other species are still being defined
- The hydraulic and hydrologic conditions under which Eagle Marsh becomes a viable bridge between the Wabash and Maumee basins are ill-defined
- Water levels in Eagle Marsh influence urban flooding in Ft. Wayne, IN and other communities; therefore any manipulation at the marsh must be accomplished without exacerbating flooding in populated areas.
- There is no apparent local sponsor for this project. On the contrary, local interests may perceive any changes to the marsh as increasing their already problematic flooding.

Function Analysis Phase

Function Analysis is the heart of the VM process and is the key activity that differentiates the VM process from other problem solving or improvement practices. During the Function Analysis Phase of the VM Job Plan, functions are identified that describe the expected outcomes of the project under study. Function Analysis also defines how those outcomes are expected to be accomplished by the plan. These functions are described using a two-word, active verb and measurable noun pairing.

This identification and naming convention of project functions enables a more precise understanding by limiting the description of a function to an *active verb* that operates on a *measurable noun* to communicate what work an item or activity performs. This naming convention also helps multidisciplinary teams to build a shared understanding of the functional requirements of the project.

Function Determination

Defining functional requirements for the project allowed the District to be sure that the facility, with the current plan, would fulfill the needed purposes. The entire project was analyzed to determine what functions are being accomplished by the current plan. Required functions were retained. Some functions were not necessary to accomplish the mission of the project and thus became candidates for deletion.

During the Function Analysis Phase, the Value Team used various function analysis techniques to analyze the project. This analysis helped the team confirm its understanding of the overall project objectives and analyzed the functions of key project elements. The Value Team Leader led the team through an in-depth discussion of the possible functions of each key project element to clearly and precisely identify the purposes of each.

FAST Diagram

Function analysis was enhanced by using a graphical mapping tool known as the *Function Analysis System Technique* (FAST), which allows team members to understand how the functions of a project relate to each other. The resulting FAST Diagram allowed quick visualization of the logical relationship between project functions and the project as a whole. The FAST diagram is in the Function Analysis section of the Appendix.

The FAST Diagram is structured such that moving to the right of any function answers the question, “How are we accomplishing this function?” Moving to the left of any function answers the question, “Why are we accomplishing this function?” Elements that are vertically connected occur “When” or as a consequence of the function it is connected to on the horizontal path.

The diagram shows on the far left that the ultimate function or the mission that must be accomplished by this project is to Block Passage. This is accomplished by (Narrate or read the FAST diagram for the reader)

The functions between the two dashed lines, called Scope Lines, represent the functional elements of the project which are within the scope of the Value Study. The first column of functions (basic functions) within the left Scope Line represents the functions that must occur in order for this project to successfully accomplish its mission. The remaining functions (secondary or support functions) represent how the current plan has chosen to accomplish those basic functions.

Function Findings

From the function analysis of this project, the team concluded that:

- The project could be designed to counter the threat of a single species or could include deterrents to multiple invasive species.
- Ice management poses significant design and maintenance challenges for barrier-type projects.
- Trapping fish may be viable as parameters are developed on what inititates movement

- The three primary measures by which invasive species can be deterred in this case are creating a barrier, separating the basins and potentially trapping.

In addition to identifying the essential project functions, this phase of the workshop also serves two other objectives:

1. The unification of the individual Value Team members into a synergistic, cohesive team, and

2. The stimulation of creative ideas prior to beginning the subsequent creative phase.

The function analysis worksheets are included in the Appendix.

Creative Phase

This step in the VM process involved generating ideas using creativity techniques. The team recorded all ideas regardless of their feasibility. In order to maximize the Value Team's creativity, evaluation of the ideas was not allowed during the creative phase. The team's effort was directed toward a large quantity of ideas. These ideas were later screened in the Evaluation Phase of the workshop.

The creative ideas generated by the team are included in the Appendix. The list also includes ratings for each idea based on the Evaluation Phase of the workshop. These lists should be carefully reviewed, as there may be other good ideas not developed by the team because of time constraints. These should be further evaluated or modified to gain the maximum benefit for the project.

Evaluation Phase

In this phase of the workshop, the team selected the ideas with the most merit for further development.

After an initial vote, the Value Team Leader assessed how many ideas could be developed into Value Alternatives within the remaining duration of the workshop. From this assessment, all ideas with a certain number of votes were selected for development. However, prior to the final selection, the results were revisited collectively by the Value Team to ensure that those selected by the voting process truly represented the best ideas for development. This gave the team the opportunity to down-rate some ideas and to up-rate other ideas based upon team discussion of the ideas.

The criteria used for selection were:

1. The inherent value, benefit and technical appropriateness of the idea

2. The expected magnitude of the potential cost savings, both capital and life cycle

3. The potential for the District acceptance of the idea

Ideas were selected for development as Value Alternatives based on all three criteria.

Not all ideas were developed. This evaluation process is designed to identify those ideas with the greatest potential for value improvement that can be developed into Value Alternatives within the time constraints of the workshop and the production capacity of the team. The remaining ideas were eliminated from further consideration by the team; however, the ideas not developed should also be reviewed, as there may still be other good ideas not developed by the team because of time constraints or other factors. These could be further evaluated or modified to gain the maximum benefit for the project.

To further ensure the Value Team is focused on developing the best ideas, a mid-point review meeting is conducted with the Value Team Leader and the District representatives. This mid-point review allowed the District to identify any fatal flaws in the ideas that were not apparent to the Value Team but were apparent to the District project team because of their greater institutional knowledge of the project. These fatal flaws may be technical, operational, political, etc.

Development Phase

During the Development Phase of the workshop, each idea was expanded into a workable alternative to the original project concept. Development consisted of preparing a description of the value alternative, evaluating advantages and disadvantages, and making cost comparisons.

Each alternative is presented with a brief narrative to compare the original concept and the alternative concept. Sketches and brief calculations were also developed, if needed, to clarify and support the alternative. The value alternatives developed during the workshop are presented in Section 4 – Value Improvement Alternatives.

The Value Team Leader and, to the extent possible, other team members reviewed each alternative to improve completeness and accuracy.

Redesign costs are not included in the cost comparison of alternatives. the District will be responsible for determining these costs.

Presentation Phase

The last phase of this workshop was the presentation of the Value Alternatives. The presentation was made by the Value Team on January 21, 2011 to representatives of the District's project team. The Value Team described each Value Alternative and the rationale that went into the development. This was followed by answering the audience's questions. The acceptability of the Value Alternatives was deferred pending the District's review of our Preliminary Report.

From this presentation, the following key points of discussion were noted:

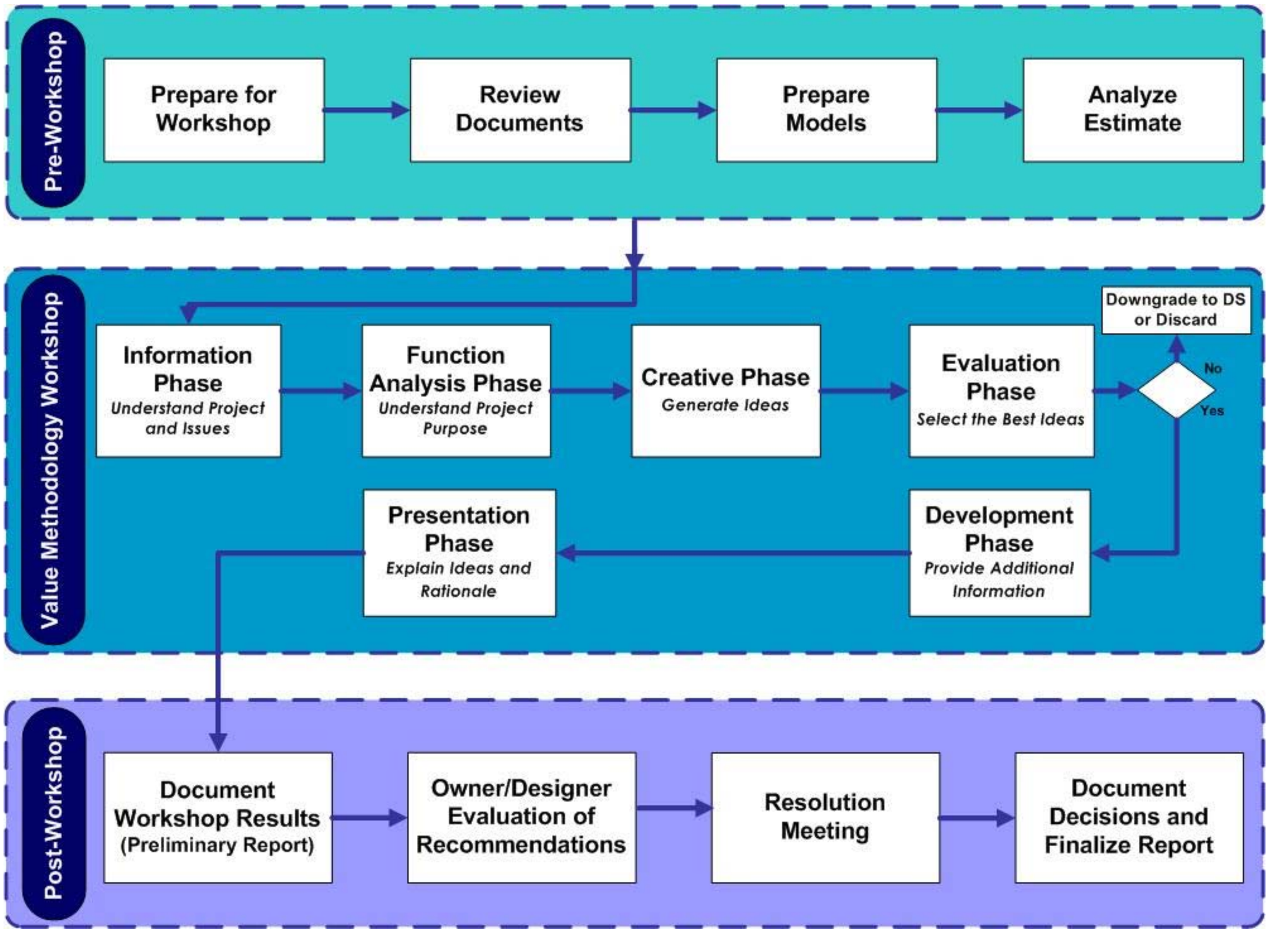
- The importance of providing appropriate drainage for any potential barrier was stressed. While permeable berms are attractive, the addition of drop structures will be required.

- Land acquisition is likely to be problematic and will strongly influence selection of the preferred option. Specifically the team was not able to readily identify acreage suitable for storage on a large enough scale to materially influence flood levels.

POST-WORKSHOP

The Post-Workshop activities of this Value Study consisted of preparing the Value Study Reports. Shortly after the conclusion of the workshop, our Preliminary Report was submitted to the District for review. This report contained the raw workshop product. This Final Value Study Report includes documentation of the Value process, as well as, the Value Alternatives developed during the workshop. The decisions regarding implementation of the alternatives are documented outside this report.

Figure 3-2
Value Engineering Process Diagram



SECTION 4

VALUE ALTERNATIVES

SECTION 4
VALUE ALTERNATIVES

The results of this Value Study represent the value improvement opportunities that can be realized on this project. They are presented as individual alternatives for specific changes to the current plan.

Each alternative includes:

- A summary of the original concept
- A description of the alternative concept
- A brief narrative comparing the original plan and the recommended change
- Sketches, where appropriate, to further explain the alternative
- Calculations, where appropriate, to support the technical adequacy of the alternative
- A capital cost comparison
- And a life cycle cost analysis, if appropriate

Cost was the primary resource that was compared to the functions being accomplished in the project. To ensure that costs were compatible within the Value Alternatives proposed by the team, the project cost estimate was used as the basis of cost.

EVALUATING THE VALUE ALTERNATIVES

Each part of a Value Alternative should be evaluated on its own merit, rather than discarding an entire Value Alternative because of concern over a particular aspect of the proposed change. Furthermore, the District is encouraged to review all of the ideas shown in the creative idea listing in the Appendix. Since the Value Team was constrained by a finite duration for the workshop and the production capacity of the team not all ideas were developed. Therefore there may be other ideas in that list that would provide additional value improvement opportunities for the project.

ORGANIZATION OF ALTERNATIVES

The alternatives presented on the following pages are organized by concept (scenario), that is, alternative solutions to the project objective(s). The project or functional categories used to organize the alternatives and design suggestions are as follows:

Create Barrier (CB)

Separate Basins (SB)

Trap Fish (TF)

General (G)

Ideas Previously Generated By Project Team (Prev)

Handle Ice (HI)

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Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No:
Prev. B-4

Title:
Rock/Sand Berm Parallel to I-69 w/ Graham-McCulloch Ditch realigned (Baseline)

Description of Proposed Concept:

The alternative concept is to:

- realign the Graham-McCulloch Ditch to the north edge of the Eagle Marsh property from downstream of the wastewater treatment plant to the I-69 roadway fill, and then parallel to the I-69 roadway to the existing I-69 bridge over the railroad and existing Graham-McCulloch Ditch;
- reconstruct confining berm(s) separating the realigned Graham-McCulloch ditch from Eagle Marsh during low flows, but allowing overtopping at select locations at high flows to inundate the wetlands areas. The downstream arm of the confining berm parallel to I-69 would be constructed of permeable materials such as uniformly graded riprap with sand core and an overflow structure near the I-69 Bridge. The berm would block the existing Graham–McCulloch Ditch alignment and tie-in to the existing railroad berm.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☐ Increased	☐ Increased
☑ Maintained	☑ Maintained
☐ Decreased	☐ Decreased

Cost Savings Summary

First Cost: $ 4,273,000

Advantages/Disadvantages

Alternative No.: Prev B-4

Advantages of Alternative Concept

- Creates a barrier to migration of invasive species by separating the watersheds with flow only allowed between basins through the sand/riprap berm, except at extreme high flow events.
- Sand core of berm prevents migration of microscopic and larger organisms and eggs of larger organisms.
- Confining berm separates urban runoff with low water quality from upper Graham-McCulloch watershed from Eagle Marsh during minor flood events.
- Realignment channel passes low flows, preserving the majority of storage in Eagle Marsh for high flow flood events that create backwater flooding from the St. Mary's River across the existing basin divide.
- Potential opportunity to improve Eagle Marsh performance as a wetland.

Disadvantages of Alternative Concept

- Requires coordination with railroad for real estate rights to tie into railroad berm.
- Significantly affects function of existing Eagle Marsh. NRCS has expressed reservations to alternatives affecting Eagle Marsh function.
- Sand filter and/or riprap could potentially "clog" over time with sediment "filtered" from flood waters, requiring periodic maintenance to remove accumulated sediment
- Will likely trap debris and/or ice, requiring periodic removal of debris
- Design of berm to achieve necessary permeability to prevent flooding could be difficult to achieve. Present models suggest about 1800 cfs would be required to pass the 1% flow without surcharge. With a length of about 2000 feet and a height at the 1% flow of about 3 feet, the structure would need to pass flow of about 0.3 ft/sec to avoid a surcharge.

Discussion

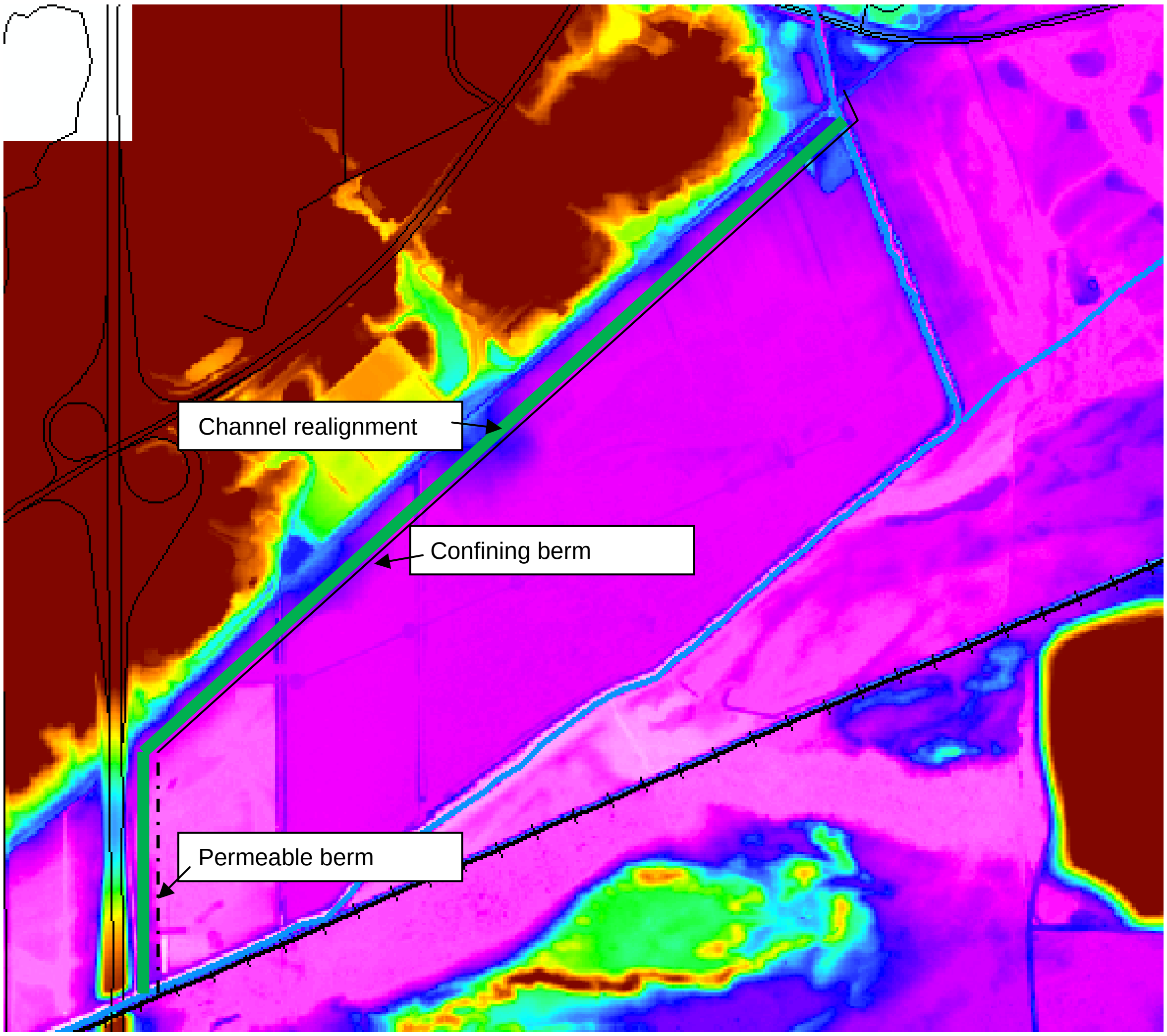
Alternative No.: Prev B-4

This concept creates a barrier to multiple invasive species by establishing a physical structure separating the two basins, while allowing flood flows from backwater flooding on the St. Mary's river to pass through the pervious berm structure. Realigning the Graham-McCulloch Ditch around the Eagle Marsh to downstream of the barrier and isolating it from Eagle Marsh allows passage of daily flows and saves the storage volume within the Eagle Marsh for extreme flood events on the St. Mary's River. Separating daily flows from Eagle Marsh protects the Marsh from regular contamination of low quality urban runoff. An emergency overflow structure would be required to pass extreme flood events.

