Value Engineering Report

Flood Control for Watertown and Vicinity, Watertown, South Dakota

August 2009

U. S. Army
Corps of Engineers

Conducted by
GeoVal, Inc.

GeoVal Inc.
Geotechnical & Value Engineering
Forensic Consultation

August 4, 2008

U.S. Army Corps of Engineers
Omaha District
1616 Capitol Ave.
Omaha, Nebraska 68102-9000

ATTN: Richard Stricker, Value Engineering Officer

Reference: Value Engineering Study Report
Flood Control for Watertown and Vicinity, Watertown, South Dakota

Dear Mr. Stricker:

I am pleased to submit electronic copy of the Value Engineering Report for the above-referenced project, transmitted to your FTP site.

I enjoyed working with you and the team on this important project and hope that the findings of this report will be of benefit to the U.S. Army Corps of Engineers as the agency moves forward with a decision as to the best alternative(s) that will focus on providing 1% flood protection to the City of Watertown and its vicinity in South Dakota.

If you have any questions or comments regarding the study, please call me at (858) 484-6498.

Sincerely,

GeoVal, Inc.

Ronald J. Tanenbaum, CVS, PhD, PE, GE, FASCE
President

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EXECUTIVE SUMMARY

INTRODUCTION

This Value Engineering (VE) Report summarizes the events of the VE workshop facilitated by GeoVal, Inc., July 22-24, 2009 for the U.S. Army Corps of Engineers (USACE) Omaha District, Nebraska. The Flood Control for Watertown and Vicinity, Watertown, South Dakota Value Engineering Study focuses on the assessment of several alternatives currently under consideration in the General Reevaluation Report (GRR), being prepared by the U.S. Army Corps of Engineers (USACE), so as to make a recommendation as to the most appropriate approach to provide flood damage reduction in the community of Watertown and its vicinity.

Watertown and its vicinity are subject to periodic flooding from the Big Sioux River and its tributaries. The Watertown area has experienced eight major floods since 1943, averaging a major flood approximately every eight years. Watertown's susceptibility to flood damages has increased over time as the City has grown and development has increased around nearby Lakes Kampeska and Pelican. FEMA has recently issued a new floodplain map for the community that has expanded the area that might be inundated by a 1% flood event significantly increasing the number of structures involved in a flood insurance program. The purpose of the current phase of the project is to assess flood risk management alternatives in order to identify a feasible and economically justified recommended alternative.

The intent of the VE study is to identify potential viable alternatives to provide up to 1% storm event flood damage reduction in the Watertown and vicinity, South Dakota area. Such improvements generally look to improving function, improving quality, and reducing and/or increasing cost/performance as appropriate to improve the project value.

SUMMARY OF FINDINGS

Outlined below is a summary of the findings of the VE team with regard to alternatives and comments that offer the most potential of meeting project objectives:

- There appears to be an opportunity to create a storage impoundment north of the City of Watertown that could store most if not all of the anticipated volume of water generated by the 1% flood event, which, in turn, would reduce or eliminate the need to conduct significant structural and/or channel improvements within the City of Watertown.

- When a review of the advantages, disadvantages, anticipated costs and impacts to the community of alternatives was completed by the VE team, the unanimous consensus of the participants was that the Mahoney Creek Dry Dam offered the optimum potential for achieving project objectives of maximizing 1% flood event protection to the City of Watertown and its vicinity. This would further maximize the number of properties removed from the FEMA 1% floodplain map eliminating their need to obtain flood insurance.

- In order to improve the level of communication and understanding within the community regarding the selected alternative, as well as the reasoning behind the rejection of other alternatives, the City of Watertown is encouraged to engage the services of a public relations individual or firm. In addition, a computer graphic model of the selected alternative should be developed to enhance the communication of information to the public. The City should consider supporting a Stakeholders Advisory Group to ensure that diverse opinions are considered in the decision making process and that consensus is achieved for the project.

PROJECT DESCRIPTION

The study area is Watertown and its vicinity, which is located in Codington County, South Dakota in the northeastern part of the state. The area includes the Big Sioux River, which runs through the City of Watertown, as well as Lakes Kampeska and Pelican, which are located northwest and southwest of the City, respectively. The drainage area of the Big Sioux River upstream of Watertown is 1,902 square miles, 724 square miles of which contribute to the flow through Watertown. The general study area is shown in **Figure 1**. A more detailed presentation can be found in **Appendix A.**