Sketch

Alternative No.: Prev B-4

☐ Original ☑ Alternative

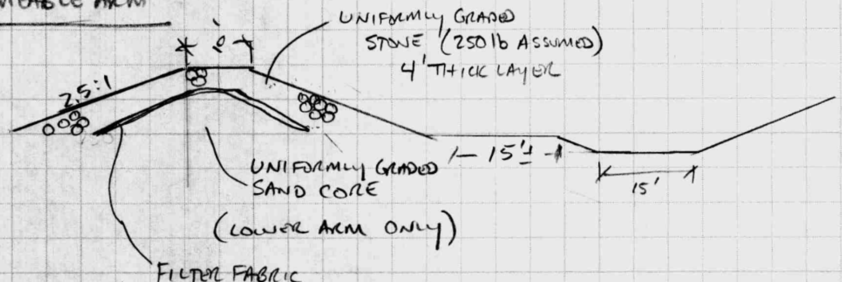


Calculations

Alternative No.: Prev B-4

☐ Original ☑ Alternative

PERMEABLE ARM



VOLUME SAND CORE / LF = ½ (6' x 15') x 2 + (6' x 2') = 102 CF/LF

LENGTH SAND CORE / RIPRAP ARM ≈ 1750 LF

VOLUME SAND = 178,590 CF = 6614 CY SAY 6600 CY

VOLUME RIPRAP / LF ≈ ½ (10 x 25) x 2 + (10 x 10) − 102 CF/LF (VOL SAND)

≈ 350 CF/LF − 102 CF/LF = 248 CF/LF

VOLUME RIPRAP ≈ 248 x 1750 = 434,000 CF ≈ 16,074 CY
SAY 16,100 CY

STANDARD BERM:

ASSUME VOLUME BERM ≈ 350 CF/LF PER ABOVE
VOLUME RIPRAP ONLY ON REALIGNED DITCH SIDE ≈ 125 CF/LF
LENGTH = (4.8/3.5 x 5280) = 7241 SAY 7250
(^ measured on map)

VOLUME COMPACTED SOIL = (350 − 125) x 7250 = 1,631,250 CF = 60,416.6 CY
SAY 60,400 CY

VOLUME RIPRAP = 125 x 7250 = 906,250 CF = 33564.8
SAY 33,560 CY

FILTER FABRIC ENTIRE LENGTH = 7250 + 1750 = 9000 LF x 1.1 = 9900 LF

Calculations

Alternative No.: Prev B-4

☐ Original ☑ Alternative

SA/LF FILTER FABRIC $= \left(\sqrt{6^2 + 15^2}\right) \times 2 + 10 = 42.3$ SAY 45 SF/LF

SA FILTER FABRIC = 45 SF/LF × 9900 LF = 445,500 SF

EXCAVATION DITCH REALIGNMENT

ASSUME 751 EX GROUND ELEVATION AVERAGE

LENGTH ≈ 9000 LF

VOLUME EXCAVATION/LF $\approx \frac{1}{2}(4 \times 10) \times 2 + 15 \times 4 = 100$ CF/LF

VOLUME ≈ 900,000 CF = 33,333 CY

CONCRETE OVERFLOW STRUCTURE

ASSUME 200 CY CONCRETE

Construction Cost Estimate

Alternative No.: B-4

Item	Unit of Meas.	Unit Cost	Original Concept (Deletions) Qty	Original Concept (Deletions) Total	Alternative Concept (Additions) Qty	Alternative Concept (Additions) Total
Uniformly Graded Sand	CY	$30	6600	$198,000		
Uniformly Graded Riprap (250 Lb)	T	$37	67,041	$2,480,517		
Embankment	CY	$12.45	60,400	$751,980		
Filter Fabric	SY	$2.45	49,500	$121,275		
Excavation	CY	17.85	33,333	$594,994		
Concrete for Overflow Structure	CY	$200	200	$40,000		
Seed and Straw	SF	$0.10	445,500	$44,550		
Remove store and replace topsoil	cy	$5	8,250	$41,250		
TOTALS				$4,272,566		

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SCENARIO 1

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No: CB-2

Title:
Create a vertical drop structure

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

The alternative concept is to utilize the Homestead Road embankment as an impermeable earthen levee that would block all low flow in the Graham-McCulloch Ditch except through a vertical drop structure similar to drop inlet structures on lakes to control water levels. Flows would be controlled by multiple vertical risers. Low flow would be maintained by small diameter openings at low levels of the drop inlet with the inlet ends buried in open graded gravel. Storm water from the Maumee Basin discharging through Eagle Marsh would be temporarily stored in the areas upstream of Homestead Road and discharge through the drop inlet structures. A short section of levee would need to be constructed between the railroad and the Homestead Road embankment. Assume the levee height would be 10 feet above existing ground with 3H:1V side slopes and 75 feet in length. Drop inlets would be constructed along the length of Homestead Road with pipe jacked under Homestead Road. The drop structures would be designed to pass 500 cfs for up to 5 days.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☐ Increased	☐ Increased

Cost Savings Summary

Prev B-4 First Cost:	$ 4,273,000
CB-2 First Cost:	$ 493,000
CB-28 First Cost:	$ 1,023,000
Cost Savings:	$ 2,757,000

Advantages/Disadvantages

Alternative No.: CB-2

Advantages of Alternative Concept

- Significantly reduces risk of invasive species moving towards Lake Erie. Intake screens would reduce risk of gobi and other species migrating into the Wabash Basin depending on screen size. Vertical drop would be sufficient to stop Asian Carp from migrating upstream.
- Maintains hydraulic characteristics of area. No increase in flooding. May reduce peak flooding downstream slightly.
- Can utilize existing Homestead Road embankment with some modifications reducing construction work and schedule.
- Would allow removal of the fence barrier in Eagle Marsh and eliminate any long term impacts to the Marsh. Would cause longer periods of inundation of Eagle Marsh which would be a positive.
- Would increase upper drainage area wetlands by about 400 acres with land between Homestead and I-69.

Disadvantages of Alternative Concept

- Maintenance cost after each significant rainfall event
- Risk of debris, sedimentation and ice blocking the inlet structures
- Increased risk of inducing flooding in Ft Wayne if outlet structure is partially or fully blocked. Could cause inundation of Homestead and Ellison Road. Overtopping of Homestead Road would increase risk of ANS from the Maumee Basin to migrate into the Wabash Basin.
- Requires a long term sponsor which has not been identified.
- Would require periodic inspections and removal of debris from inlet structures
- Some Maumee Basin species would be able to pass through drop structure into the Little River
- Requires easement or purchase of land between I-69 and Homestead Road. Most likely this would be a cost to NRCS. The land in question is frequently flooded agricultural property and several landowners have approached NRCS expressing a desire to enter the Conservation Reserve Program.

- Would retain some floodwater longer than current condition which may be perceived negatively by the public.

Discussion

Alternative No.: CB-2

The alternative concept is to utilize the Homestead Road embankment as an impermeable earthen levee and install drop inlet structures. Low flow would be maintained by several small diameter inlets into the drop structure buried in open graded gravel. A short section of levee would need to be constructed between the railroad and the Homestead Road embankment. This alternative assumes the levee height would be 10 feet above existing ground with 3H on 1V side slopes and 75 feet in length. Flow rates are estimated at 500 cfs for up to 5 days. Outlet headwalls and channels back to the Graham-McCulloch Ditch would need to be constructed.

Both faces of the Homestead Road embankment may need wave action erosion protection. The west face would also serve as a physical deterrent for snakehead.

Maintenance and inspection would likely be required after each flood event. Debris would need to be removed periodically from the inlet structure area.

Advantages of this alternative are reduced operating costs associated with pumping water, creation of additional wetlands, ability to leverage with NRCS wetland funds. Little River Wetlands is a potential administrator of the additional wetlands and construction would be confined within a small area outside of the sensitive Eagle Marsh area. This alternative allows removal of the temporary fence barrier at Eagle Marsh and risk of Asian carp and snakehead migrating from the Wabash to the Maumee Basin through this pathway is greatly reduced, migration of goby and species in the Great Lakes/Maumee Basin to the Wabash is somewhat to greatly reduced.

This alternative would require the owner to inspect, monitor, maintain, operate and repair the facilities. Operation cost will be incurred for inspection and periodic debris removal.

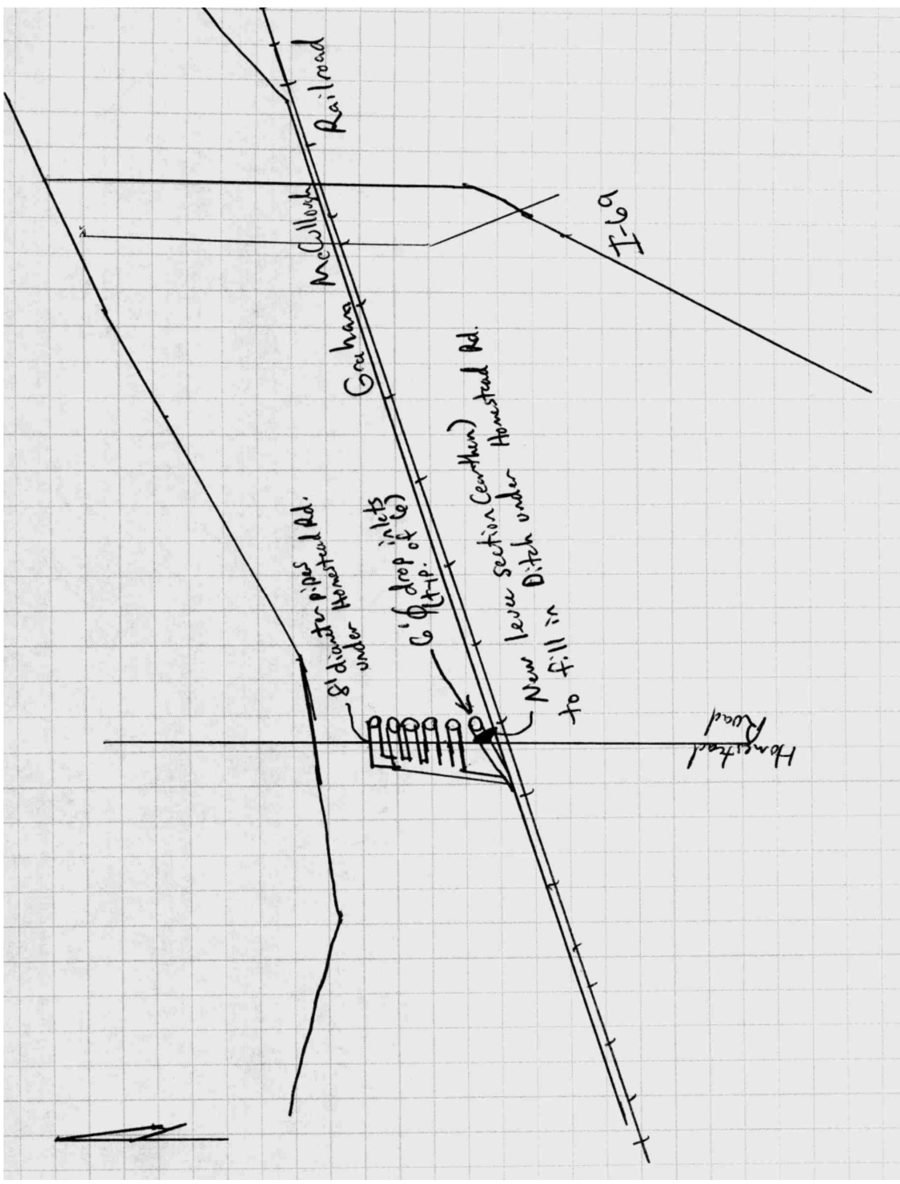
The levee would be approximately 75' in length beginning at the railroad embankment and tie into the highway embankment. Six new 6 foot diameter PVC or concrete riser pipe or box inlets would be constructed on the east side of Homestead Road at locations across the length of Homestead Road. Each structure would carry approximately 92 cfs at 1.3 ft of head on the inlet structure. Total maximum design flow of 500 cfs would be met. An eight foot diameter horizontal pipe, each 100 feet in length will carry storm water from the drop inlets from the east side of Homestead Road under the road to discharge on the west side of the road. Excavation depth would be approximately 10 feet. Some earthwork would be needed to construct ditches from the end of each outlet pipe back to the Graham-McCulloch Ditch.

Redundant water level sensors located on the east and west side of Homestead Road would send information to the project owner. The inlet structures would be designed to minimize collection of debris, handle ice and potential to block flow with the use of grating.

Sketch

Alternative No.: CB-2

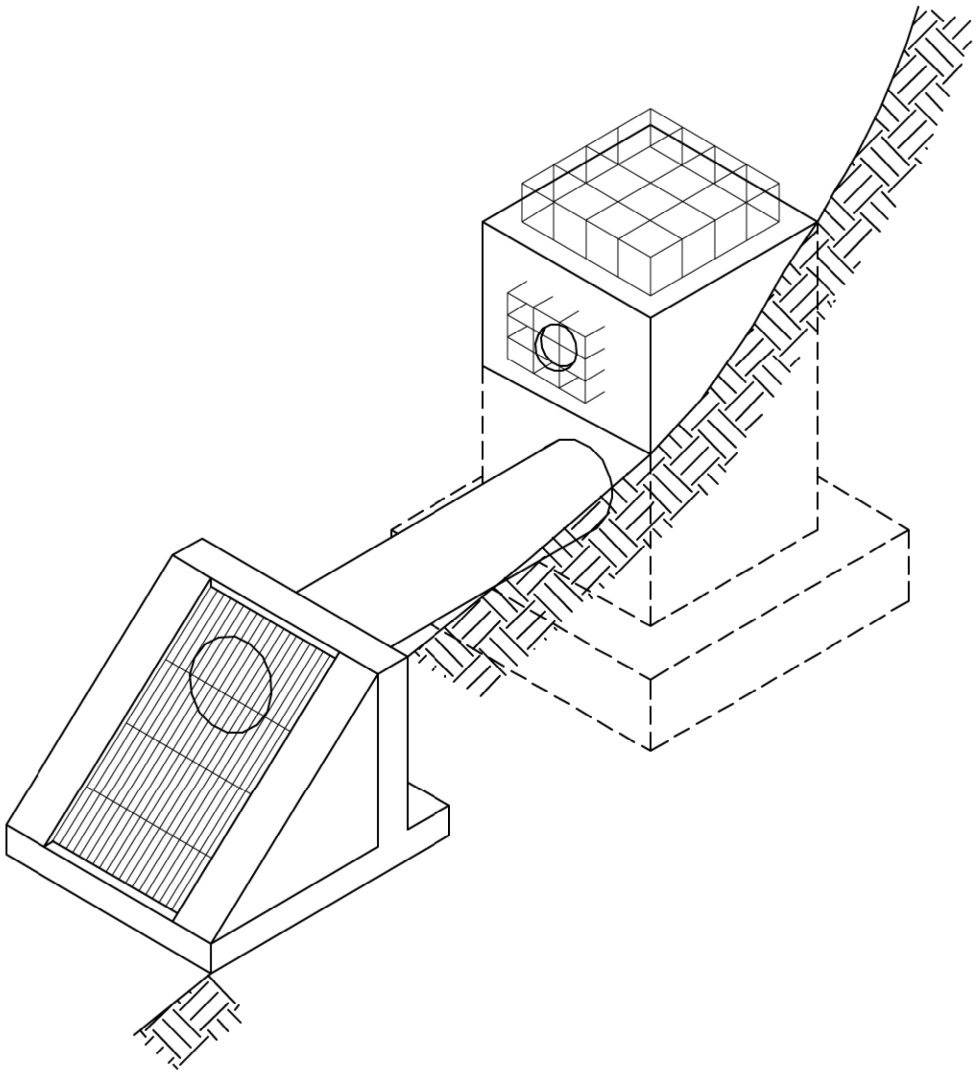
☐ Original ☑ Alternative



Sketch

Alternative No.: CB-2

☐ Original ☑ Alternative



Calculations

Alternative No.: CB-2

☐ Original ☑ Alternative

H=(.3225xQ/L)^2/3 for a broadcrested weir

H=Head on weir (FT), Q=Weir flow (CFS), L=Weir Length (FT)

Assumed 6'diameter inlet, 92 cfs results in 1.3 feet of head.

500 cfs flow rate

(Flow rate provide by project Hydraulic Engineer.)

Calculations

Alternative No.: CB-2

☐ Original ☑ Alternative

Levee earthwork

Assume levee is 10 feet tall, 5 feet wide at top and 3/1 slopes, 75 feet long

2x1/2x30x10=300 10x5=50 Total cross-sectional volume is 350 sq ft.

350x 75= 26250 cu ft =973 cu yds

Outlet channel excavation

Assume outlet pipes are 50 feet apart. Total length of outlet channel would be

50+100+150+200+250= 750 LF

Assume cross-section is 10 ft bottom with 3/1 slopes, 6 ft deep

Cross-section is 10x6+3x6x6=168 sq ft

Volume 168x750/27=4667 cu yds

Aggregate on Homestead Road slopes, assume 1 ft deep

2x1600x10=32,000 sq ft x 1 ft = 1185 cy

1185 cy x 1.35 T/cy = 1600 T

Construction Cost Estimate

Alternative No.: CB-2

			Original Concept (Deletions)		Alternative Concept (Additions)	
Item	**Unit of Meas.**	**Unit Cost**	**Qty**	**Total**	**Qty**	**Total**
75’ earthen berm 10’ high, 3/1 slopes.	CY	$30.30			973	$29,500
8’ diameter PVC pipe	LF	$375			600	$225,000
6’ diameter Concrete pipe	LF	$250			60	$15,000
Concrete inlet with grated structure	EA	$2,500			6	$15,000
Outlet earthwork	CY	$30.30			4,667	$141,410
Road cuts (5 cuts @ 10 ft deep)	Ea	$1,500			5	$7,500
Aggregate on embankment slope 1 ft deep	T	$37			1,600	$59,200
TOTALS						$492,610

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Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No:
CB-28

Title:
Berm (permeable) with underdrains

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

The alternative concept is to install a berm at a specific location which creates a barrier to fish and other aquatic species. The foundation of the berm would contain buried perforated piping surrounded by pervious materials which would capture water and transport under the berm in the direction of flow, while still maintaining a permanent cutoff for fish. The berm itself could also be constructed of pervious material to help pass additional water.

Locations:

Downstream (Graham McCulloch)- within Eagle Marsh, Ellison Road, Homestead Rd, or somewhere between running from high ground, south to the railroad

Upstream (Junk Ditch)- along Junk Ditch within the valley northeast of Engle Rd.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☑ Increased	☐ Increased
☐ Maintained	☐ Maintained
☐ Decreased	☑ Decreased

Advantages/Disadvantages

Alternative No.: CB-28

Advantages of Alternative Concept

- Provides cutoff to all fish species
- Allows passage of some/most water to reduce additional flooding
- No utility costs, low maintenance
- No human error – structure functions as constructed
- Intakes cover wide area, reduced concern with debris
- If placed downstream of I-69, small effect on frequency of water levels of flood events in populated areas

Disadvantages of Alternative Concept

- Likely not to address normal flow conditions of Graham McCulloch or Junk Ditch without additional flow structure or rerouting.
- Maintenance issues- siltation of underdrain piping, aggregate berm, and pervious materials around piping. Cleaning of piping, potential replacement of pervious materials.
- If placed at Junk Ditch, reduced flows through/under the berm may cause increase in elevation during storm events
- Difficulty/uncertainty in modeling flow rates through/under the berm
- Groundwater levels could limit lengths/depths/effectiveness of underdrains
- Would require buyout/easement for constructed area, potentially for affected inundation areas

Discussion

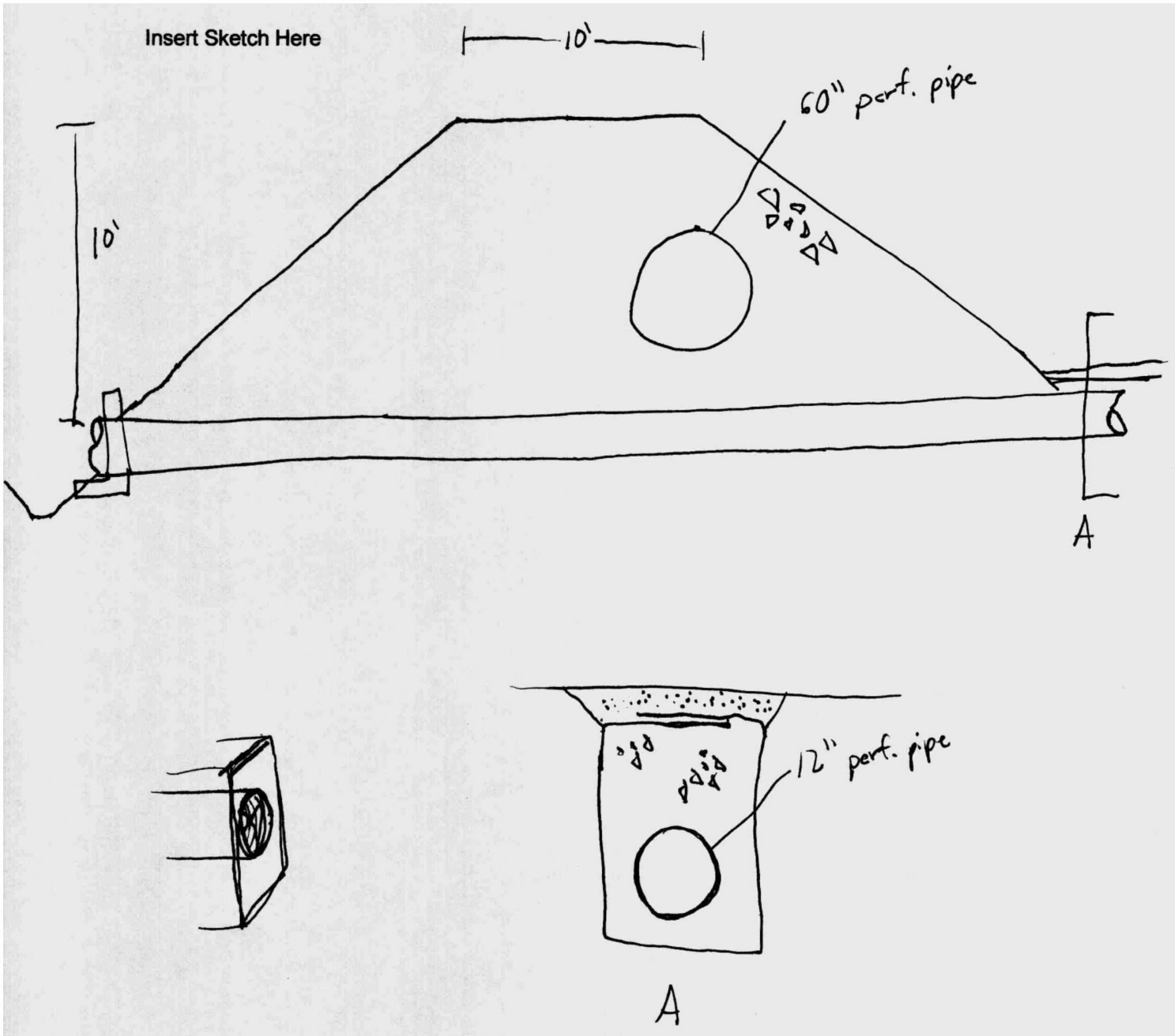
Alternative No.: CB-28

A well designed berm and underdrain system that passes water efficiently is a very feasible option. The berm would essentially exist for cutoff purposes yet have minimal effects on flood levels due to its ability to pass water through the other side, all the while maintaining the cutoff for fish. The berm could exist with minimal maintenance and concern. As the underdrain system would intake from a wide area, buildup of debris and ice would be less of a concern as with other flow structures.

Sketch

Alternative No.: CB-28

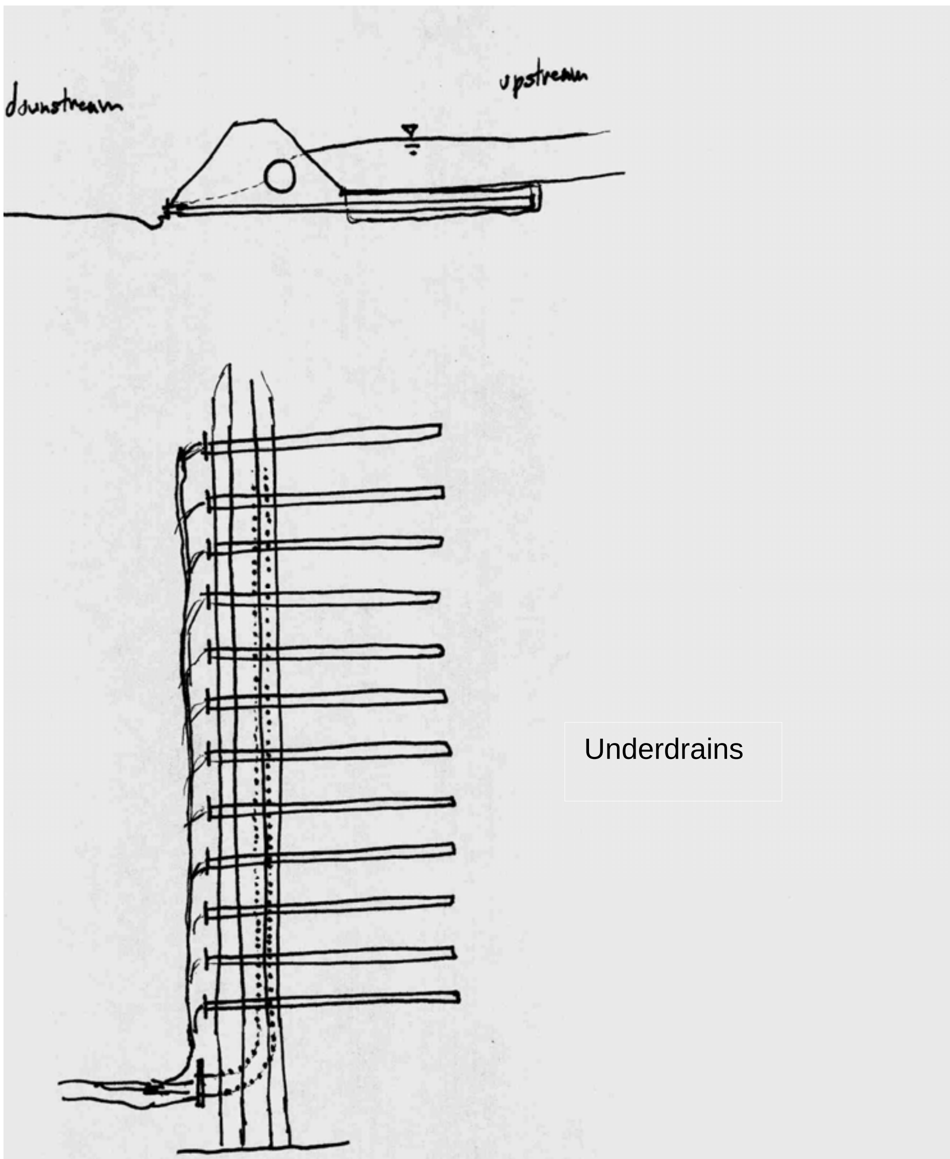
☐ Original ☑ Alternative



Sketch

Alternative No.: CB-28

☐ Original ☑ Alternative



Calculations

Alternative No.: CB-28

☐ Original ☑ Alternative

Berm

2H:1V side slopes

10 ft crown

10 ft Height

2 x ½(10 x 10) + (10 x 10) = (200 sf x 1200 lf)/27cf/cy = 8900 cy

Piping

12" dia. pipe – 16 ea. @ 80 ft long = 1,280 LF

Pervious Material

(2 ft x 3 ft x 1,280 lf)/27cf/cy = 285 CY

Excavation

(2 ft x 3 ft x 1,280 lf)/27 cf/cy = 285 CY

Filter Fabric

(10 ft x 1,280 LF)/9 sf/sy = 1500 sy

Construction Cost Estimate

Alternative No.: CB-28

Item	Unit of Meas.	Unit Cost	Original Concept (Deletions) Qty	Original Concept (Deletions) Total	Alternative Concept (Additions) Qty	Alternative Concept (Additions) Total
Berm	CY	30.30			8,900	$269,670
Rockfill	T	37.00			14,230	$526,510
60” Perforated piping –within berm	LF	120.00			850	$102,000
12" Perforated Piping	LF	26.00			1280	$33,280
Pervious material	CY	51.25			285	$14,606
IN 23 Sand	T	20.00			150	$3,000
Excavation	CY	17.85			285	$5,087
Filter fabric	SY	2.45			1,500	$3,675
Excavation for outlet ditch	CY	28.95			1,100	$31,845
Concrete Headwalls						
12” dia.	EA	$1,000			16	$16,000
60” dia	EA	$8,575			2	$17,150
TOTALS						$1,023,000

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SCENARIO 2

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No:
CB-3

Title:
Enhance the fence

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

This concept is to enhance the present fence site to allow for extended use of the system beyond the current schedule of summer 2015.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☐ Increased	☐ Increased
☑ Maintained	☐ Maintained
☐ Decreased	☑ Decreased

Cost Savings Summary

Prev B-4 First Cost:	$ 4,273,000
CB-3 First Cost:	$ 1,764,000
Cost Savings:	$ 2,509,000

Advantages/Disadvantages

Alternative No.: CB-3

Advantages of Alternative Concept

- Minor, definable regulatory issues
- Easily constructible
- Real estate in control of partners
- Provides for >20 year service life for blocking present ANS threat

Disadvantages of Alternative Concept

- Powerlines conflict
- Needs railroad agreement
- NRCS Compatible use agreements
- Blocks only the present AIS threat, ie, adult Asian Carp

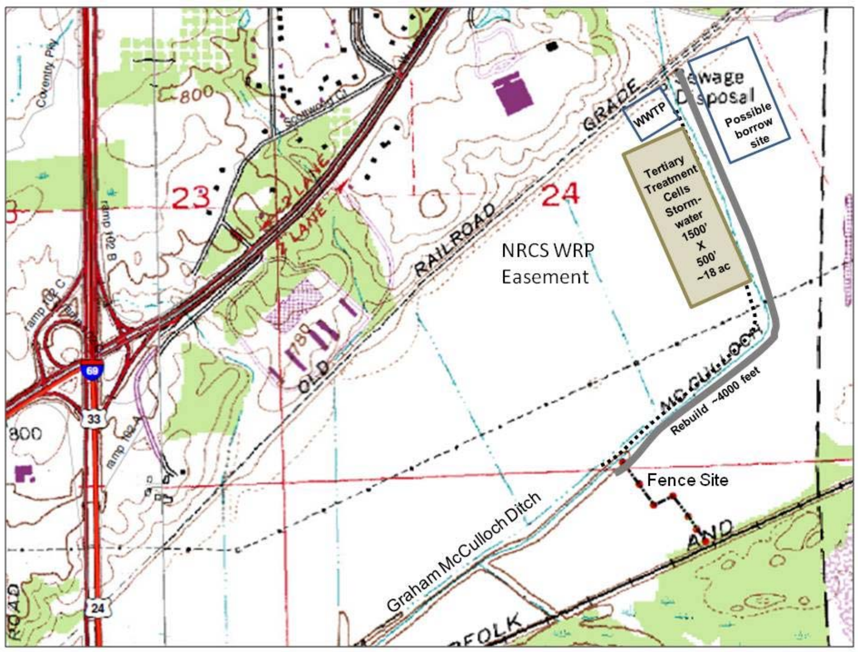
Discussion

Alternative No.: CB-3

This alternate will provide mechanisms to meet regulatory compliance issues including the local compensatory storage. The construction is relatively standard and simple providing for ease of design, estimating, bidding, and construction.

Main design components:

Use the present fence as constructed October 2010, including rockfill end closures, without modification.



Rebuild the left (east) bank of the Graham-McCulloch Ditch berm from the present fence site to the access road leading to the WWTP.

Remove much of the right (west) bank of the Graham-McCulloch Ditch berm to be used as borrow for the left bank rebuild (Compensatory Storage).

Construct a multi-cell wetland for pretreatment of urban storm water discharges from the Graham-McCulloch ditch and combine WWTP effluent discharge at an appropriate location in the design. For this example, an area of 18 acres was chosen. The stream will be located inside the wetland and therefore the containment levee would decrease. The additional soil volume would be for interior structures.

Source additional borrow from areas on the near north side of the site, near the WWTP.

There would be an increase in wetland area and a water quality improvement for the total discharge from the urban stream. Except for the foot-print of the existing stream, mostly incorporated in the treatment wetland, there should not be any wetland impacts, thus easing the regulatory aspects associated with the USACE 404 and IDEM 401 permits.

The section of the Graham-McCulloch under consideration is eroding both banks and thus is eroding the training berms. Eventually these berms will fail and discharge directly into the Eagle Marsh area. This project will address that aspect and thus provide a side benefit locally, helping the perception of the project and potential local support.

Discussion

Alternative No.: CB-3

The existing fence remains in service with little or no modifications. Details of the berm rebuild near the fence would be defined. Sufficient distance currently exists to provide for this fill upon removal or relocation of the present rockfill.

The fence as it presently exists will need to formally go through the IDNR construction in the floodway permit. The fence has multiple features to decrease the potential for surcharge. However, an Emergency Operation Plan or EAP would need to be prepared to fully address this aspect as well as some provision to provide for long term stage monitoring by the USGS.

The present fence location has already been scrutinized by local officials, land holding agency staff, and design staff as the best overall site for such barrier. One primary residual concern was the long term integrity of the 4000 foot berm on the Graham McCulloch. The berm is a spoil structure intended to train the flows from the Graham McCulloch out of the agriculture area.

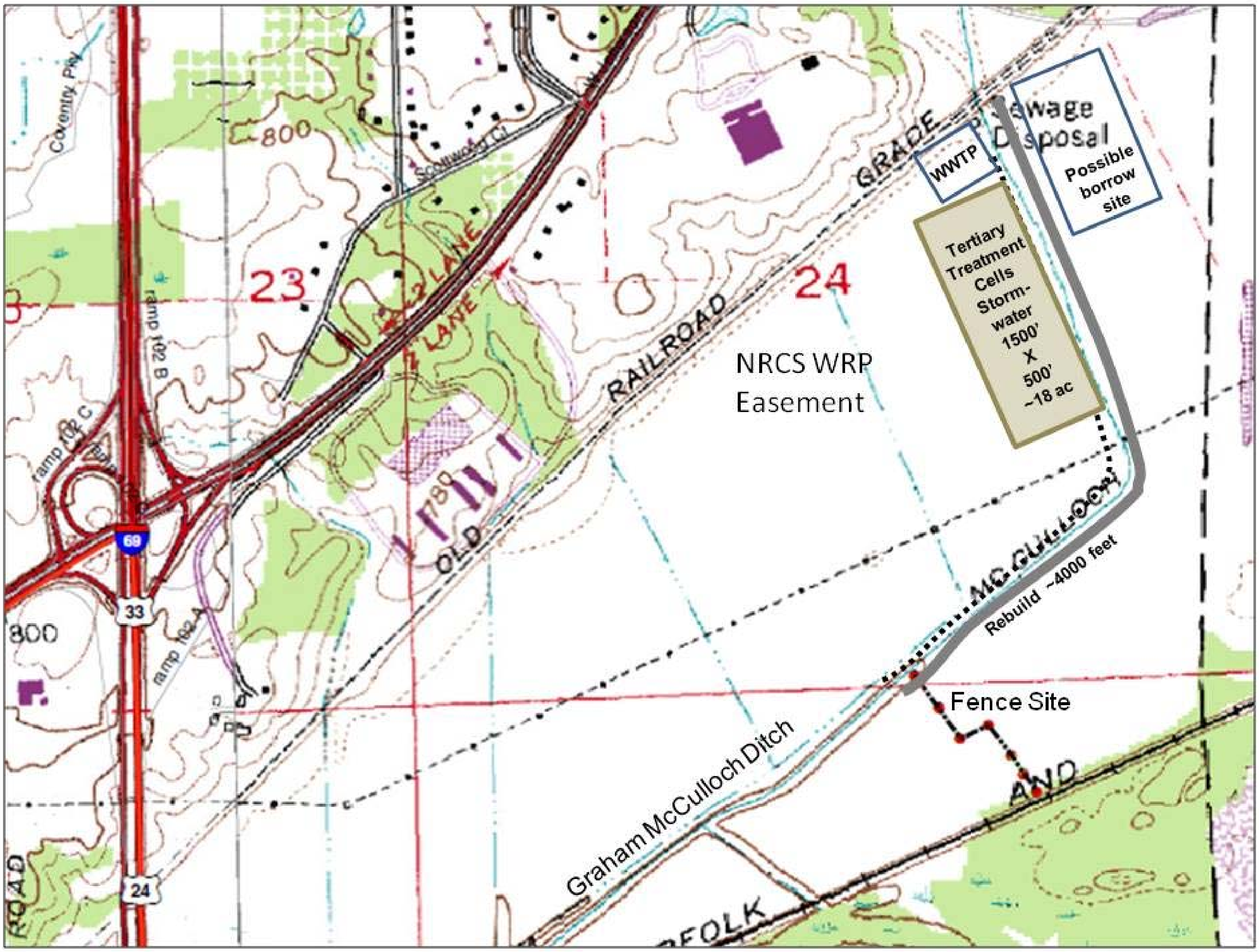
The soil in this general area should be silt and clay based with lower organics than other areas on the site. This is due to the alluvial fan that developed at the discharge of the historic natural drainage into the glacial drainage system. Modification, through ditching, of this alluvial fan resulted in this segment of the Graham McCulloch Ditch.

In design, care should be taken to address the access needs of the utility company for the high-tension electric power lines. In addition, the Norfolk-Southern Railroad will need to provide for some type of easement allowance for the rockfill on the south limit of the fence.

Sketch

Alternative No.: CB-3

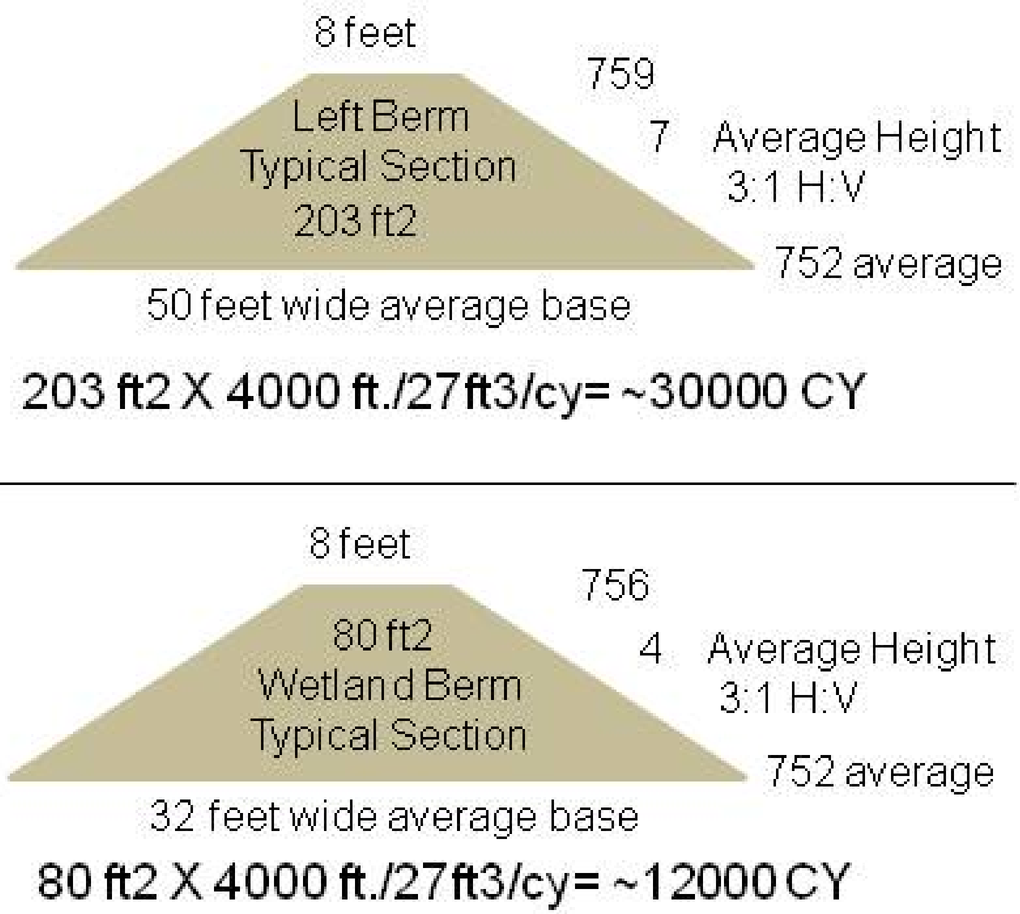
☐ Original ☑ Alternative



Sketch

Alternative No.: CB-3

☐ Original ☑ Alternative



Calculations

Alternative No.: CB-3

☐ Original ☑ Alternative

Wetland Cells construction ~18 acres

Construction Cost Estimate

Alternative No.: CB-3

			Original Concept (Deletions)		Alternative Concept (Additions)	
Item	**Unit of Meas.**	**Unit Cost**	**Qty**	**Total**	**Qty**	**Total**
Embankment – barrier berm	Cy	$12.45			30,000	$373,500
Embankment – wetland berm	Cy	$12.45			12,000	$149,500
Excavation – barrier berm	Cy	$17.85			30,000	$535,500
Borrow – wetland berm	Cy	$17.85			12,000	$214,200
Remove and replace topsoil	Cy	$5.00			15,000	$75,000
Straw and seed	Sf	$0.10			800,000	$80,000
Treatment wetland construction/ planting	ac	$10,000			18	$180,000
Land acquisition, barrier berm	ac	$5,000			5	$23,000
Land acquisition, wetland berm	ac	$5,000			18	$90,000
Land acquisition, borrow	ac	$5,000			5	$23,000
Regulatory	Hr	$100			40	$4,000
Rule 5, ESC	hr	$100			80	$8,000
EAP Development	hr	$100			80	$8,000
TOTALS						$1,763,700

SCENARIO 3

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No:
CB-4

Title:
Construct berm fence combination

Description of Original Concept:

The original concept is to construct an earthen berm and chain link fence structure to block the movement of Asian carp into the Great Lakes via Eagle Marsh. The structure would replace the existing temporary fence and be constructed in its footprint

Description of Alternative Concept:

The alternative concept is to construct a 4 foot tall berm around the base of the existing chain link fence to block the movement of Asian carp into the Great Lakes via Eagle Marsh. This permanent alternative would be constructed around of the existing fence. The existing Jersey Barriers would be removed and reinstalled on top of the berm. Repairs would need to be conducted on the existing berms that the existing chain link fence ties into. The berm would be on a 3H to 1V slope with a 12 foot wide flat top to allow for attachment of the fence.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☐ Increased	☐ Increased
☑ Maintained	☐ Maintained
☐ Decreased	☑ Decreased

Cost Savings Summary

Prev B-4 First Cost:	$ 4.273,000
CB-4 First Cost:	$ 332,000
Cost Savings:	$ 3,941,000

Advantages/Disadvantages

Alternative No.: CB-4

Advantages of Alternative Concept

- Provides for reuse of existing, temporary barrier
- Simplifies real estate issues

Disadvantages of Alternative Concept

- Will require extensive interagency coordination and regulatory processes.
- May be difficult to construct the berm around the existing fence
- May be damaged by ice
- Remediation to the existing berms along the Graham McColloch required
- Does not prevent small fish from passing through the fence