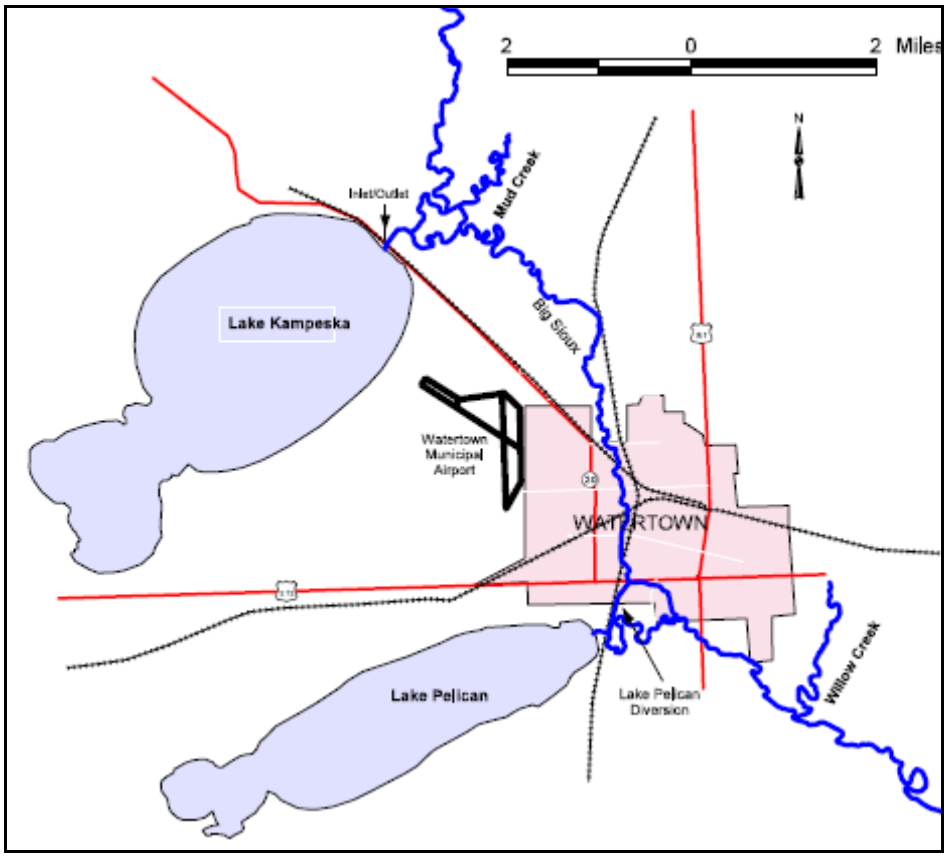


Figure 1 - Location Map for Watertown, South Dakota Flood Control Project

A 1994 Feasibility Report and a 2000 General Reevaluation Report both recommended construction of the Mahoney Creek Dry Dam upstream of Watertown (referred to as the Upper Big Sioux River Flood Control Project by the City of Watertown). Lack of local support for the Mahoney Creek Dry Dam alternative has prevented its implementation in the past. At the City's request, the scope of the current General Reevaluation Study has been expanded to include consideration of several new alternatives. The Corps, the City, and other stakeholders are also working together to establish a collaborative approach to the project that will help build local consensus on the decision making process and conclusions of the study.

COST ASSESSMENT

The VE Team was provided with preliminary/planning level cost estimate for the Mahoney Creek Dry Dam Alternative to use as a guide in making the general comparisons associated with individual alternatives. The summary table of total costs for the alternative is presented in **Appendix B.** The VE team did not make any judgments as to the accuracy or completeness of the construction components of the estimate. The current total project cost estimate is approximately $23,750,000. The VE team modified the cost estimate associated with real estate and land damages that

produced an increased estimated project cost for the Mahoney Creek Dry Dam alternative of approximately $33,650,000.

PROJECT ANALYSIS

The SAVE International VE tools and Job Plan were used by the VE team to analyze the project. The results of these analyses clarified the programmatic objectives and major project functions developed by the team.

The team enlisted the assistance of the project managers and designers from USACE Omaha District and the City of Watertown, South Dakota.

Team and Stakeholder Issues

In preparing to enter the Evaluation Process, the VE team first participated in an exercise whereby they identified critical issues they saw to be important to the project. In doing so, the team members were able to focus on these items and develop alternatives relevant to the critical issues in addition to the project functions.

Two lists were developed. The first identified project constraints and the second critical issues the VE team felt were still open where additional information would eventually be needed for a complete assessment. The Project Constraints and Critical Issues identified are presented in **Appendix A**.

VE ALTERNATIVES AND COMMENTS

The VE team developed 3 project alternatives, and 8 comments/suggestions, that may potentially improve the project value. The alternatives and comments were developed by referring to the functional categories developed during the function analysis of the study as a stimulus to creative thinking, including: *protect community, enhance environment, save property, save lives, enhance development and minimize project impacts.* Other significant functions include *reduce damages, protect structures, reduce flooding, eliminate flood insurance* and *lower flood stages*. The critical issues presented above were also consulted regularly during the process to assure that all concerns raised in the study were addressed.

A summary list of the alternatives is presented below. The reader should note that this list represents, in most cases, a combination of Speculation Ideas where appropriate. Detailed documentation of these key alternatives is contained in the Value Engineering Alternatives Section of this report. It is also important to note that the listed alternatives generally represent individual concepts. Combinations of these concepts can, and should, be considered as possible additional comprehensive options. The comments and suggestions are presented later in this report.

Alternative Number*	Creative Idea Number(s)	SUMMARY OF VE ALTERNATIVES Alternative Description	Potential Estimated Construction Cost Savings/(Expense)
1.0	1, 25, 67	Build Mahoney Creek Dry Dam	$0
2.0	4	Divert water from Lake Kampeska and Lake Pelican back to the Big Sioux River	($9,424,000)
3.0	10, 42, 62, 63	Implement LPWPD Comprehensive Water Resources Management Plan	($46,657,000)

NOTE: Each of these alternatives is considered to be competing proposals where only one of them could be selected for implementation. A more detailed presentation of cost can be found in the VE Alternatives section of the report, including estimated operations and maintenance costs (life cycle costs), where appropriate.