Discussion

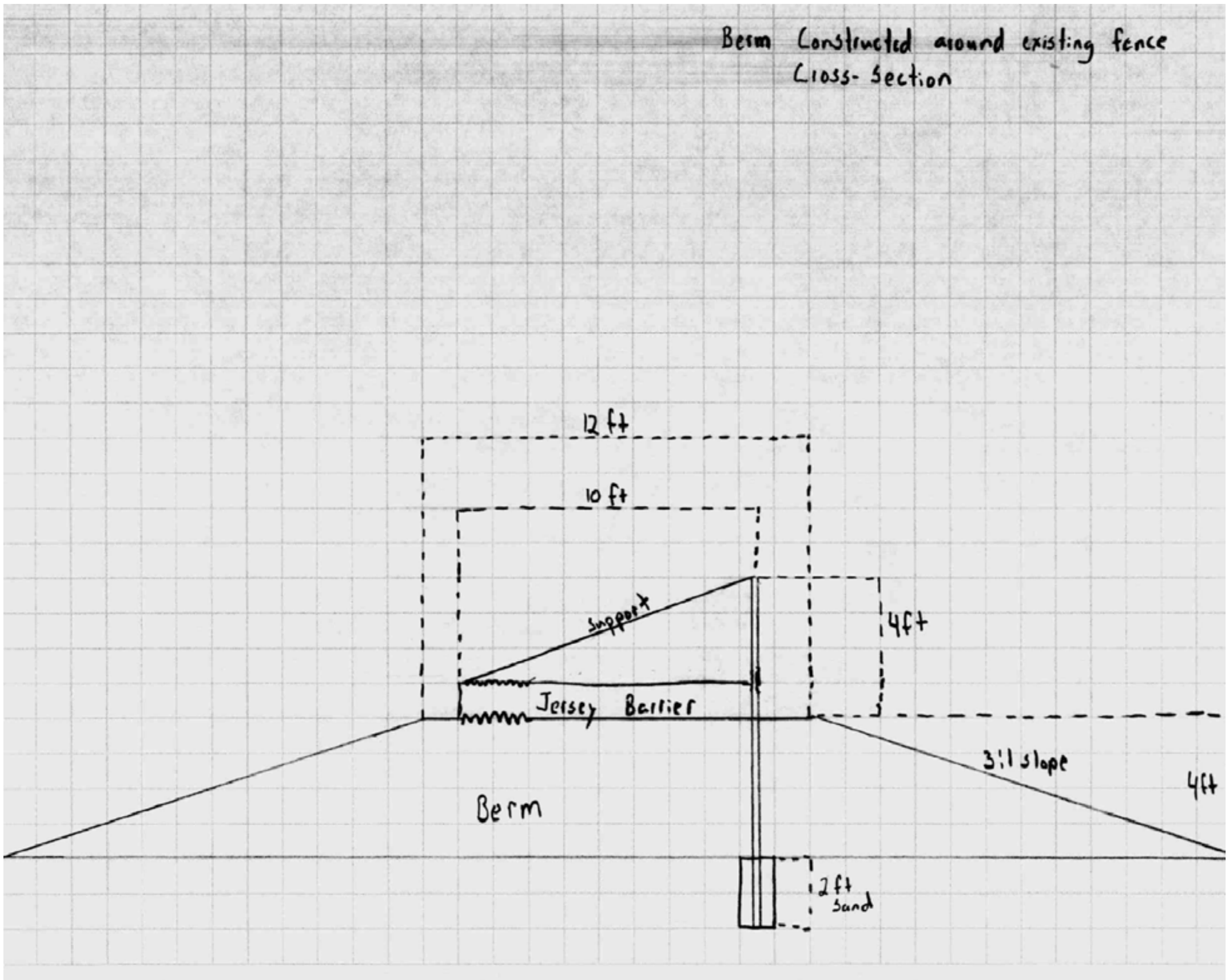
Alternative No.: CB-4

In this concept, the reduced risk of Asian carp migration is achieved by blocking high-frequency flood flows with a berm while allowing low-frequency flows to pass through the fence. It entails constructing an earthen berm and chain link fence structure to block the movement of Asian carp into the Great Lakes via Eagle Marsh. This structure would serve as a permanent alternative to the temporary chain link fence that is currently in place (Figure 1) and would be constructed in the footprint of the existing fence. The berm would be on a 3H to 1V slope with a 12 foot wide flat top to allow for attachment of the fence. The berm would require 4,185 cubic yards of soil. The lowest elevation of the fence crossing area is 749.5 feet with maximum elevation of 753.16 feet. The berm would need to be 4 feet tall to prevent overtopping from the 10 year flood event (elevation 753.3). The fence would serve as additional protection for 100 year flood events (elevation 755.3) and need to be 4 feet tall. The fence would be constructed of chain link, buried 2 feet into the top of the berm and attached to 10 feet long Jersey barriers. The fence would allow water to pass through, cause no increase in flood damage to the surrounding areas, and prevent the passage of migrating adult Asian carp. Tree planting in front of the structure would reduce the impacts of ice on the fence. The total length of the structure would be 1,200 linear feet. The earthen berm would replace and expand existing berms in the area that the existing fence ties into. The existing berms are currently in a state of disrepair.

Sketch

Alternative No.: CB-4

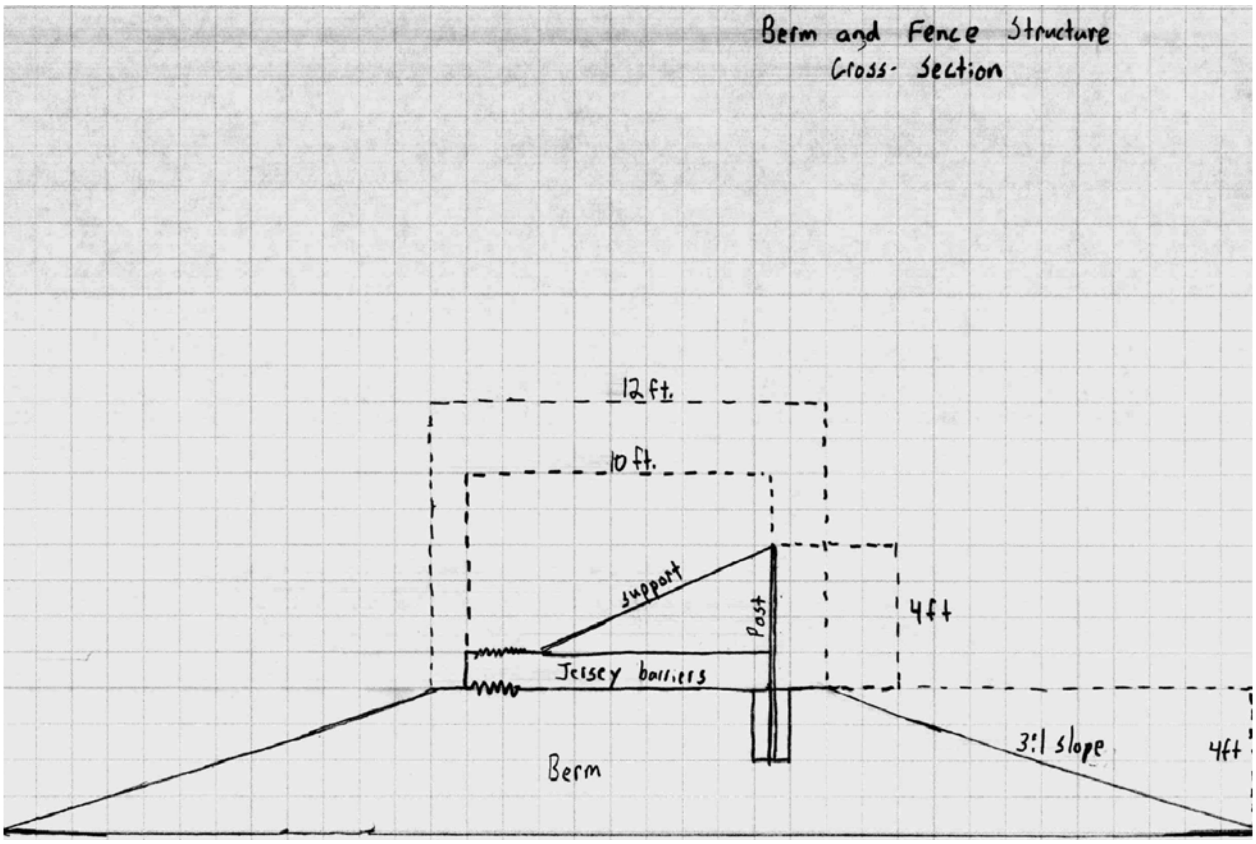
☐ Original ☑ Alternative



Sketch

Alternative No.: CB-4

☐ Original ☑ Alternative



Sketch

Alternative No.: CB-4

☐ Original ☑ Alternative

Calculations

Alternative No.: CB-4

☐ Original ☑ Alternative

4185 cubic yards of soil for berm construction

1177 linear feet of chain link fence

120 10-foot long 32-inch tall Jersey barriers

120 6 foot steel pipe for fence braces

Construction Cost Estimate

Alternative No.: CB-4

			Original Concept (Deletions)		Alternative Concept (Additions)	
Item	**Unit of Meas.**	**Unit Cost**	**Qty**	**Total**	**Qty**	**Total**
Borrow material – clay	BCY	$17.85			4,185	$74,702
Strip store and place topsoil back	BCY	$5			2,300	$11,500
Place and compact clay material	LCY	$12.45			5020	$62,499
Seed and straw	SF	$0.10			90,000	$9,000
6' high chain link fence	LF	$95.71			1,200	$114,852
6' long support posts	EA	$56			120	$6720
10' long – 32" Jersey barriers	EA	$440			120	$52,800
TOTALS						$332,000

SCENARIO 4

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No: CB-2

Title:
Create a vertical drop structure

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

The alternative concept is to utilize the Homestead Road embankment as an impermeable earthen levee that would block all low flow in the Graham-McCulloch Ditch except through a vertical drop structure similar to drop inlet structures on lakes to control water levels. Flows would be controlled by multiple vertical risers. Low flow would be maintained by small diameter openings at low levels of the drop inlet with the inlet ends buried in open graded gravel. Storm water from the Maumee Basin discharging through Eagle Marsh would be temporarily stored in the areas upstream of Homestead Road and discharge through the drop inlet structures. A short section of levee would need to be constructed between the railroad and the Homestead Road embankment. Assume the levee height would be 10 feet above existing ground with 3/1 side slopes and 75 feet in length. Drop inlets would be constructed along the length of Homestead Road with pipe jacked under Homestead Road. The drop structures would be designed to pass 500 cfs for up to 5 days.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☑ Increased	☐ Increased
☐ Maintained	☐ Maintained
☐ Decreased	☑ Decreased

Cost Savings Summary

Prev B-4 First Cost:	$ 4.273,000
CB-2 First Cost:	$ 493,000
CB-9 First Cost	$ 531,000
Cost Savings:	$ 3,249,000

Advantages/Disadvantages

Alternative No.: CB-2

Advantages of Alternative Concept

- Significantly reduces risk of ANS moving upstream. With intake screens would reduce risk of gobi and other species downstream depending on screen size. Vertical drop would be sufficient to stop Asian Carp from migrating upstream.
- Maintains hydraulic characteristics of area. No increase in flooding. May reduce peak flooding downstream slightly.
- Can utilize existing Homestead Road embankment with some modifications reducing construction work and schedule.
- Would allow removal of the fence barrier in Eagle Marsh and eliminate any long term impacts to the Marsh. Would cause longer periods of inundation of Eagle Marsh which would be a positive.
- Would increase upper drainage area wetlands by about 400 acres with land between Homestead and I-69.

Disadvantages of Alternative Concept

- Maintenance cost after each significant rainfall event
- Risk of debris, sedimentation and ice blocking the inlet structures
- Increased risk of inducing flooding in Ft Wayne if outlet structure is partially or fully blocked. Could cause inundation of Homestead and Ellison Road.   Overtopping of Homestead Road would increase risk of ANS from the Maumee Basin to migrate into the Wabash Basin.
- Requires a long term sponsor which has not been identified.
- Would require periodic inspections and removal of debris from inlet structures
- Some Maumee Basin species would be able to pass through drop structure into the Little River
- Requires easement or purchase of land between I-69 and Homestead Road. Land is farm land that is frequently flooded.
- Would retain some floodwater longer than current condition which may be perceived negatively by the public.

Discussion

Alternative No.: CB-2

The alternative concept is to utilize the Homestead Road embankment as an impermeable earthen levee and install drop inlet structures. Low flow would be maintained by several small diameter inlets into the drop structure buried in open graded gravel. A short section of levee would need to be constructed between the railroad and the Homestead Road embankment. Assume the levee height would be 10 feet above existing ground with 3 on 1 side slopes and 75 feet in length. Flow rates are estimated at 500 cfs for up to 5 days. Outlet headwalls and channels back to the Graham-McCulloch Ditch would need to be constructed.

Both faces of the Homestead Road embankment may need wave action erosion protection. The west face would also serve as a physical deterrent for snakehead.

Maintenance and inspection would likely be required after each flood event. Debris would need to be removed periodically from the inlet structure area.

Advantages of this alternative are operational costs are less than pumping water, creation of additional wetlands, funding can be leveraged with NRCS wetland funds, Little River Wetlands is a potential administrator of the additional wetlands, construction would be confined within a small area outside of the sensitive Eagle Marsh area, temporary fence barrier at Eagle Marsh can be removed, risk of Asian Carp and snakehead migrating from the Wabash to the Maumee Basin through this pathway is greatly reduced, migration of goby and species in the Great Lakes/Maumee Basin to the Wabash is somewhat to greatly reduced.

This alternative would require the owner to inspect, monitor, maintain, operate and repair the facilities. Operation cost will be incurred for inspection and periodic debris removal.

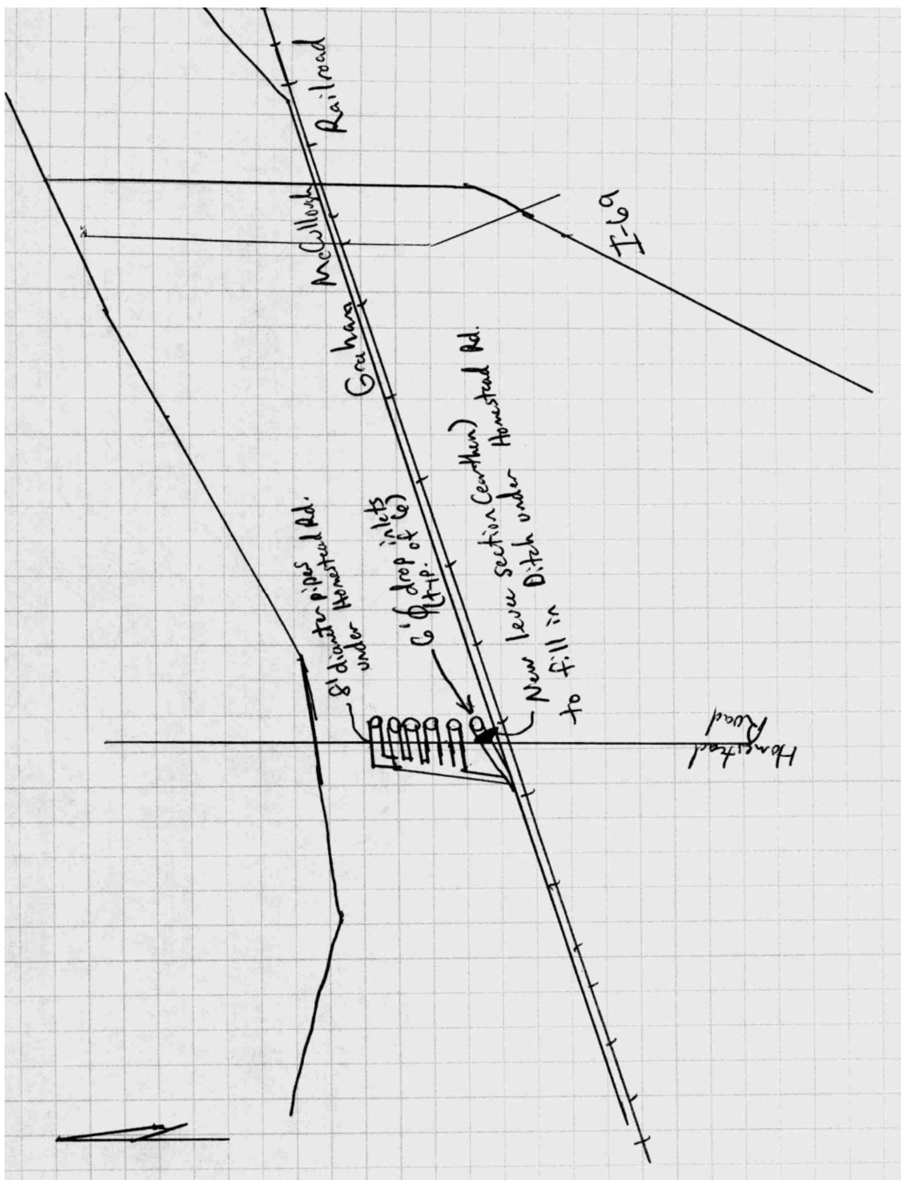
The levee would be approximately 75' in length beginning at the railroad embankment and tie into the highway embankment. Six new 6 foot diameter PVC or concrete riser pipe or box inlets would be constructed on the east side of Homestead Road at locations across the length of Homestead Road. Each structure would carry approximately 92 cfs at 1.3 ft of head on the inlet structure. Total maximum design flow of 500 cfs would be met. An eight foot diameter horizontal pipe, each 100 feet in length will carry storm water from the drop inlets from the east side of Homestead Road under the road to discharge on the west side of the road. Excavation depth would be approximately 10 feet. Some earthwork would be needed to construct ditches from the end of each outlet pipe back to the Graham-McCulloch Ditch.

Redundant water level sensors located on the east and west side of Homestead Road would send information to the project owner. The inlet structures would be designed to minimize collection of debris, handle ice and potential to block flow with the use of grating.

Sketch

Alternative No.: CB-2

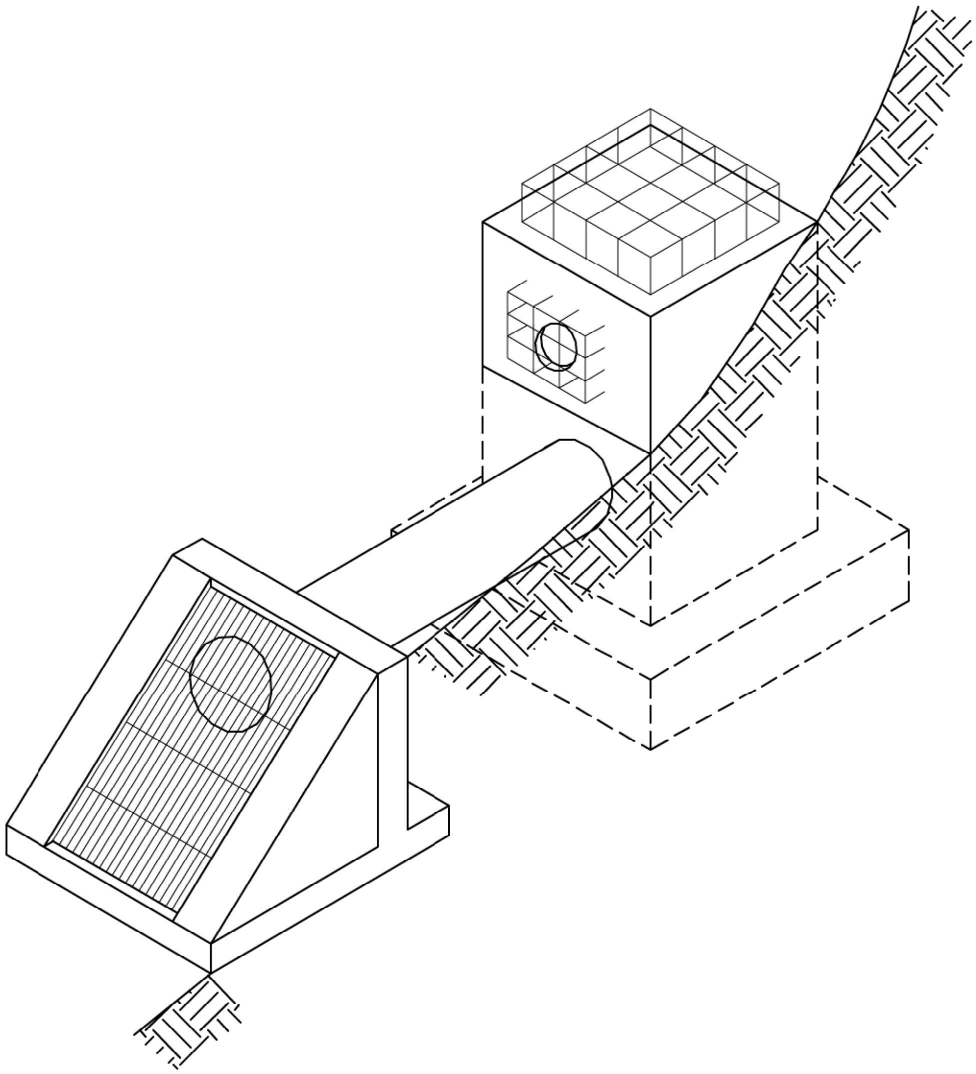
☐ Original ☑ Alternative



Sketch

Alternative No.: CB-2

☐ Original ☑ Alternative



Calculations

Alternative No.: CB-2

☐ Original ☑ Alternative

H=(.3225xQ/L)^2/3 for a broadcrested weir

H=Head on weir (FT), Q=Weir flow (CFS), L=Weir Length (FT)

Assumed 6'diameter inlet, 92 cfs results in 1.3 feet of head.

500 cfs flow rate

(Flow rate provide by project Hydraulic Engineer.)

Calculations

Alternative No.: CB-2

☐ Original ☑ Alternative

Levee earthwork

Assume levee is 10 feet tall, 5 feet wide at top and 3/1 slopes, 75 feet long

2x1/2x30x10=300 10x5=50 Total cross-sectional volume is 350 sq ft.

350x 75= 26250 cu ft =973 cu yds

Outlet channel excavation

Assume outlet pipes are 50 feet apart. Total length of outlet channel would be

50+100+150+200+250= 750 LF

Assume cross-section is 10 ft bottom with 3/1 slopes, 6 ft deep

Cross-section is 10x6+3x6x6=168 sq ft

Volume 168x750/27=4667 cu yds

Aggregate on Homestead Road slopes, assume 1 ft deep

2x1600x10=32,000 sq ft x 1 ft = 1185 cy

1185 cy x 1.35 T/cy = 1600 T

Construction Cost Estimate

Alternative No.: CB-2

			Original Concept (Deletions)		Alternative Concept (Additions)	
Item	**Unit of Meas.**	**Unit Cost**	**Qty**	**Total**	**Qty**	**Total**
75' earthen berm 10' high, 3/1 slopes.	CY	$30.30			973	$29,500
8' diameter PVC pipe	LF	$375			600	$225,000
6' diameter Concrete pipe	LF	$250			60	$15,000
Concrete inlet with grated structure	EA	$2,500			6	$15,000
Outlet earthwork	CY	$30.30			4,667	$141,410
Road cuts (5 cuts @ 10 ft deep)	Ea	$1,500			5	$7,500
Aggregate on embankment slope 1 ft deep	T	$37			1,600	$59,200
TOTALS						$492,610

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No:
CB-9

Title:
Build permeable barrier (riprap)

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

Construct barrier with rip-rap. The barrier will be approximately 5 feet high with 3H:1V slope and will vary in length depending on the location. Assume a length of 1,200 linear feet for this alternative and comparison. One approach to managing the Graham-McCulloch flows is to add a grated culvert.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☑ Increased	☐ Increased
☐ Maintained	☐ Maintained
☐ Decreased	☑ Decreased

Advantages/Disadvantages

Alternative No.: CB-9

Advantages of Alternative Concept

- Construction duration would be short
- Would not retain water
- Construction materials are readily available
- Construction is simple
- Easy to maintain

Disadvantages of Alternative Concept

- Does not retain water
- Not aesthetically pleasing
- Cause debris to collect
- Will need to be maintained (replace riprap as needed)
- Could become impermeable due to debris filling voids and cause damming of water.
- Existing berm is not an engineered structure

Discussion

Alternative No.: CB-9

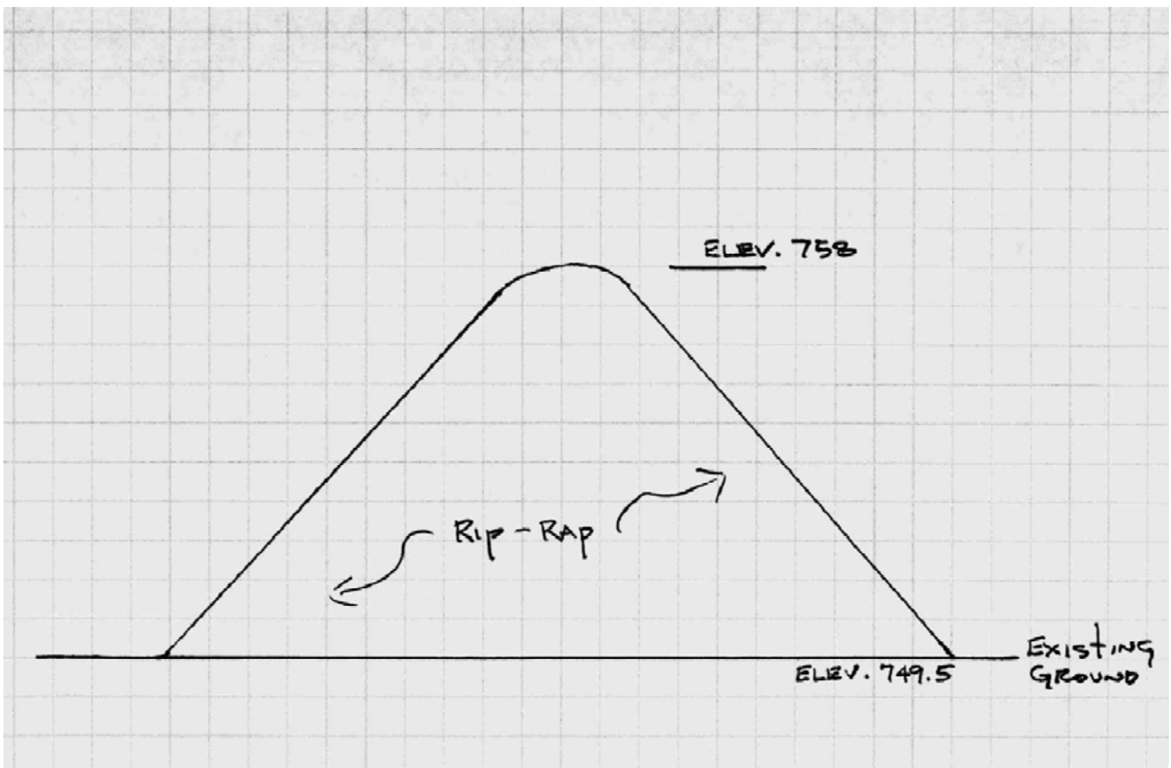
The idea of this alternative is to create a permeable berm from rip-rap. The ground elevation of 749.5' and the flood elevation of 755.6 plus 2' and rounded is 758. This was used to determine the height of the rip-rap barrier. This is what was used with the existing fence and rip-rap that is at the site currently. The barrier will be constructed on a 2H to 1V slope. The barrier will be tied into an existing berm. The existing berm will not be reconstructed. Eight inches of topsoil will be removed then a geotextile fabric will be placed prior to the rip-rap being installed.

The design must include measures to accommodate flows so that no additional flooding to upstream areas occurs.

Sketch

Alternative No.: CB-9

☐ Original ☑ Alternative



Calculations

Alternative No.: CB-9

☐ Original ☑ Alternative

A. REMOVE top SOIL

55' x 8"/12 x 1,200 = 44,000 CF / 1,630 BCYDS

B. HOUL top SOIL OFF

1,630 BCYDS x 1.20 = 1,960 LCYDS

C. GEOTEXTILE FABRIC

55' x 1,200' = 66,000 SF / 7,335 SYDS.

D. Rip-Rap

[1/2 (8.5' x 25.5') x 2] x 1,200' = 260,100 CF

9,635 CYDS

13,500 TONS

Construction Cost Estimate

Alternative No.: CB-9

Item	Unit of Meas.	Unit Cost	Original Concept (Deletions) Qty	Original Concept (Deletions) Total	Alternative Concept (Additions) Qty	Alternative Concept (Additions) Total
Remove topsoil	BCY.	$1.41			1630	$2,300
Geotextile fabric	SY.	$2.45			7335	$17,970
Rip-rap	T	$36.50			13500	$492,750
Haul off topsoil	LCY	$9.12			1960	$17,875
TOTALS						$530,895

SCENARIO 5

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No:
CB-25

Title:
Build structure and pump around

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

The alternative concept is to utilize the Homestead Road embankment as an impermeable earthen levee that would block all low flow in the Graham McCulloch Ditch and provide a pump station that would pump water over the levee back into the Graham McCulloch Ditch. Low flow would be maintained by small diameter PVC pipe with the inlet ends buried in open graded gravel. Stormwater from the Maumee Basin discharging through Eagle Marsh would be pumped from the created storage area into the Wabash Basin. A short section of levee would need to be constructed between the railroad and the pump station. Assume the levee height would be 10 feet above existing ground with 3H:1V side slopes and 75 feet in length. The pump station would consist of three pumps sized at 60% of the peak flow each constructed immediately adjacent to the existing Graham McCulloch Ditch. Estimate is 500 cfs for up to 5 days.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☑ Increased	☐ Increased
☐ Maintained	☐ Maintained
☐ Decreased	☑ Decreased

Cost Savings Summary

Prev B-4 First Cost	$ 4,273,000
CB-25 First Cost:	$ 863,500
Cost Savings:	$ 3,409,500

Advantages/Disadvantages

Alternative No.: CB-25

Advantages of Alternative Concept

- Significantly reduces risk of ANS moving upstream. With intake screens would reduce risk of gobi and other species downstream. Pumping would also kill some species. Head differential would stop Asian Carp.
- Maintains hydraulic characteristics of area. No increase in flooding east of I-69. May reduce peak flooding downstream slightly.
- Can utilize existing Homestead Road embankment with some modifications reducing construction work and schedule.
- Would allow removal of the fence barrier in Eagle Marsh and eliminate any long term impacts to the Marsh. Would cause longer periods of inundation of Eagle Marsh which would be a positive.
- Would increase upper drainage area wetlands by about 400 acres with land between Homestead and I-69.

Disadvantages of Alternative Concept

- Cost of pumps, both initial and operational. Would require monitoring, testing, inspection after event, utility costs and future replacements.
- Requires a long term sponsor which has not been identified.
- Some species would be able to pass through low flow drainage or survive pumping from the Maumee Basin into the Little River.
- Requires easement or purchase of land between I-69 and Homestead Road. Land is farm land that is frequently flooded.
- Would retain some floodwater longer than current condition which may be perceived negatively by the public.

Discussion

Alternative No.: CB-25

The alternative concept is to utilize the Homestead Road embankment as an impermeable earthen levee that would block all low flow in the Graham McCulloch Ditch and provide a pump station that would pump water over the levee back into the Graham McCulloch Ditch. Low flow would be maintained by several small diameter PVC pipe with the inlet ends buried in open graded gravel. Storm water from the Maumee Basin discharging through Eagle Marsh would be pumped from the created storage area into the Wabash Basin. A short section of levee would need to be constructed between the railroad and the pump station. Assume the levee height would be 10 feet above existing ground with 3:1 side slopes and 75 feet in length. The pump station would consist of three pumps sized at 60% of the peak flow each constructed immediately adjacent to the existing Graham McCulloch Ditch. Estimate is 500 cfs for up to 5 days. Controls would be automatic with redundant water level sensors located on the east side of Homestead Road. Total maximum flow for the pump station is 500 cfs with an assumed head of 10’ including system losses requires each pump to be 600 hp (very large pumps). The pump station will be 100 feet wide by 50 feet deep with the pumps enclosed in the pump house and protected from freezing. Controls would allow remote monitoring of the system including upstream and downstream water levels. A stilling basin would need to be constructed at the outlet end of the discharge piping directing flow back into the Graham McCulloch Ditch.

Operation of the flood station would be automatic with 2 pumps starting in sequence once the available storage reaches about 50%. All pumps would cycle automatically. Notification would be sent to the project owner of pump operations. A pump operator should be dispatched to ensure proper operation of equipment. Remote monitoring could be use to identify problems and dispatch repairman.

Both faces of the Homestead Road embankment may need wave action erosion protection. The west face would also serve as a physical deterrent for snakehead.

Maintenance and inspection would likely be needed after each pumping event. Debris would need to be removed periodically from the pump station area.

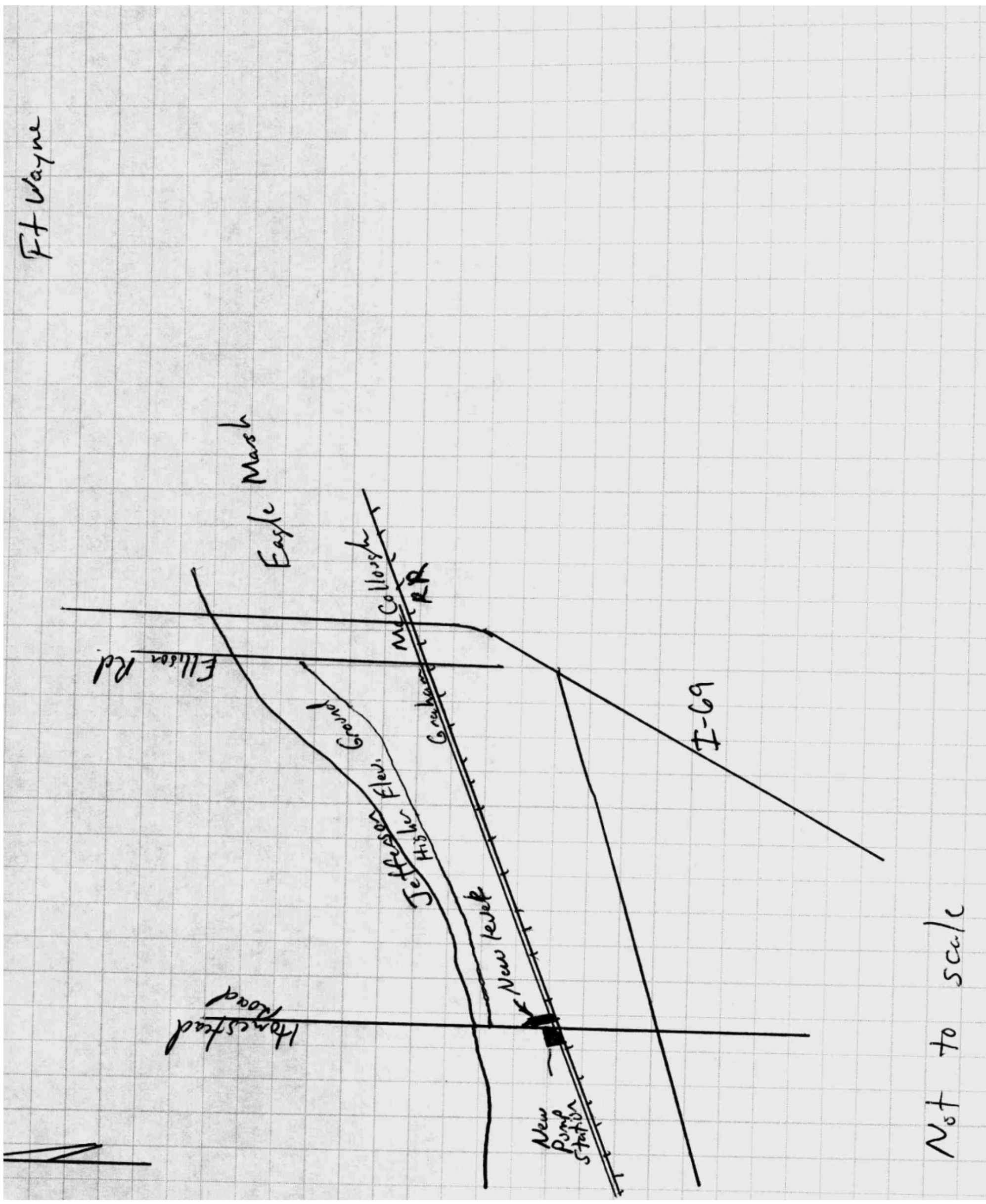
Advantages of this alternative are creation of additional wetlands, funding can be leveraged with NRCS wetland funds, Little River Wetlands is a potential administrator of the additional wetlands, construction would be confined within a small area outside of the sensitive Eagle Marsh area, temporary fence barrier at Eagle Marsh can be removed, risk of Asian Carp and snakehead migrating from the Wabash to the Maumee Basin through this pathway is greatly reduced, migration of gobi and species in the Great Lakes/Maumee Basin to the Wabash is somewhat to greatly reduced.

This alternative would require the owner to inspect, monitor, maintain, operate and repair the facilities. Operation cost will also be incurred for utilities and periodic debris removal.

Sketch

Alternative No.: CB-25

☐ Original ☑ Alternative



Calculations

Alternative No.: CB-25

☐ Original ☑ Alternative

Flow rate provide by project Hydraulic Engineer. Pump information was provided by LRL Mechanical Engineer given the following criteria:

10 feet of head max, 500 cfs flow rate by two pumps for 4-5 days.

Construction Cost Estimate

Alternative No.: CB-25

			Original Concept (Deletions)		Alternative Concept (Additions)	
Item	**Unit of Meas.**	**Unit Cost**	**Qty**	**Total**	**Qty**	**Total**
Pump Station Building – masonry	SF	$64			5,000	$320,000
Pumps – 600 hp	EA	$170,000			3	$510,000
Clay levee 3:1 slope, 10' high, 16' wide						
Borrow material – clay	BCY	$17.85			1,000	$17,850
Strip store and place topsoil back	BCY	$5			70	$350
Place and compact clay material	LCY	$12.45			1,200	$14,940
Seed and straw	SF	$0.10			3,750	$375
TOTALS						$863,515

SCENARIO 6

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No: CB-31

Title:
Reroute Graham McCulloch Ditch into Junk Ditch and create barrier downstream

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

The alternative concept is two parts; Rerouting of Graham McCulloch Ditch into Junk Ditch which drains to the Maumee watershed, and then building a berm west of I-69 to serve as the cutoff to aquatic nuisance fish. The rerouting of Graham McCulloch into Junk Ditch eliminates having the berm to deal with normal flows from Graham McCulloch. The berm would create a detention basin and would likely require a release structure(s). The berm could be constructed of a variety of materials or methods, the most economical likely being available onsite soils. However, a concrete wall or sheet piling wall could serve the same purpose.

Locations:

Rerouting of Graham McCulloch would likely have to occur starting near it's crossing of Engle Rd, and then along Engle Rd to the Junk Ditch drainage channel located near the intersection of Smith Rd and Engle Rd. Two options are available; piping or an open channel cut.

The berm could be installed anywhere across the valley within the Wabash basin. However, to eliminate higher water levels, areas beyond I-69 are more feasible. The berm would need to provide positive cutoff yet allow for release of collected floodwaters. The berm could be in combination with one of the roadways downstream including Ellison, Homestead, and Aboite. The drainage structure of the berm could be multiple different options, including a vertical drop structure(s), pervious aggregate berm, section of fish screen fence, etc. which would pass the water accumulated upstream of the berm.

Value Improvement

Value ≈ Function / Resources

Function	Resources
☑ Increased	☑ Increased
☐ Maintained	☐ Maintained
☐ Decreased	☐ Decreased

Cost Savings Summary

Prev B-4 First Cost:	$ 4,273,000
CB-31 First Cost:	$ 5,027,000
Cost Savings:	($ 754,000)

Advantages/Disadvantages

Alternative No.: CB-31

Advantages of Alternative Concept

- Provides appropriate cutoff to all fish species
- Eliminates debris concerns from Graham McCulloch flows
- Simplifies other berm issues by eliminating constant flows from Graham McCulloch
- no utility costs, low maintenance
- no human error – structure functions as constructed
- If berm placed downstream of I-69, small effect on frequency of water levels of flood events in populated areas

Disadvantages of Alternative Concept

- Increased flows into Junk Ditch drainage from the Graham McCulloch will cause increased high water events and will likely increase flood elevations downstream.
- Outflow of WWTP will also need to be rerouted or addressed.
- Real estate by Engle Road is limited; modifications to Engle Road are likely.
- Would require buyout/easement for constructed area, potentially for affected inundation areas.