VE TEAM AND PROCESS

The three-day study was performed during the period of July 22 to 24, 2008, at the office of U.S. Army Corps of Engineers, Omaha, Nebraska. An exit briefing was held at the end of the workshop. Ron Tanenbaum, GeoVal, Inc., facilitated the VE study. The VE team members are listed below (see **Appendix C** – Contact Directory and Attendance):

Ronald J. Tanenbaum, CVS, PhD, PE, GE	GeoVal, Inc.
Richard Stricker, CCC, AVS, VEO	USACE – Omaha District
Chris Fassero	USACE – Omaha District
Kevin Adams, PE	USACE – Omaha District
Victoria French	USACE – Omaha District
Dennis Gaare, PE	USACE – Omaha District
Steven Hightower	USACE – Omaha District
Jody Ruckman, PE	USACE – Omaha District
Nicole Shorney, EIT	USACE – Omaha District
Sarah Caron, PE	City of Watertown

Throughout the VE session, members of the Omaha District supported the VE team.

Value Engineering is a strictly adhered-to process that follows specific steps and procedures. The specific steps in the VE process, also known as the VE Job Plan, are as follows:

Step 1. Preparation – developing a basic understanding of the client's/user's needs and requirements, specific goals and current costs with an agreement on the scope of the study.

Step 2. Information – which is gathered prior to and during the study, and is reviewed and discussed with the team. A summary of project constraints and critical issues can be found in **Appendix A.**

Step 3. Function Analysis – defines the functions of the project through an organized use of the Function Analysis System Technique (FAST) diagram that shows how the functions are related to one another. A FAST diagram was developed for this study and is shown in **Appendix D.**

*Step 4. Speculati*on – also known as creativity – is the application of brainstorming techniques to develop a large quantity of ideas rather than the quality of ideas. A complete list of workshop ideas can be found as **Appendix E**.

Step 5. Evaluation – reduces the large quantity of ideas to a few high quality ideas.

Step 6. Development – the concepts identified in the evaluation phase are developed into specific recommendations/alternatives that have been technically validated and quantified as much as possible.

Step 7. Report – containing the team's recommendations and a presentation to the management group to receive their approval of these recommendations.

Step 8. Implement and Audit – tracking the implementation of projects and auditing the results measure the effectiveness of the value engineering effort.

The VE Job Plan was followed to analyze the criteria/functions of the project and the issues of concern, create and evaluate ideas for change, and develop and present alternatives to the project team and stakeholders. The study concluded with the informal presentation of the VE alternatives and suggestions.

VALUE ENGINEERING ALTERNATIVES

EVALUATION PROCESS

The VE team, as a group, generated and evaluated ideas on how to represent the various major components/functions identified that would enhance decisionmakers' ability to select the best proposal(s) that would produce a high level of performance at an acceptable level of cost to provide reduction of flooding-related damages in Watertown and its vicinity, South Dakota. The idea list (see **Appendix E**) was based on the key criteria listed above and the function analysis performed by the VE team.

The team evaluated each of the ideas with respect to current conditions for each of the key evaluative criteria to determine whether it was better than, equal to, or worse than the status quo, which for this study was considered to be the Mahoney Dry Dam alternative. The team reached a consensus on the ranking of the idea. High-ranked ideas would be developed further; low-ranked ones would be dropped from further consideration.

All of the numerous ideas that were generated during the creative phase using brainstorming techniques were recorded on the Idea Evaluation Form worksheets presented in **Appendix E**. These ideas were discussed and the advantages and disadvantages of each were debated. Once an idea was fully evaluated, it was rated as described later in this report, **Value Engineering Process**. All readers are encouraged to review the creative idea listings in the Idea Evaluation Form, because even the low-rated or rejected ideas may suggest additional ideas that can be applied to the project.

VE ALTERNATIVES

Each VE Alternative consists of a summary of the original concept, a description of the suggested change, a listing of its advantages and disadvantages, and a brief narrative describing the justification for the alternative. A listing of the alternatives is shown in the Executive Summary.

Alternative cost estimates compare *relative* items of the current baseline design (assumed to be the Mahoney Dry Dam alternative) and proposed change for the sole purpose of estimating the net difference between the two options. In several cases, the estimates do *not* include the total feature cost but only those components that are changed by the alternative.

The reader should also note that the efforts of the VE team in developing the alternatives in the short time period of the VE workshop limits their findings to conceptual level analyses and rough order-of-magnitude cost estimates only. The descriptions contained in the alternatives presented do not represent detailed design nor do they provide equally detailed cost estimates.

VALUE ENGINEERING ALTERNATIVE

Project: Flood Control for Watertown and Vicinity, Watertown, South Dakota

ALTERNATIVE NO: 1 **PAGE NO: 1 OF 4**

TITLE: Build Mahoney Dry Dam

ORIGINAL DESIGN: Build Mahoney Creek Dry Dam.

PROPOSED DESIGN: The proposed design is the same as the original design from the 1994 Feasibility Report and the 2000 General Reevaluation Report; that is, build the Mahoney Creek Dry Dam.