Discussion

Alternative No.: CB-31

If we can eliminate Graham McCulloch flows under the I-69 corridor and beyond, designing and constructing a berm becomes much easier. This eliminates concerns with passing flows from the Graham McCulloch, debris associated with this flow, and additional water that would have to be stored. The berm could store water that occurs from Junk Ditch backwater events, and could release in a controlled manner. There would be no worry of a large influx from a rain event on the Graham McCulloch watershed during this storage period. The berm could be designed or incorporated into existing road crossings north of the railroad

Sketch

Alternative No.: CB-31

☐ Original ☐ Alternative

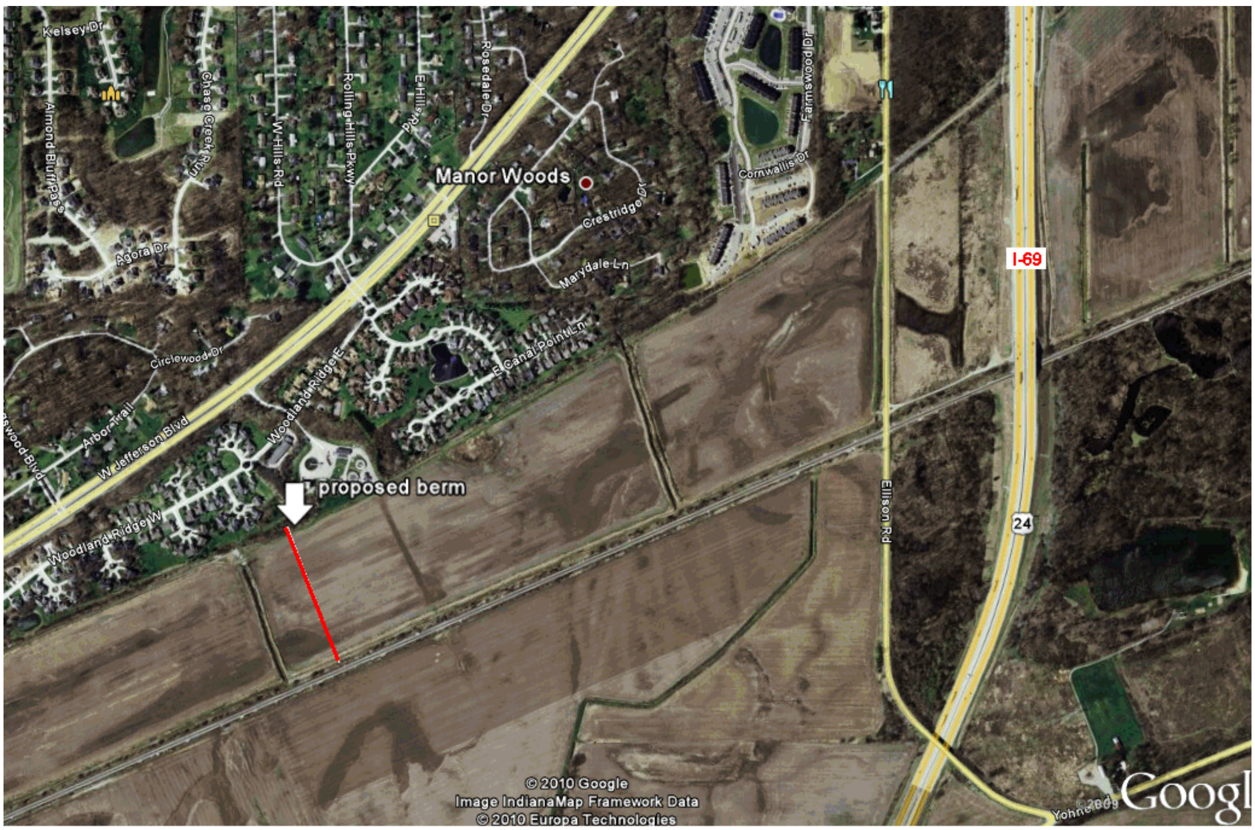
Figure 1. Rerouting of Graham McCulloch along Engle Road

Sketch

Alternative No.: CB-31

☐ Original ☐ Alternative

Figure 2. Proposed Berm location west of I-69



Calculations

Alternative No.: CB-31

☐ Original ☑ Alternative

Reroute Graham McCulloch into Junk Ditch watershed, install Berm downtream of I-69				
BERM				
berm, excavate, haul, place and place	1200	lf	8,888.89	CY
2H:1V side slopes				
10' crown				
10' height				
berm drainage structure(s)			1.00	LS
JUNK DITCH REALIGNMENT				
excavation 10'deep, 15' wide, 3H:1V side slopes by 7,500 ft long			166,666.67	CY
haul off/placement of excavation in floodplain			166,666.67	CY
stone protection			500.00	ton

Construction Cost Estimate

Alternative No.: CB-31

			Original Concept (Deletions)		Alternative Concept (Additions)	
Item	**Unit of Meas.**	**Unit Cost**	**Qty**	**Total**	**Qty**	**Total**
Berm Excavate and haul - 800 lf	cyd	30.3			8,900	$269,670
Drainage Structure	ea	15,000.00			1	$15,000
Excavate 10' deep x 15' wide, 7,500 lf - 3:1	bcyd	17.85			166,700	$2,975,595
Haul off material and spread	lcyd	9.12			191,700	$1,748,304
Stone Protection	ton	37			500	$18,500
TOTALS						$5,027,000

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SCENARIO 7

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No: CB-35

Title:
Build barrier for the longest economical crest with lowest flow depth

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

The alternative concept is to build a short barrier that will raise the drainage divide elevation to an elevation at which flow depth is minimized, but will offset the reduction in conveyance by provided additional conveyance by increasing the weir length in order to pass more extreme flood flows. The allowable depth of flow is anticipated to be on the order of 6 inches or less, such that it is inadequate or inhospitable for fish (primarily adult carp) to swim through. Concept is envisioned as a concrete control sill constructed along a saw-tooth or serpentine alignment near the existing basin divide, embedded approximately 3.5 feet into existing ground. The ground would slope from there on a long, gradual slope to maintain minimal depth for a distance of approximately 100 feet on the Graham – McCulloch side, to significantly reduce the risk of a carp or similar species from jumping the barrier or surviving attempts to push through the shallow depth.

For the purposes of costing, a 5000 ft length was assumed.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☐ Increased	☐ Increased
☑ Maintained	☑ Maintained
☐ Decreased	☐ Decreased

Cost Savings Summary

Prev B-4 First Cost:	
CB-35 First Cost:	**No Cost Developed**
First Cost Savings:	

Advantages/Disadvantages

Alternative No.: CB-35

Advantages of Alternative Concept

- Reduces frequency of hydraulic connection, thereby blocking passage of Asian Carp species and similar nuisance species from passing to the Great Lakes basin except at extreme events
- Construction should be generally simple
- Minimal real estate acquisition likely
- Minimal aesthetic impact, and could be blended into the landscapes
- Proximity to Eagle Marsh and other wetlands provides opportunities to use weir as a walkway
- Traversable by native terrestrial species
- Minimal impacts to Eagle Marsh (depending upon length required)
- Could potentially be designed to avoid involving railroad property

Disadvantages of Alternative Concept

- Does not satisfy perception of creating an absolute barrier for Asian Carp
- Does not prevent passage of all aquatic nuisance species
- Does not stop transfer of nuisance species from Great Lakes side
- Increases water surface elevations in Junk Ditch floodplain at more frequent events, requiring mitigation.
- Location would have to consider affects on wetlands to reduce impacts and required mitigation

Discussion

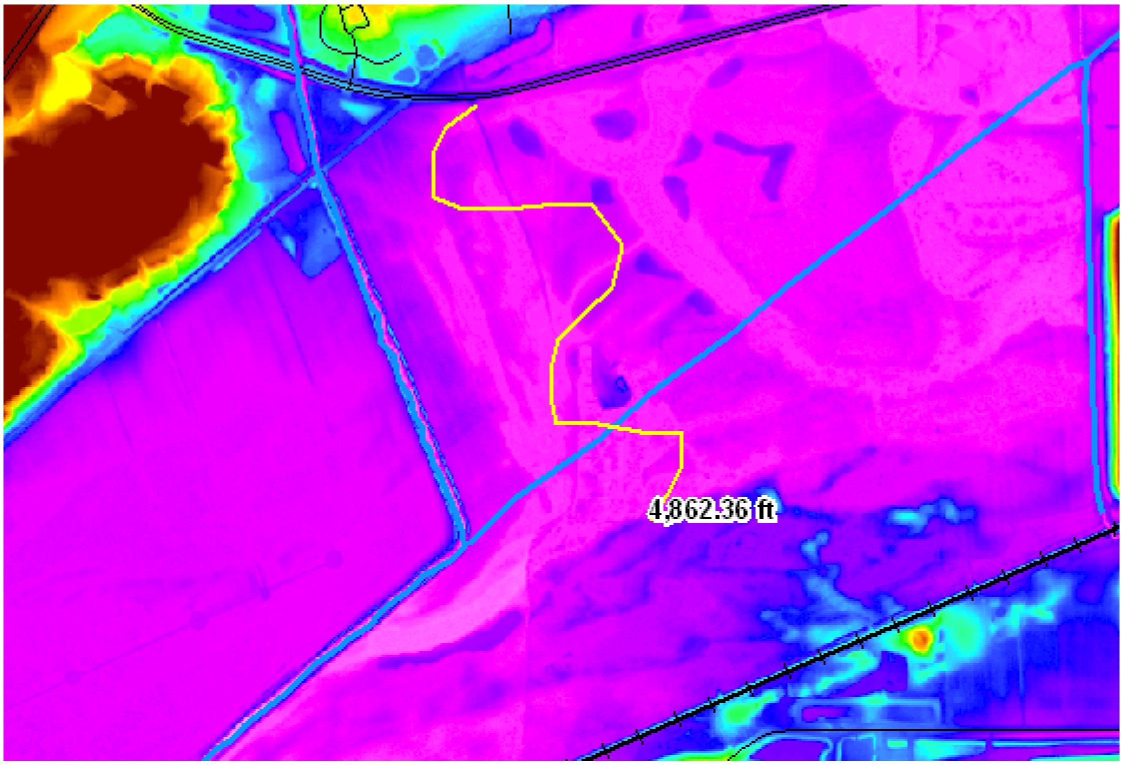
Alternative No.: CB-35

This alternative generally is easy to construct and could be designed to work into the surrounding landscapes with minimal aesthetic impacts. This concept would reduce the frequency of hydraulic connection, thus reducing the risk of species transfer to more extreme events, particularly for the Asian Carp and similar species, which would be reduced to events greater than a 1% chance exceedence event. The area would be traversable to local terrestrial species. The lower elevation would allow for tie in at a lower elevation, therefore it is likely that the weir could end on Eagle Marsh property and not require coordination with the railroad or additional significant real estate acquisition.

Sketch

Alternative No.: CB-35

☐ Original ☑ Alternative



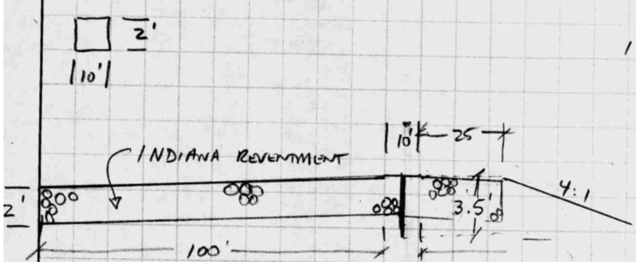
Alignment in yellow for conceptual purposes only to demonstrate approximate footprint of assumed 5000 ft length.

Calculations

Alternative No.: CB-35

☐ Original

TYPICAL SECTION



INDIANA REVETMENT = 18" STONE
$D_{50} \approx 8"$

QUANTITIES:

CONCRETE

V = 2' × 3.5' = 7 CF/LF
× 5000 LF = 35,000 CF = 1296.3 CY SAY 1300 CY

RIPRAP BLANKET

V = (2' × 104') + 2' × 29' = 208 + 58 = 266 CF/LF
× 5000 LF = 1330000 CF = 49,259 CY
SAY 49,250

MODEL STUDY TRIALS WERE INCONCLUSIVE IN DETERMINING AN APPROXIMATE WEIR LENGTH NECESSARY. FOR PURPOSES OF COST, AN ESTIMATED 5000 LF WEIR IS ASSUMED, BUT IS VERY QUESTIONABLE, SINCE WIDTH OF FLOWAGE IS APPROXIMATELY 4100 FT.

FILL QUANTITIES:

ASSUME AVERAGE FILL DEPTH OF 3', LESS ROCK FILL.

(ESTIMATED AVERAGE)

VOLUME OF FILL = ½(4 × 3.5) + (1') × 100' + (1') × 35' = 142 CF/LF
× 5000 LF = 710,000 CF
= 26,296 CY
SAY 26,300 CY

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SCENARIO 8

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No: SB-2

Title:
Create storage in both basins

Description of Original Concept:

Realign the Graham-McCulloch ditch and construct a confining berm that provides overflow in select locations and will allow seepage in others. The berm will act as a physical barrier for migration of invasive species. (See Alternative B-4 for details.)

Description of Alternative Concept:

By creating more storage in both basins, rain water will be discharged more slowly into the Little River-Graham-McCulloch Ditch and St. Mary's-St. Joseph's-Maumee Rivers. This will reduce the WSEL thus allowing flood waters to drain without backing over the divide. If water does not back over the divide, no NAS can transfer either way between basins.

Value Improvement

$$\text{Value} \approx \frac{\text{Function}}{\text{Resources}}$$

Function	Resources
☑ Increased	☐ Increased
☐ Maintained	☐ Maintained
☐ Decreased	☑ Decreased

Cost Savings Summary

Prev B-4 First Cost:	$ 4.273,000
SB-2 First Cost:	$ 2,361,500
First Cost Savings:	$ 1,911,500

Advantages/Disadvantages

Alternative No.: SB-2

Advantages of Alternative Concept

- Hydraulically separates basins
- Eliminates ANS threat to both basins
- Can be completed in phases
- Reduces flooding as storage is added

Disadvantages of Alternative Concept

- Requires substantial purchase of land affecting many property owners
- Real estate near Ft. Wayne may be difficult and costly to acquire
- May require an extended timeline to achieve meaningful protection

Discussion

Alternative No.: SB-2

By creating more storage in both basins, rain water will be discharged more slowly into the Little River-Graham-McCulloch Ditch and St. Mary's-St. Joseph's-Maumee Rivers. This will reduce the WSEL thus allowing flood waters to drain without backing over the divide. If water does not back over the divide, no NAS can transfer either way between basins.

Additional storage would take two forms: constructed detention basins and rehabilitated natural wetlands. Returning ditches to their historical meandering courses would also add storage albeit at the cost of taking crop land out of production or changing the crops grown and strategy to grow them. (What used to be large monocultural blocks of, say, corn could instead be managed for multiple crops grown in smaller plots.)

Construction of detention basins, although a rather straight forward from an engineering perspective, would require considerable effort in obtaining easements. The NRCS would be the lead agency in obtaining these easements possibly under the Wetland Reserve Program or other applicable programs. Approximately 7,700 acre-feet of storage for a 1% event will be required on the western side of the divide. Over-topping of the divide from the Wabash Basin to the Maumee Basin to a depth that will allow passage of the Asian carp is not known, but is expected to be at less than the 1% event.

On the eastern side of the divide, construction of detention basins could be difficult due the presence of residential and commercial structures. Another approach may be to rehabilitate the historic wetlands to increase their capacity and detention times. Approximately 7,700 acre-feet of storage for a 1% event will be needed on the Fort Wayne side of the divide. The function of the increased storage and detention times is to reduce the WSEL in principally the St Mary's River. This reduced WSEL will allow flood waters from Junk Ditch to drain away from the divide as opposed to crossing the divide and forming a path for NAS. Increased conveyance of Trier Ditch and discharge downstream of New Haven (SB12), and improved conveyance of the Maumee River below Fort Wayne would reduce the detention requirements on the St. Mary's.

Improved storage on the Fort Wayne side of the divide is critical to eliminating the flow into the Wabash Basin. With the flow of water eliminated, the threat of movement of Asian carp into the Maumee Basin is eliminated. Over-topping the divide to a depth that will allow passage by Asian carp will occur during a 10% event.

Given that the probability of water flowing from the Maumee Basin to the Wabash Basin is much greater than the probability of water flowing from the Wabash Basin to the Maumee basin, the priority of effort should go to improved detention in the Maumee Basin. Separation of the basins at the historic divide and rehabilitation of the St. Mary's and St. Joseph's wetlands will probably be the most acceptable alternative to the Eagle Marsh stakeholders.

Sketch

Alternative No.: SB-2

☐ Original ☐ Alternative

The identification of specific storage basins has not occurred. Generally, in the Maumee basin, the shorage basins should be between 10-20 acres and 1-2 feet deep holding from 10-40 acre-feet of water. Approximately 770 basins or rehabilitated wetlands holding 10 acre-feet each would be required.

Construction Cost Estimate

Alternative No.: SB-2

Item	Unit of Meas.	Unit Cost	Original Concept (Deletions) Qty	Original Concept (Deletions) Total	Alternative Concept (Additions) Qty	Alternative Concept (Additions) Total
Uniformly Graded Riprap (250 Lb) 18”	T	$37			3,465	$128,205
Embankment	CY	$12.45			71,230	$886,813
Excavation - Borrow	CY	17.85			71,230	$1,271,456
Seed and Straw	SF	$0.10			250,000	$25,000
Remove store and replace topsoil	CY	$5			5,400	$27,000
Land acquisition	AC	$5,000			5	$23,000
TOTALS						$2,361,474

SCENARIO 9

Value Alternative

Project: Wabash-Maumee River Basin Connection Study
Location: Fort Wayne, IN

Alternative No:
Prev B-12

Title:
Create a barrier at the Huntington Dam as shown on the map below:

Description of Original Concept:

Not applicable.

Description of Alternative Concept:

This alternative can be developed into other sub-alternatives.

1. Install permanent electric barrier at Huntington Dam.
2. Install a barricade on the Huntington Dam and install a trash and debris boom upstream

Value Improvement

Value ≈ Function / Resources

Function	Resources
☐ Increased	☐ Increased
☑ Maintained	☐ Maintained
☐ Decreased	☑ Decreased

Cost Savings Summary

Prev B-4 First Cost:	$ 4.273,000
Prev B-12 First Cost: Alternative 3	$2,982,000
First Cost Savings:	$1,291,000

Advantages/Disadvantages

Alternative No.: Prev B-12

Advantages of Alternative Concept

- This alternative moves the solution away from the Fort Wayne Area which will avoid any negative perceptions from the public.
- Alternative does not negatively impact Eagle Marsh or any other wetland areas which are environmentally sensitive.
- Alternative is constructed at an area where carp is last known to be found. This alternative appears to be more preventative than having an alternative constructed closer to the basin divide.
- Acquisition of real estate is minimal compared to most other alternatives. Huntington Dam area has already been identified constructed and access has already been established. Our project would need to upgrade and improve the access road.

Disadvantages of Alternative Concept

- Huntington Dam would need rehabilitation work completed . Also, a sponsor would need to be identified.
- Monthly electric bills may be costly unless an alternative power source can be identified and utilitized. The electric fence concept is the least intrusive and visual to the public.
- This alternative does not address the Goby migration.
- Failure of the project may imply Corps of Engineers failed to prevent migration of the carp. Public may assume Corps did not properly maintain the project.
- A build up of fish may occur downstream of the fish barrier. It may be necessary for removal of this fish at some time. Since this is a farming area, can the idea of using the fish as a product to fertilizer farms be promoted?
- Debris from the trash boom will need to be removed on a routine basis. This removal schedule will be dependent on how much builds up and flooding.
- A solution would need to be determined how to handle ice break up or melting of the ice.

Discussion

Alternative No.: Prev B-12

The Huntington Dam is an approximate 200 foot wide dam which is approximately six to eight feet high. It is located west of South Jefferson Street in Huntington, Indiana and is approximately 20 miles southwest from Eagle Marsh and is north of the J. Edward Roush Reservoir. See map below.

To the north of the dam is the railroad. Access to the site would be made by a dirt road off of South Lafoniane Street which is west of the dam. Based on aerial photography, it appears an existing dirt road already exists. This dirt road is at the base of the railroad embankment and goes to the existing Huntington Dam Site.

Currently it is believed that no one claims ownership to the Huntington Dam. It is not owned or maintained by anyone or any company/facility. And it is currently in need of repair. Acquisition of the access road and of the Huntington Dam area would be necessary for the construction, operation, and maintenance of this project.

Discussion

Alternative No.: Prev B-12

Photo 1: Huntington Dam upstream.

CONSTRUCTION: It is assumed water must continue to flow during the construction phase. There are several options for construction. For this VE Study, assume water can be diverted to one side while construction of the posts are in the dry. Then once posts construction are completed. Diversion is then re-routed to the other side. This method is currently being used for construction of a Gate Structure in the Indianapolis Water Works Canal.

Several alternatives can be considered at this site in order to keep the carp from migrating toward the Eagle Marsh area.

This alternative can be developed into other sub-alternatives.

1. Install permanent electric barrier at Huntington Dam. It is proposed that during a dry time of the year a trench be constructed across the dam for the placement of a conduit which will contain electric cabling producing an electric current which will deter the fish from migrating. Upstream. A small permanent block structure of approximately 8' x 8' would need to be constructed that would hold the electrical panel and any controls for the electric fence. From the aerial photograph, it appears electric is available.

Alternative sources of energy can also be used at this site in lieu of electric which may be costly. Other energy sources may be solar power. Also, is hydro-power a possibility. See Photo 1 above and Sketch 1 and Sketch 2.

Discussion

Alternative No.: Prev B-12

2. Install a barricade on the Huntington Dam and install a trash and debris boom upstream. From the aerial photograph, it appears debris may be a problem. It is recommended that a trash boom be installed across the upstream portion of the river to collect floating materials. The purpose of the trash boom is to catch debris before it reaches the barricade. The trash debris is to be approximately 300 feet in length. An example of the trash boom is shown on Photo 2 below.