ADVANTAGES:

- Eliminates 1% flood from vicinity
- Protects most property/people
- Reduces overall sediment below dam that enters lakes
- Simple concept with single major component and not structures or gates
- Proven technology; and acceptable to FEMA
- Straightforward maintenance at minimal cost
- Good construction materials nearby
- Direct impacts to the community is minimal
- Passed environmental review
- No railroads in pool area (from Google Earth aerials)
- 2002 election supported this alternative
- Protects more property north of the City than several other suggested alternatives

DISADVANTAGES:

- Opposition from impacted land owners and LPWPD
- May require use of eminent domain to acquire land in pool area
- Forms physical barrier in river to fish passage, which must be resolved through downstream mitigation
- Cutoff trench, if built, may cut off groundwater flow to the south impacting wells
- During inundation, concern for rising groundwater
- May impact 9 roads in pool area (155th Street, 451st Avenue, Cottonwood Street, 452nd Avenue, 453rd Avenue, 159th Street, 160th Street, Sioux Conifer Road, 454th Avenue)
- May be considered poor aesthetic

COST ASSESSMENT SUMMARY:

Since the Mahoney Creek Dry Dam alternative was considered the baseline design for the purpose of performing this value engineering workshop, this alternative has no impact on the cost of the project, currently estimated to be approximately $33,650,000.

DISCUSSION/JUSTIFICATION

Mahoney Creek Dry Dam (Mahoney) is located on the Big Sioux River just downstream of the junction with Mahoney Creek. Other possible dam locations were considered, but Mahoney was selected as the optimum location. The Mahoney Creek Dry Dam site would require less total surface area for temporary flood water storage than the other possible locations. While there are some homesteads in the Mahoney inundation area, other possible locations would inundate more homesteads and farm land. The Mahoney site also appears to have favorable quantities of impervious soils needed for construction of the dam. The Mahoney Creek Dry Dam would impact fewer historical sites than the other possible locations, and there appear to be no historical Native American lands at the site. No railroads were found in the inundation area of the Mahoney Creek Dry Dam, which could make construction easier and quicker than at other locations or for other alternatives.

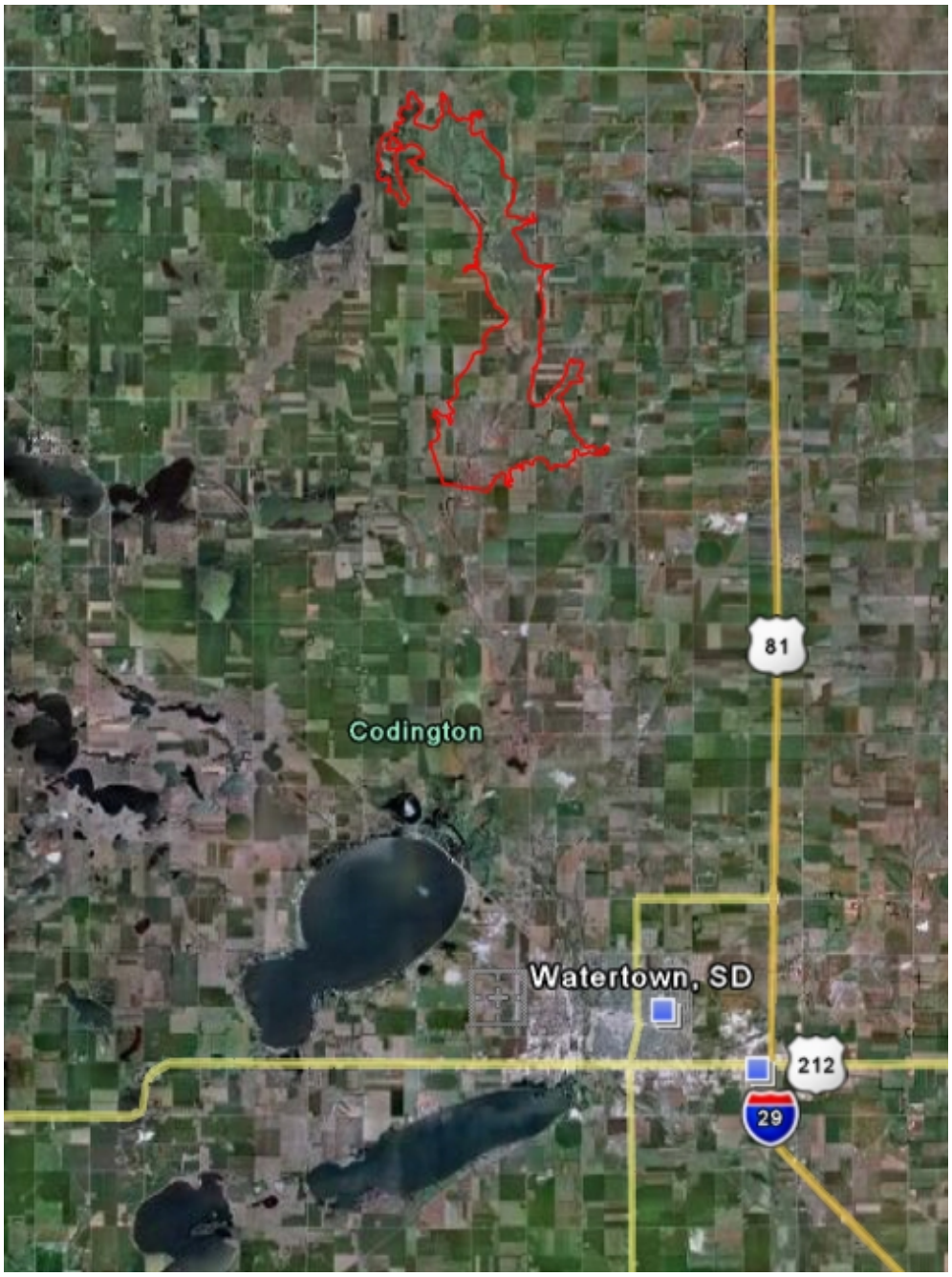
The Mahoney Creek Dry Dam would also help improve water quality in the Big Sioux River, Lake Kampeska, and Lake Pelican by lowering the sediment load. Lowering the sediment load would allow further actions to be taken to alleviate current problems in Lake Kampeska, which is an important objective to the City. The U.S. Fish and Wildlife Service has already approved the construction of Mahoney Creek Dry Dam since no threatened or endangered species were identified at the location, including the Topeka Shiner.

The Mahoney Creek Dry Dam was the recommended alternative in previous Corps studies. This alternative was found to be the most economical and beneficial to the community. Mahoney Creek Dry Dam would be designed to remove most people in the community from the 1% flood plain. The Mahoney Creek Dry Dam alternative would provide protection for more structures and property in the community than any of the other alternatives, since the dam would be located upstream of the City. The dam would be a straightforward design with an uncontrolled culvert pipe and a spillway. Minimal operation and maintenance would be required. All emergency routes, except those in the inundation area upstream of the dam, would be kept open and protected by Mahoney from flooding.

The Mahoney Creek Dry Dam could be constructed in conjunction with downstream diversions and channel improvements. By increasing channel capacity downstream, more homes could possibly be removed from the 1% flood plain and water could be released at a higher rate from Mahoney. The faster water can be released from Mahoney without impacting structures downstream, the smaller the inundation area upstream of the dam becomes and the shorter the duration of inundation.

ALTERNATIVE NO: **PAGE NO: 3 OF 4**
TITLE: Build Mahoney Dry Dam

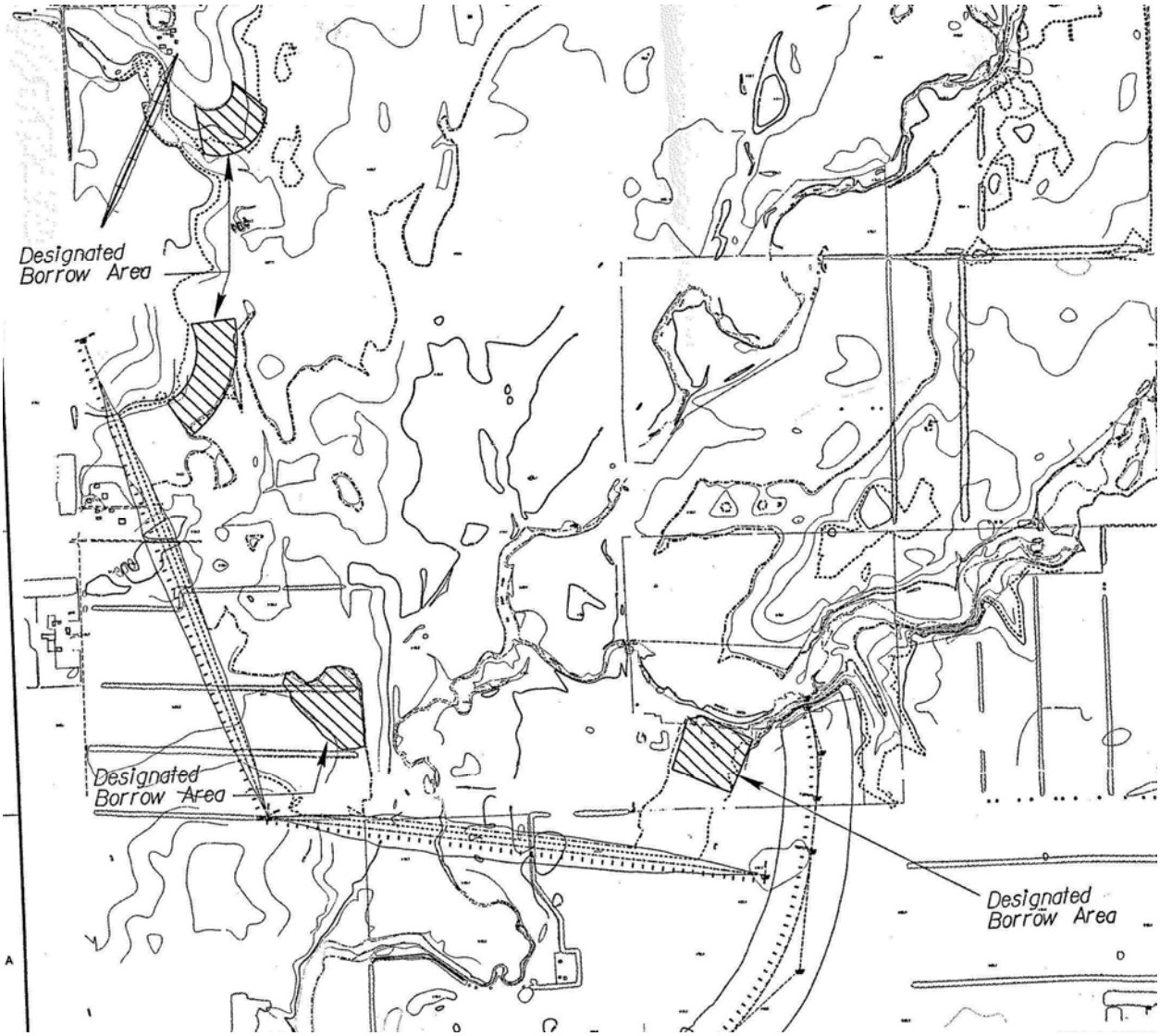
DRAWING/SKETCH CURRENT/PROPOSED DESIGN



Mahoney Creek Dry Dam inundation at elevation 1775 (red line).
Current 1% inundation elevation is 1773.3.