There are several types of barricades which can be constructed on the Huntington Dam. The one which comes to my mind would be shapes similar to the anti-climb barriers seen at prisons. An example of this is shown on Photo 3 below. The height of the barrier is to be determined by hydraulic studies. However, for this VE Study, we will propose the barrier to be 3 meters in height. The material to be used shall be strong enough to withstand water and ice loads.

The width of the slats to be used shall be sufficient to keep out carp. For the sake of this study we will use 2" width since this is the approximate mesh size used on the IDNR fence located at the Eagle Marsh site.

3. Construct a Ice and Fish Barrier Weir Wall. It is proposed to demolish the existing Homestead Dam structure and to reconstruct a new weir wall that is approximately one foot below the existing dam elevation. The center of the proposed weir will be an additional two feet lower to maintain a constant flow during the extremely cold weather. The constant flow will minimize the ice barrier issues. See Photo 4 below. Also see Sketch 3.

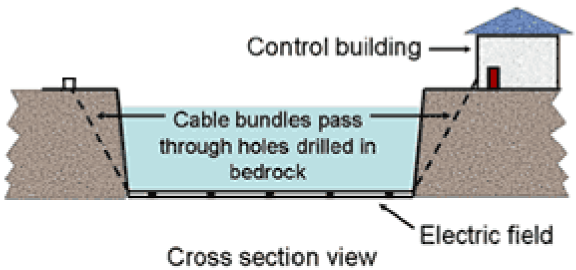
This alternative does move the solution away from the city of Fort Wayne which will avoid the negative perception of construction and blame for any future flooding issues. Also, this alternative required minimal real estate acquisition and is proposed to be constructed at a location which is already used for flood control. An access road has already been constructed by the Huntington Dam owners. While the access road will need improving, it is minimal. No change to the existing alignment for the access road will be necessary. This solution is also unobtrusive. The alternative does not bypass any existing wetland areas and will not require any large property acquisition for detention. There is little to no environmental issues with this alternative.

Sketch

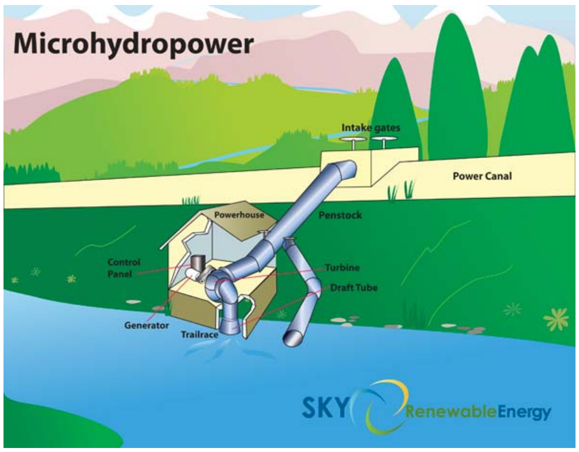
Alternative No.: Prev B-12

☐ Original ☑ Alternative

Alternative 1: Install Permanent Electric Barrier at Huntington Dam.



Sketch 1: typical section of the electric field at Huntington Dam.



Sketch 2: small hydropower plant.

Sketch

Alternative No.: Prev B-12

☐ Original ☑ Alternative

Alternative 2: Install a barricade at the downstream spillway area

Photo 2: Example of a trash boom proposed to be used upstream of Huntington Dam.

Photo 3: Example of Fish Barrier proposed at Huntington Dam.

Sketch

Alternative No.: Prev B-12

☐ Original ☑ Alternative

Alternative 3: Ice and Fish Barrier Weir Wall

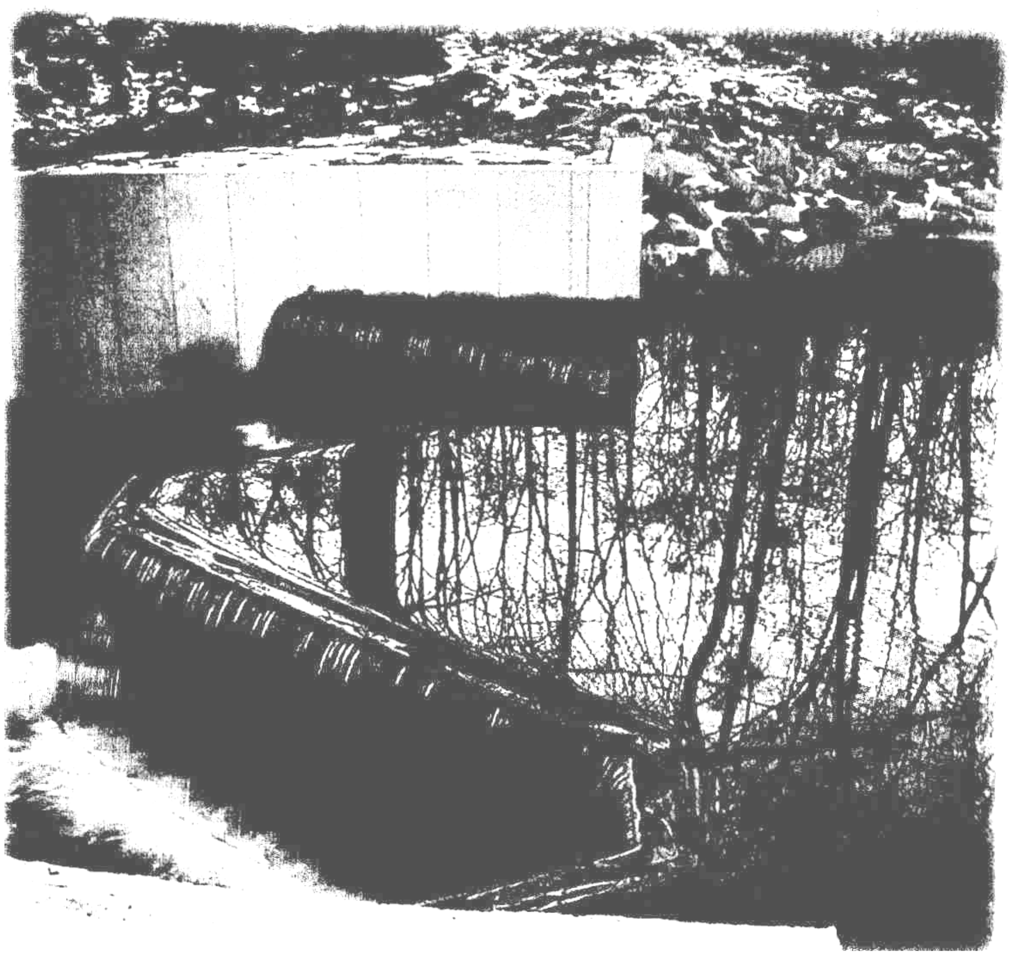


Photo 4: Example of multiple weir to be proposed.

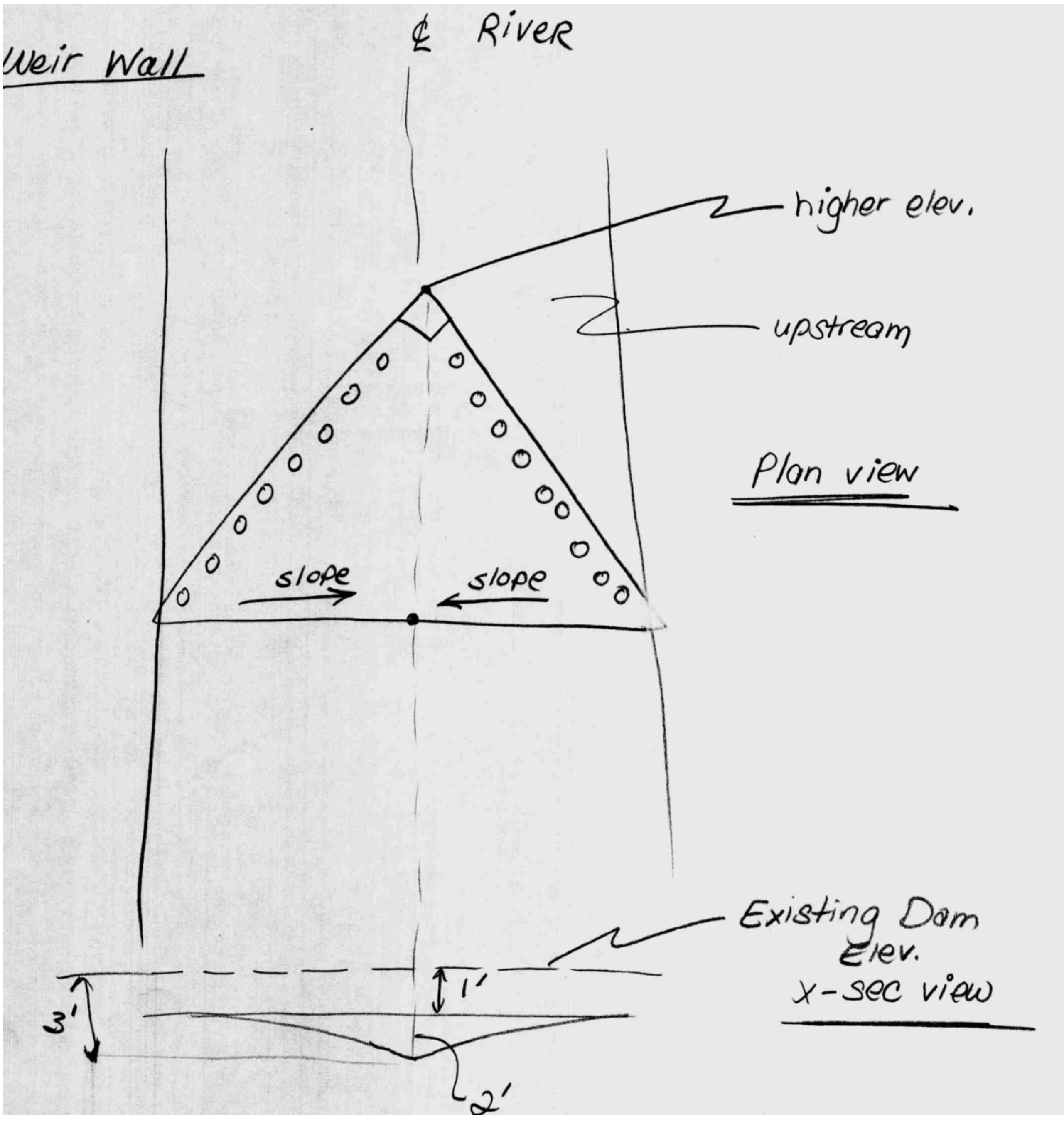
Sketch

Alternative No.: Prev B-12

☐ Original ☑ Alternative

Sketch 4: Proposed weir and slopes.

Trash boom on upstream end of Huntington Inland Dam.



Construction Cost Estimate

Alternative No.: Prev B-12

Item	Unit of Meas.	Unit Cost	Original Concept (Deletions) Qty	Original Concept (Deletions) Total	Alternative Concept (Additions) Qty	Alternative Concept (Additions) Total
Alternative 1						
Conduit and electric cabling across lake bottom	LF				200	
8'x8' block building,	EA				1	
Electric panel box	EA				1	
Conduit and cabling	LF				250	
Trenching	LF				250	
Access Road, 10' width , 200 feet length, and parking area	CY				45	
Electric Service Hook-up	EA				1	
Alternative 2						
Barrier—Railing with curved top, 3 meter pale length	LF				225	
Posts, every 8 feet, length 11 feet	EA				28	
Upstream trash boom	LF				300	
Concrete for posts, 28 holes, 3 feet concrete, 1 foot diameter posts holes,	CY				2.5	
28 posts holes to be dug 3 feet in depth, 1 foot diameter. Will be accomplished during low water.						
Divert flow operation during construction	EA				1	
Alternative 3						
Ice Barrier and Fish Weir Wall Design	EA				1	
TOTALS						

SECTION 5

DESIGN SUGGESTIONS

SECTION 5
DESIGN SUGGESTIONS

In addition to the Value Alternatives in the previous section, the team generated several other ideas that we have termed design suggestions. These are presented to bring attention to areas of the plan which, in the opinion of the team, should be changed. In general these ideas were designated as design suggestions rather than Value Alternatives for one of two reasons:

1. The value improvement opportunity is relatively small
2. The concept could not be adequately evaluated or developed within the constraints of the workshop resources

Design suggestions typically are associated with issues such as:

Improved operation

Ease of maintenance

Easier construction

Reduced risk of construction claims

Clarification of construction documents

Or safer working conditions

CB-43 Build wall, separate basins and buy-out flood-prone structures

The value engineering team identified the idea of physically separating the basins and buying out flood-prone structures. The advantage of a large physical structure is that it prevents all aquatic transfer across the divide from either basin. The structure could be constructed to blend into the surrounding landscape.

This alternative is generally believed to be the most expensive and disruptive to the community because of relocation. This would also be a time consuming inter-agency endeavor.

TF Trapping of Aquatic Nuisance Fish

The value engineering team identified the idea of creating methods of trapping, monitoring, eradicating, and deterring aquatic nuisance species as potential areas of further evaluation. These included fish attractors and traps, government incentives for commercial fisheries, eradication of fish eggs or breeding habitat, a reward/bounty system for caught fish, poisoning of the fish, introduction of pathogens or diseases harmful to the nuisance species, and traps for jumping carp near low-head structures. It is possible that by one or more of these methods, the risk of nuisance species migrating between basins can be largely reduced.

Locations or areas which these methods might take place are species dependent. For Asian carp and snakehead species, these methods would need to take place on the Little

River/Wabash system. For goby species, these methods would need to take place along the Maumee/St Mary's system. Methods used in the Pacific Northwest to keep salmon out of intakes might be considered.

G-5 Monitoring of Aquatic Nuisance Fish

The value engineering team identified the idea of extensively monitoring and studying the advancement of aquatic nuisance species within both the St Mary's and Little River basins to identify risks. This stemmed mainly from questions regarding why in particular the Asian carp have not successfully migrated upstream into the Little River system. The study would need to address many factors that could influence movement of this species. These factors would include hydraulic parameters including flow history, water temperature, sediment load, and possible chemistry variables. One USGS gage does exist in the stream section for historic flow data. Additional parameters may be added to the existing gage. Literature research should be extensively researched to aid in identifying flow, chemistry, and temperature triggers that would influence movement to aid in the focus of the data collection.

Images from Google-Earth, March 2005, at the confluence of Little River and the Wabash River in Huntington show a distinct difference in sediment load with a long mixing zone, possibly associated with temperature differences. It does provide evidence of distinct differences in the two streams. In addition, during flood flow the Little River would have a considerable urban runoff factor in the water chemistry. The possibility exist that a trace compound in the discharge acts as a deterrent to movement.

This would need to be a longer term data collecting and monitoring research effort and is therefore outside the boundaries of this study. University research resources do exist in the area, thus grant programs should target the need. Knowledge gained through an improved understanding of species specific movement at this site would be applicable to other areas on the basin boundary. Currently some Asian Carp monitoring for movement tracking is planned. Expanding this study in combination with other parameters would be prudent at this time.

G-10 Generate Separate Solutions by Species

The VE team discussed the list of invasive species that had been previously generated prior to this workshop. The species on the list (see attached) were generally grouped into the following categories: swimmers, floaters, and parasites. A lengthy discussion occurred as to what the scope was for this project and what could reasonably be stopped. Some of these species are microscopic that could be transported as easily via a fishing rod and reel as could be transported hydraulically within a stream bed, therefore this project has chosen to focus on the macro level species more associated with the swimmers. The team quickly analyzed the risk associated with the swimmers as well as the threat timeline and determined the Goby, Asian Carp, Snakehead and the Ruffe to be the most critical within the 50 year life of this project.

<u>Mississippi to the Great Lakes</u>:

The only species currently documented near the site or known to be moving to the site are the Silver and Bighead Asian Carp. Black Carp movement is expected to be similar to the Silver and Bighead with similar barrier function. Snakeheads are expected to require a dry-barrier or separate basin approach.

Great Lakes to Mississippi:

At the present time knowledge of Gobi migration is not documented that closely. Some options may exist to block Gobi at distance, even near Lake Erie. The Ruffe currently exists in the Great Lakes but the participants of this study aren't aware , at this time, of what information is available on the Ruffe migration.

This idea suggests considering a solution to address the function of STOP TRANSPORT by species rather than a one size fits all solution. Each one of these species has different characteristics which may require different solutions; a species specific solution could be installed at different locations.

The Asian Carp (Bighead & Silver Carp):

The Fish

- Once they reach sexual maturity they seek to move upstream, against flow, to spawn
- A sexual mature Asian carp is expected to be approximately 21.5" inches in size which has the capability to swim against very strong flows
- They have been known to jump 10' vertically which could translate into nearly twice that diagonally

The Eggs

- They must have water flow in order to survive: 0.6- 1.8 m/s
-
- The eggs prefer hard water because soft water is said to allow moisture to penetrate

Temperature Tolerance:

Bighead Carp

Bighead Carp can tolerate extremes in water temperature, from cold temperate to tropical. In their native range in China, Bighead Carp spawn at different temperatures: in the Yangtze River, from 26 to 30°C in 1957 to a range of 18.3 to 23.5°C in 1953 and 1954 and as low as 18°C in the Han River. Their critical thermal maximum is 38.8ºC, and a preferred temperature range of 25.0 to 26.9ºC.

Silver Carp

As with Bighead Carp, the water temperature range at which larval Silver Carp can exist is broad: 16-40°C, with optimum temperature experiments reporting ranges from 26-39°C. The upper lethal temperature of larval Silver Carp (aged 3 to 28 days) was 43.5- 46.5°C. Although no lethal minimum temperature has been documented, it is common for silver carp to survive over-winter in ice-capped water bodies that are near 0°C. Some research suggest that the silver carp may be more cold tolerant that the bighead carp.

Salinity Tolerance

The ability of bighead carp fry to osmoregulate increased with age and 6% appears to be the critical maximum salinity. Studies have indicated that silver carp can survive in water up to 12% salinity.

Sexual Maturity and Spawning Behavior

Bighead Carp

Age at maturity varies significantly with environmental and climatic conditions. The average age of bighead carp at first maturity in temperate climates is 6 to 8 years. In these dame temperate climates, bighead carp matured at an average weight of 5 to 10 kg and 70 to 80 cm.

Mating activity of bighead carp generally takes place at the surface with males actively chasing females and sometimes leaping out of the water. Usually more than two males follow one female; like other carps, the Bighead Carp is promiscuous.

Silver Carp

Like male bighead carp, male silver carp usually mature one year earlier than females, and the age at which this species reaches sexual maturity was variable across systems (2-5 kg, age 3-6). When silver carp are ready to spawn, ripples have been seen on the water surface from spawners chasing each other. About 40 to 80 minutes later, males and females ascended close to the water surface, chasing each other and shedding eggs and sperm

Feeding Habits

Bighead Carp

Most literature cites the Bighead Carp as being predominantly zooplanktivorous, particularly when zooplankton biomass is high. The youngest larvae (7-9 mm) have been found to eat primarily protozoa and zooplankton, including rotifers, the cladocerans Bosima and young Moina, and copepod nauplii and copepodites. At lengths between 18 and 23 mm, larvae began to eat phytoplankton (mainly diatoms), and at 24 to 30 mm they readily consumed zooplankton and phytoplankton.

Silver Carp

Many studies have found Silver Carp to feed primarily on phytoplankton. They consume plankton and other particles that are harvested by filtration, but can effectively filter and consume smaller particles than Bighead Carp (Table 3). They are thought to be pump filter feeders. Silver Carp have been found to be ineffective at removing nannoplankton and picoplankton from the water. Studies have consistently shown that filter feeding by Silver Carp shifts the species composition of the phytoplankton community to smaller species.

Response to Stimuli

Bighead Carp

U.S. Fish and Wildlife Service (2003) reported that Bighead Carp submerged at the sound of an outboard motor in the Missouri River below Gavins Point Dam, South Dakota and Nebraska. It has observed that bighead and silver carps are susceptible to being driven by a boat or other noise-generating methods useful in their capture. Nevertheless, Bighead Carp are more lethargic than Silver Carp and do not often jump from the water.

Silver Carp

Silver Carp is a pelagic, schooling species. Unlike bighead carp, silver carp in the Missouri River or its tributaries are rarely observed on the surface until disturbed. DCC has observed that once disturbed, Silver Carp often swim rapidly near the surface creating a characteristic large wake. Silver Carp regularly jump out of the water when disturbed, particularly in response to outboard motors. It's been stated that this response is more pronounced with higher RPMs and greater motor noise.

Tubenose Goby:

The species was introduced via ballast water into the St. Clair River, Michigan sometime before 1990.

Habitat Preferences

The usual habitat for this species is shallow bays, offshore banks, or flowing water of streams. However, it also can be found in ponds and canals overgrown with vegetation. When current is strong, it hides under boulders. It is often found under stone or among weeds, to which it retreats rapidly if disturbed. The preferred conditions probably restrict its probable range of suitable habitat to shallow waters.