ALTERNATIVE NO: **PAGE NO: 4 OF 4**
TITLE: Build Mahoney Dry Dam

DRAWING/SKETCH CURRENT/PROPOSED IDEA



Topographic Location of Proposed Dams and Spillway

VALUE ENGINEERING ALTERNATIVE
Project: Watertown Flood Control Project

ALTERNATIVE NO: 2.0 **PAGE NO: 1 OF 5**
TITLE: Divert water from Lake Kampeska and Lake Pelican back to the Big Sioux River

ORIGINAL DESIGN: Build Mahoney Creek Dry Dam.

PROPOSED DESIGN: The proposed design would divert water from the Big Sioux River north of Watertown into Lake Kampeska, then on to an improved natural channel between Lake Kampeska and Pelican Lake, then connecting to a final channel that ties back into the Big Sioux River south of Watertown.

ADVANTAGES:

- Water in the channels would only be temporary during flood events and should not increase attraction to birds that might adversely impact airport traffic.
- Reduces the size of the required Mahoney Creek Dry Dam upstream or may eliminate the need for the dam completely.

DISADVANTAGES:

- FAA would need to approve concept due to concerns over birds.
- Ice jams may occur on Lakes during flood events restricting flows.
- Does not improve water quality and may even exacerbate the problem.
- Requires numerous control structures.
- May not be a standalone solution.
- Railroad trestle, highway bridge and other structures may need to be addressed.

COST ASSESSMENT SUMMARY:

	Present Worth Values For:				
COST SUMMARY	**Initial CWE Costs**	**Replacement & Future Costs**	**Salvage Value**	**O&M Costs**	**Total Life Cycle Costs**
Original Concept	$33,675,000	$0	$0	$0	$33,675,000
Alternative Concept	$43,099,000	$0	$0	$0	$43,099,000
Savings / (Expense)	($9,424,000)	$0	$0	$0	($9,424,000)

Note: Life cycle (O&M) costs were considered to be approximately the same for both the original design and the proposed alternative.

DISCUSSION/JUSTIFICATION

POTENTIAL DIVERSION ALIGNMENTS FROM LAKE KAMPESKA TO PELICAN LAKE

All the alignments suffer from the problem of having to cross U.S. Highway 212 and the old C&NW railroad line; this would necessitate some type of new structure to allow flows under these two transportation corridors.

GOOSE LAKE: This alignment is the longest of all alignments. The biggest drawback of this alignment is that Goose Lake is lower than Pelican Lake. Either Goose Lake would have to fill about 30 feet before spilling into Pelican Lake or a channel would have to be excavated to allow flows into Pelican at a lower Goose Lake elevation. It also passes through a State Park area.

WEST: This alignment is the shortest but has the deepest cuts of all alignments.

CENTRAL: This alignment is slightly longer than the WEST alignment but has less cut. However, this alignment requires the deepest cuts at Highway 212 and the railroad.

AIRPORT: This alignment passes along the west side of the airport. This would very likely require some type of closed conduit parallel the runway, which would be very expensive and a great deal of coordination with the FAA. It also passes through more commercial development along Highway 212 than the other alignments.

The Central Option was chosen for costing purposes.