Feeding

Tubenose goby do not feed on zebra mussels, as do round gobies. Tubenose gobies feed on various aquatic invertebrates and have been shown to have a significant overlap in diet preference with rainbow darters, Etheostoma caeruleum, and may compete with these native fish for food.

Spawning

Male tubenose gobies guard their nesting sites defending the eggs and young. They spawn multiple times during the warmer months of the year and as a result are rather prolific. Their eggs have adhesive properties that attach to vegetation or to whatever is nearby.

Sexual Maturity

Tubenose gobies are typically 2-3 inches in total length at sexual maturity. Adults can reach 4 inches

The Snakehead:

The Northern Snake Head (Channa argus) can exceed 33 inches in total length. It is a veracious predator with teeth capable of inflicting injuries to anglers. The northern snakehead can tolerate water temperatures from 0-30 degrees Celsius. Its upper salinity limit has been reported at 18 parts per thousand. The northern snake head reaches sexual maturity at 2 to 3 years. Snakeheads form monogamous pair that remain throughout the spawning season. They build nest from vegetation. Snakeheads practice parental protection of the nest until the fry absorb their yolk sacs. At this time the fry are usually 8mm in length. Adult females can produce 22,000-51,000 eggs per spawn and can spawn 1 to 5 times per year. Adult snakeheads feed mostly on other fish. Young northern snakeheads eat a wider variety of food items. In optimal conditions the northern snakehead can survive out of water for up to 4 days. It can survive buried in mud for much longer periods of time. It can also travel short distances across land in moist conditions. The northern snakehead prefers stagnant, shallow, weedy, waterways with mud bottoms. However, they can survive and reproduce in a variety of habitats.

Snakeheads are popular food items in Asia. Some introductions into the United States have been traced to this source. They are also kept in the aquarium trade. The northern snake head resembles the bowfin (Amia calva), a native fish species. The most obvious difference is the larger anal fin and prominent teeth of the snakehead when compared to the bowfin. Measures to control the Northern snakehead include the use of chemicals such as Rotenone.

The northern snakehead was first detected in the United States at Silverwood Lake, California in 1997. They have also been reported from Maryland, North Carolina, Arkansas, Massachusetts, Illinois, New York, Virginia, and Pennsylvania. Several of these areas have reported reproduction. This species has the potential to spread aggressively from these areas. The northern snakehead has also invaded popular culture including made for TV movies (see below).

The Ruffe:

The ruffe (Gymnocephalus cernuus) reaches an adult length of 4 to 6 inches. It is highly aggressive and can survive a wide variety of environmental conditions from deep cold lakes to shallow warm bodies of water. The optimal temperature for growth is between 25 and 30 degrees Celsius. The upper lethal temperature for juveniles is between 30 and 34 degrees Celsius. It can tolerate murky, polluted, nutrient rich waters and salinities ranging from fresh to brackish (salinities up to 12%). It is most often found in areas free of vegetation with a soft bottom. The ruffe spends its days in deeper water to avoid predation. It has sharp spines on its fins and gill covers to detour predators. At night it moves into shallow water to hunt. It has anatomical features that make it a very effective nocturnal hunter at all stages of its life. The ruffe matures quickly, typically reaching sexually maturity at 2-3 years but in warmer water it can reach sexual maturity in as little as 1 year. A single female can produce up to 20,000 eggs per year. Newly hatched embryos are 3.5-4.4 mm in size.

The ruffe was first detected in the St. Louis River in the early 1986. Genetic research indicates that ruffe populations in the Great Lakes originated from southern Europe. It is currently found in Lakes Superior, Huron, and Michigan. Additionally, it is found in several tributaries to these lakes.

In Lake Superior attempts to control growth of ruffe populations was attempted by stocking predators including walleye and northern pike; this did not work. Based on examination of stomach contents of several predatory fish species, the only fish species that appears to consume ruffe regularly is the bullhead catfish. The predatory fish that were stocked preferred native fish that lacked the sharp spines the ruffe possesses.

Recent research has examined using alarm pheromones and reproductive pheromones to manage ruffe. Chemical control has also been considered. Chemicals may be effective but if a small number of fish survive they can repopulate the area.

Invasive Species				
Taxa	**Species**	**Common Name**	**Basin Est.**	**Inter Basin Dispersal Mech.**
algae	*Bangia atropupurea*	red macro-algae	GL	ballast / rec. boating
algae	*Cyclotella cryptica*	algae	GL	unknown / any water
algae	*Cyclotella pseudostelligera*	algae	GL	unknown / any water
algae	*Enteromorpha flexuosa*	grass kelp	GL	ballast / rec. boating
algae	*Stephanodiscus binderanus*	diatom	GL	ballast water
annelid	*Branchuris sowerbyi*	tubificid worm	GL	sediment transport
bryozoan	*Lophopodella carteri*	bryozoans	GL	with aquatic plants
copepod	*Neoergasilus japonicus*	a parasitic copepod	GL	parasite to fish
crustacean	*Apocorophium lacustre*	a scud	MS	ballast water
crustacean	*Bythotrephes longimanus*	spiny waterflea	GL	ballast water / sediment transport
crustacean	*Cercopagis pengoi*	fish-hook water flea	GL	ballast / rec. boating
crustacean	*Daphnia galeata galeata*	water flea	GL	ballast water
crustacean	*Echinogammarus ischnus*	a European amphipod	GL	ballast water
crustacean	*Hemimysis anomala*	bloody red shrimp	GL	ballast water
crustacean	*Schizopera borutzkyi*	copepod	GL	ballast water
fish	*Alosa aestivalis*	blueback herring	GL	swimmer
fish	*Alosa chrysochloris*	skipjack herring	MS	swimmer
fish	*Alosa psuedoharengus*	alewife	GL	swimmer
fish	***Channa argus***	**northern snakehead**	**GL**	**swimmer**
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
fish	***Gymnochephalus cernnus***	**ruffe**	**GL**	**swimmer**
fish	***Hypophthalmichthys molitrix***	**silver carp**	**MS**	**swimmer**
fish	***Hypophthalmichthys nobilis***	**bighead carp**	**MS**	**swimmer**
fish	*Menidia beryllina*	inland silverside	MS	swimmer
fish	***Mylopharyngodon piceus***	**black carp**	**MS**	**swimmer**
fish	*Petromyzon marinus*	sea lamprey	GL	swimmer
fish	***Proterorhinus marmoratus***	**tubenose goby**	**GL**	**swimmer**
mollusk	*Pisidium amnicum*	European pea clam	GL	ballast water
mollusk	*Potamopyrgus antipodarum*	New Zealand mudsnail	GL	ballast water
mollusk	*Sphaerium corneum*	European fingernail clam	GL	ballast water
mollusk	*Valvata piscinalis*	European stream valvata	GL	ships
plant	*Carex acutiformis*	swamp sedge	GL	recreational boating & trailers
plant	*Glyceria maxima*	reed sweetgrass	GL	recreational boating & trailers

Invasive Species				
Taxa	**Species**	**Common Name**	**Basin Est.**	**Inter Basin Dispersal Mech.**
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	MS	recreational boating & trailers
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boating & trailers
plant	*Oxycaryum cubense*	Cuban bulrush	MS	recreational boating & trailers
plant	*Trapa natans*	water chestnut	GL	recreational boating & trailers

HI-1-7

The value engineering team identified a functional need to HANDLE ICE (HI) for any alternative solution that is developed. The topic of accommodating ice is a secondary function to this project but may be critical to the long term operations and success of the project. Several methods were brainstormed on how to prevent or at least minimize the opportunity for ice formation:

- H1: Melt Ice
- HI2: Break Up Ice
- HI3: Minimize surface for ice formation
- HI4: Minimize standing water
- HI5: Check need for ice load
- HI6: Build forest to block ice
- HI7: Design for appropriate ice event reoccurrence
- HI8: Use chemicals to melt ice and discourage fish

A quick review of historical data from http://www.weather.gov/climate/ yields an expected window of potential ice formation from December – February. The temperatures appear to remain at or below freezing majority of the time thus further supporting the concerns raised by the team. The probability/risk of substantial ice formation may warrant further investigation but for the purpose of this activity, no information could be obtained to discredit the need/concern. It would be prudent for the final design to account for and accommodate ice formation.

Historical Climate for Lafayette Indiana					
	Jan-10	Feb-10	Mar-10	Nov-10	Dec-10
Average High Temperature (F)	29.3	32.7	55.1	55.2	30.9
Average Low Temperature (F)	17.8	19.1	34.5	31.9	17
Highest Temperature (F)	54	41	78	76	60
Lowest Temperature (F)	-2	2	21	21	-2
Heavy Snow (# Days)	0	0	0	0	0
Snow	2	2	0	0	3
Light Snow (# Days)	11	13	0	1	18
Freezing Rain (# Days)	0	0	0	0	0

APPENDICES

APPENDIX
A – PARTICIPANTS

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Wabash-Maumee River Basin Connection Study
Fort Wayne, IN
January 19 – 21, 2011

Name:	Company:	Phone:	Email:	Introduction	Mid-Point Review	VE Presentation
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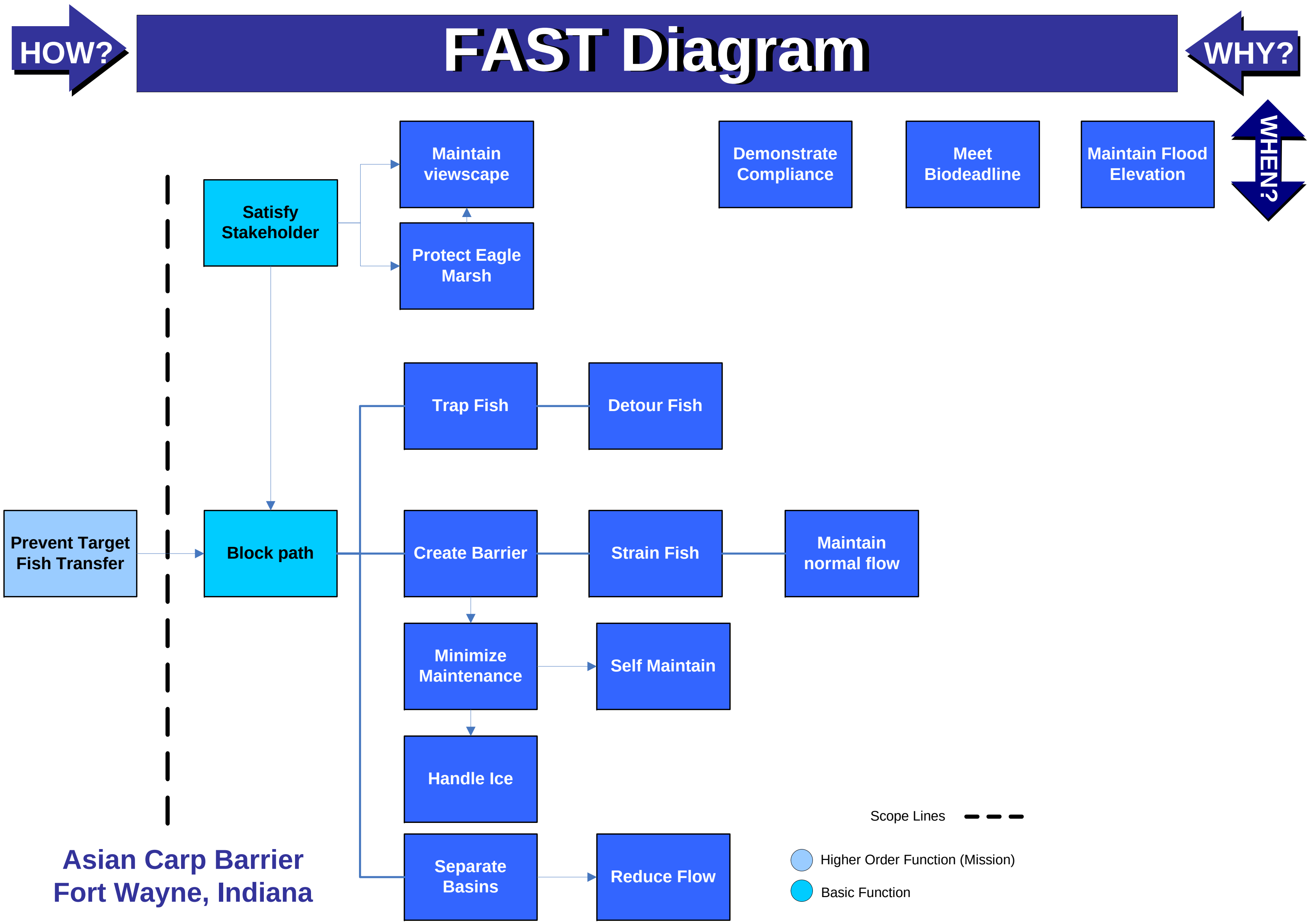
Roger Setters	US Army Corps of Engineers	(502)315-6891	Roger.d.setters@usace.army.mil	X		

APPENDIX
B – FUNCTION ANALYSIS

FAST Diagram



Asian Carp Barrier
Fort Wayne, Indiana

APPENDIX
C – CREATIVE IDEA LISTING

CREATIVE IDEA LISTING

Idea No.	Description	Votes
Create Barrier (CB)		
CB-1	Build a berm	4
CB-2	Create a vertical drop structure	5
CB-3	Enhance the fence	5
CB-4	Create a fence berm combination	6
CB-5	Build a jersey barrier wall	0
CB-6	Build a fence in one location and a berm in another	RR
CB-7	Create channel or swale as a barrier	1
CB-8	Constuct barrier as path through wetland	1
CB-9	build a permeable barrier (riprap)	7
CB-10	Use bubble barrier	0
CB-11	Use electric barrier	0
CB-12	Use a dead zone	0
CB-13	Create extremely turbulent flow zone	2
CB-14	Build a dam and siphon spillway	1
CB-15	Build a labyrinth to lengthen flow path	1
CB-16	Build an "S" shaped spillway	2
CB-17	Use disposable net	0
CB-18	Use fuse-plug section	0
CB-19	Reshape wetland a multi-cell long path	1
CB-20	Use cable-type barrier to reduce maintenance	0
CB-21	Build a vegetative barrier that will lay down under emergency flows	DS
CB-22	Build berm where Graham McCulloch crosses railroad	1
CB-23	Use inflatable dam	1
CB-24	Use partial barrier with closure for predicted flood	1
CB-25	Build structure and pump around	5
CB-26	Build a dam with traditional fish screens	4
CB-27	Fix screen full height at I-69	0
CB-28	Berm with underdrains	7
CB-29	Berm with jump barrier	0
CB-30	Use existing topo and structure while lowering tailwater	0
CB-31	Create barrier and reroute Graham-McCullom Ditch to Junk ditch and build floodwall	5
CB-32	Create flood wall enclosure at the mouth of Junk Ditch	0
CB-33	Replace existing low head dams and build Amberson Dam with bar screens to foil jumping carp	2

Idea No.	Description	Votes
CB-34	Build angled bar screen	0
CB-35	Build barrier for the longest economic crest for lowest head difference and lower velocity	6
CB-36	Add or build a new structure with self-regulating gates bottom hinged with bar screens	2
CB-37	Move fence to immediately downstream of a road and use the road as an ice filter	2
CB-38	At a road, install self-regulating tide gates to control water surface elevation with a low sill for gobi and screen for carp	1
CB-39	Add sufficient bar screens and culverts to maintain adequate flow	0
CB-40	Add a large trash rack in front of other structures and use bar screens for carp	2
CB-41	Do CB-39 with trash bypass such as stop logs or similar	3
CB-42	Build long weir for 1% flood and screen culvert for 10% flood	1
CB-43	Build wall, separate basin and buy out flood-prone structures	DS
CB-44	Create dry barrier for snakehead	0
CB-45	Create low vertical sill to block gobi	1
Separate Basins (SB)		
Sb-1	Raise elevation of the divide	4
Sb-2	Create storage in both basins	9
Sb-3	Create a pump storage detention south of the railroad and west of I-69	0
Sb-4	Create wetland detention	4
Sb-5	Use quarries for storage	2
Sb-6	Construct depressed wetland below water table and pump	4
Sb-7	Do SB-6 and use renewable energy	2
Sb-8	Enhance conveyance of the Maumee and Wabash Rivers	3
Sb-9	Use stormwater BMPs in St. Mary's and St. Joseph watersheds	4
Sb-10	Create storage in Junk Ditch	RR
Sb-11	Increase conveyance on the Trier Ditch up stream of New Haven	0
Sb-12	Do SB-11 and reroute to discharge downstream of New Haven	2
Sb-13	Divert flow to reservoir at Roush dam	2
SB-14	Lower water surface elevation as part of the design approach	0
Trap Fish (TF)		DS
TF-1	Build a carp trap for jumping fish at low head dams	2
TF-2	Create incentives for commercial fishery	4
TF-3	Create a bounty system	0
TF-4	Skim for snakehead eggs	0
TF-5	Attract fish to trap areas	0

Idea No.	Description	Votes
TF-6	Build side channel reservoir with upstream screen and preferred path for fish	1
TF-7	Poison fish	1
TF-8	Bait area to attract	0
TF-9	Create sport	0
TF-10	Kill with overpressure	0
General (G)		
G-1	Invite TNC to maintain wetland	0
G-2	Create stakeholder group by information campagn regarding threat and opportunity	2
G-3	Generate funding source for 35% cost share	1
G-4	generate funding source for long term maintenance	1
G-5	Extensively monitor and study the Little River to determine why the carp has not migrated	DS
G-6	Find and stock native competitor	1
G-7	Create a moderated, technical blog on carp biology and management practices	1
G-8	Have free conferences offering CEUs focused on carp control	1
G-9	Move solutions away from flood areas	2
G-10	Separate solutions by species (goby in one place, carp in another	DS
G-11	Use adaptive management and build additional measures as necessary - get adequate land, etc.	1
G-12	Encourage Predation	0
G-13	Find pathogens or disease to which carp are susceptible	1
G-14	Research Asian literature	1
G-15	Do nothing	5
Ideas previously generated by project team (Prev)		
prev B-1	Construct Barrier Fence	2
Prev-B-2	physical barrier at headwaters of Junk Ditch east of Eagle Marsh near theoretical basin divide	3
Prev-B-3	Barrier upstream of I-69	0
Prev-B-4	Rock/sand berm parallel to I-69 combined with realignment of Graham McCullogh Ditch - variations include sand core berm w/ rock cover; excavation of ditch realignment material used for berm; one or series of innovative release structures	5
Prev-B-5	Barrier at Homestead Road	4
Prev-B-6	Barrier at Ellison Road	0
Prev-B-7	Barrier at Aboite Road	0
Prev-B-8	System combining multiple areas with a chain of small ponds	4

Idea No.	Description	Votes
Prev-B-9	Barrier at current fence site	1
Prev-B-10	Barrier at I-69 bridge	0
Prev-B-11	Extend levee across Junk Ditch and add pump station	0
Prev D - 1	Fox Island Diversion (create more storage south of RR)	1
Prev D - 2	Divert Graham-McCulloch Ditch to Maumee watershed	0
Prev D - 3	Divert south side of Engle Road, channel parallel to Engle Road	0
Prev D - 4	Reduce flood elevations/Backflow in Junk Ditch	1
Prev D - 5	Add detention basins on St. Marys/St. Josephs watershed	4
Prev D - 6	Reroute Little River to Lake Roush	0
Prev T/K	Prevent passage of carp by electricity, "dead zone", or non-toxic repellent such as fruit juice. Maybe a leaky structure. If G-M Ditch is rerouted to the Maumee, then requirement for low water (normal) flow through the dam is eliminated.	0
Prev B 12	Create a fence or barrier at Huntington Dam	6
Prev B 13	Wicket dam barrier - floating overflow structure	2
Handle Ice (HI)		DS
HI	Melt ice	0
HI-1	Break up ice	1
HI-2	Minimize surface for ice formation	0
HI-3	Minimize standing water	0
HI-4	Check need for ice load	2
HI-5	Build forest to block ice	4
HI-6	Design for appropriate ice event reoccurance	1

DS – Indicates the Idea was selected to be written as a Design Suggestion and is included in the Design Suggestion Section of this report

RR – Indicates the Idea received enough votes by the Value Team to be developed. However, during the Development Phase the team found that the Idea was not feasible. Therefore, it has been designated RR indicating that it was Reviewed and Rejected by the Value Team.

APPENDIX
D – MATERIALS PROVIDED

MATERIALS PROVIDED

Document	Prepared by	Date
Paper map of Eagle Marsh habitat	Little River Wetlands Project	2011
Waterlines: Newsletter of IDNR describing current carp project	IDNR	Winter 2011
Topo sheets, maps and aerial photograph of Eagle Marsh & environs	IDNR	undated
Draft Alien Species White Paper (adobe and WP format)	Frank M. Veraldi, et al	November 2010
Alternatives Analysis, Parts 1&2	USACE	January 2011
Wabash-Maumee Field Report	Tetratech EM, Chicago, IL for USEPA	July 27, 2010