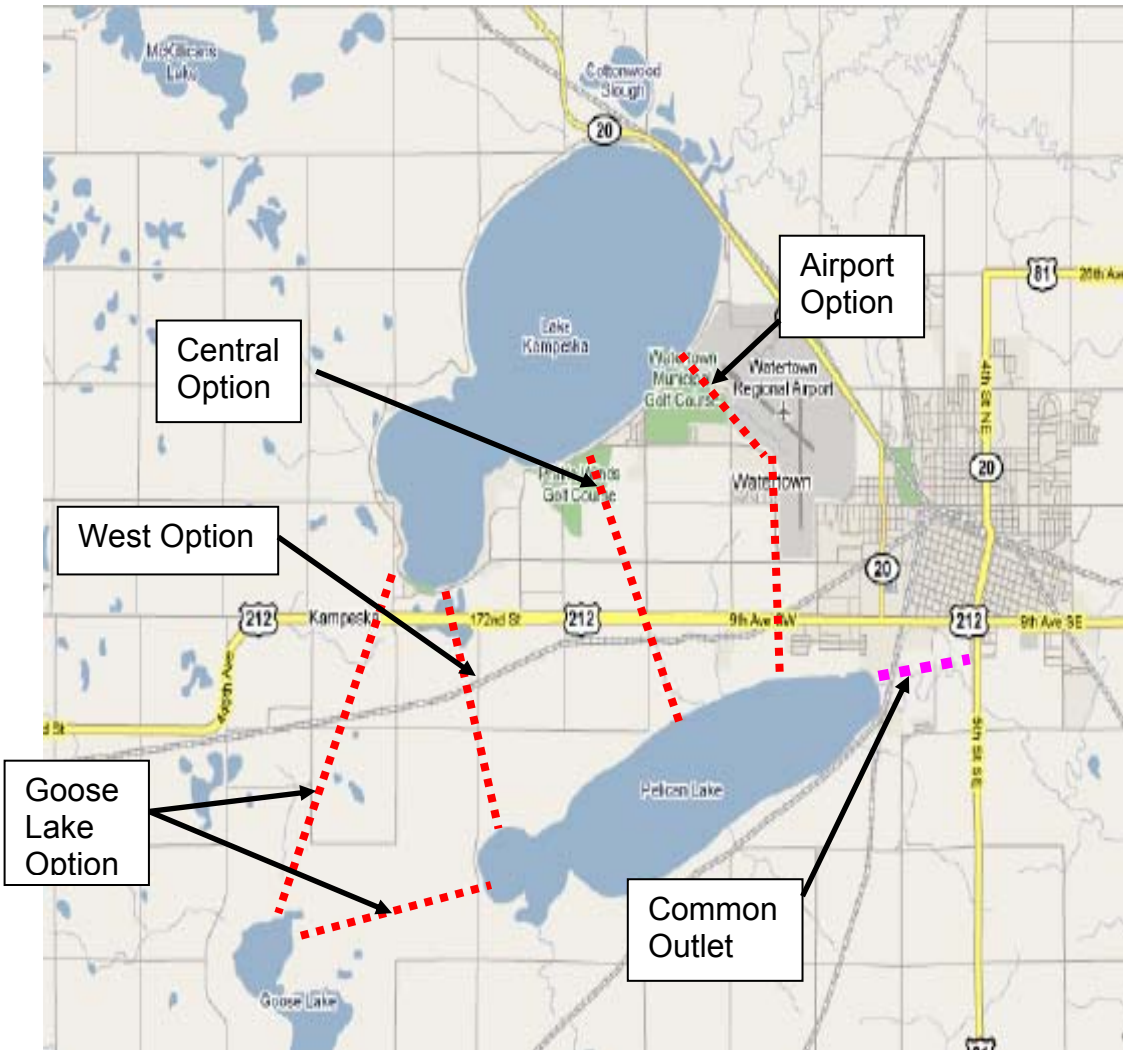
The Central Option demonstrated in the cost estimate should be able to carry the full flowage capacity to protect against the 1% event. The Central Option was chosen from the four options presented based on perceived constructability, practicality and cost.

Actually any of the four alignments should be able to carry the full flowage capacity to protect against the 1% event. As a standalone alternative, routing a flood event through the two lakes only exacerbates the water quality issues currently being experienced at those sites. Incorporating this diversion idea with the construction of the Mahoney Creek Dry Dam may result in a viable solution. Constructing the Mahoney Creek Dry Dam has the potential of enhancing the water quality. Incorporating the diversion concept with the Mahoney Creek Dry Dam has the potential of lessening the footprint required for the Mahoney Creek Dry Dam, thus impacting fewer farm acres and possibly even farm structures. Further study is required to find the right combination, if it exists.

ALTERNATIVE NO: 2.0 **PAGE NO: 3 OF 5**

TITLE: Divert water from Lake Kampeska and Lake Pelican back to the Big Sioux River

DRAWING/SKETCH CURRENT DESIGN



ALTERNATIVE NO: 2.0 **PAGE NO: 4 OF 5**

TITLE: Divert water from Lake Kampeska and Lake Pelican back to the Big Sioux River

COST ANALYSIS – INITIAL COSTS

CONSTRUCTION ELEMENT		ORIGINAL CONCEPT			ALTERNATIVE CONCEPT		
Description	**Unit**	**Quantity**	**Cost/Unit**	**Total**	**Quantity**	**Cost/Unit**	**Total**
Mahoney Dam Construction	LS	1	13,866,662	$13,866,662			$0
Mahoney Real Estate	LS	1	13,152,150	$13,152,150			$0
CENTRAL OPTION							
Control Structures Inlet/Outlet	EA				6	$750,000	$4,500,000
Railroad Crossing	EA			$0	1	$2,000,000	$2,000,000
Crossing @ Highway 212	EA			$0	1	$1,500,000	$1,500,000
Central Channel Excav. (Sidecast)	CY			$0	3,188,889	$3	$9,566,667
Common Outlet Excav. (Sidecast)	CY			$0	1,500,000	$3	$4,500,000
Lake Kampeska Inlet Excav. (Sidecast)	CY			$0	1,000,000	$3	$3,000,000
Real Estate	ACR			$0	300	$20,000	$6,000,000
				$0			$0
				$0			$0
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				$0			$0
				$0			$0
TOTAL CONSTRUCTION COST:				$27,018,812			$31,066,667
Owner Mark-Up Excluding Real Estate	48%			$6,655,998			$12,032,000
TOTAL CWE:				$33,675,000			$43,099,000
						SAVINGS	-$9,424,000

ASSUMPTIONS & CALCULATIONS

	WATERTOWN		
	QUANTITY CALCULATIONS		
	DIVERSION		
ALINGNMENT	LENGTH	DEPTH OF CUT	VOLUME
GOOSE LAKE	20,000	20	2,370,370
WEST	10,000	55	5,398,148
CENTRAL	12,000	35	3,188,889
AIRPPORT	15,000	25	2,430,556

ASSUMPTIONS:

1. It was assumed that (6) Inlet and Outlet control structures would be needed. One control structure would be used to divert water from the Big Sioux River to Lake Kampeska. Another control would be placed at the inlet to Lake Kampeska and another at the outlet. Pelican Lake would also have control structures at the inlet and outlet as well as a structure located where the common outlet from Pelican Lake enters the Big Sioux River. Costs were based on average costs from similar flood control projects.
2. The Railroad and Highway 212 crossing costs were based on similar channel impacted projects.
3. Excavation quantities for the Central Option between the two lakes are identified above and were generated by USACE technical staff previously exploring this option. The excavation quantities shown at the inlet of Lake Kampeska and the outlet of Pelican Lake were assumed relative to the Central Option quantity calculated above. There is not enough technical information available to pursue the quantities any further at this time. All of the excavated quantities were assumed to be side cast directly beside the excavated channel and compacted with little to no haul. If this option were considered more investigation would need to be conducted as to the ability to dispose of the excavated soil directly adjacent to the channel.
4. It was assumed that 100 acres of land at each of three locations would have to be purchased (the channel between the two lakes, the inlet at Lake Kampeska and the outlet at Pelican Lake). The $20,000/Acre is based on the average cost for that type of land in that area.

VALUE ENGINEERING ALTERNATIVE
Project: Flood Risk Management for Watertown and Vicinity, Watertown, South Dakota

ALTERNATIVE NO: 3.0 **PAGE NO: 1 OF 9**
TITLE: Implement LPWPD Comprehensive Water Resources Management Plan

ORIGINAL DESIGN: Construct the Mahoney Creek Dry Dam; a single large dry dam located on the Big Sioux River just below the confluence with Mahoney Creek. The dam would capture flood waters and meter them out slowly to reduce flood flows through Watertown and vicinity.

PROPOSED DESIGN: Implement the LPWPD Comprehensive Water Resources Management Plan; a collection of 822 small dry impoundments scattered throughout the watershed. Many impoundments would use existing roadway embankments, but about 32 of the impoundments would be newly constructed low-head dams.

ADVANTAGES:

- May eliminate the need for the Mahoney Creek Dry Dam.
- Would reduce some of the sediment load to the Big Sioux River.
- Smaller individual areas of disturbance to construct the project.

DISADVANTAGES:

- Ultimately this alternative would likely not be supported by FEMA.
- Predicting the behavior of such a large complex system of flood risk reduction structures with a reasonable amount of certainty would be very difficult.
- May not reduce peak flows at time needed
- Would likely not be supported by highway departments.
- Each component of the structure (e.g., embankment, conduit, etc.) will need to be designed to meet dam safety criteria.
- Would be difficult to maintain, increasing potential for failure of system.
- Requires substantial cooperation from up to 822 land owners
- Need to investigate and design up to 32 dams that would require state permits
- State wants a plan for entire system, not for each individual dam
- Very costly to verify design
- Overall impacted area is larger than that for Mahoney Dry Dam

COST ASSESSMENT SUMMARY:

	Present Worth Values For:				
COST SUMMARY	**Initial CWE Costs**	**Replacement & Future Costs**	**Salvage Value**	**O&M Costs**	**Total Life Cycle Costs**
Original Concept	$33,675,000	$0	$0	$4,891,000	$38,566,000
Alternative Concept	$80,332,000	$0	$0	$22,834,000	$103,166,000
Savings / (Expense)	($46,657,000)	$0	$0	($17,943,000)	($64,600,000)

DISCUSSION/JUSTIFICATION

The Lake Pelican Water Project District (LPWPD) "Comprehensive Water Resource Management Plan – Big Sioux River Headwaters Study Area" proposes a strategy of restricting and slowing flows and trapping sediment at 822 locations throughout the Upper Big Sioux River tributary area. This alternative proposes to construct 32 small dams/impoundment structures in strategic locations, and modify 790 existing road or bridge crossings to hold back flows in order to accomplish the following objectives as stated in the above referenced report prepared by Barr Engineering:

- Flood and peak flow reductions in the Big Sioux River, especially in and near the City of Watertown and in every basin where retention structures are implemented,
- reductions in the sediment and nutrient loads to the Big Sioux River, Lake Pelican, and Lake Kampeska,
- promotion of groundwater recharge upstream of road crossings and other flow restriction locations,
- improved wildlife habitat and ecological conditions,
- no relocation of homes required as part of implementation,
- protection and improvement of the township, county and state infrastructure, and
- protection of downstream highways from flooding.

In order for this alternative to be feasible, the County and State Highway Authorities must allow roads and bridges to be utilized as impoundment structures, the timing of flow releases must be effectively coordinated to produce the desired result, and FEMA must accept the proposal as a viable flood control method.

Ultimately this alternative would likely not be supported by FEMA. In order for this alternative to be recognized or accepted by FEMA as a means of reducing peak flow values, the flood storage area upstream of each dam or road raise must be entirely dedicated to flood control which necessitates the purchase of the affected property or at a minimum requires a flowage easement in order to guarantee that adequate storage is maintained over the life of the project. Predicting the behavior of such a large complex system of flood risk reduction structures with a reasonable amount of certainty would be very difficult. This approach may not reduce peak flows at time needed; and would likely not be supported by highway departments:

a. In a memorandum dated September 10, 2008 the Federal Highway Administration (FHWA) directed State Departments of Transportation officials (DOTs) to avoid involvement in certification of highway embankments as flood control structures by any entity. The FHWA also discourages any type of retrofit to existing road embankments for flood control purposes. In this memorandum, the FHWA opposes the certification or the designation of highway embankments as part of flood control projects for the following reasons:

DISCUSSION/JUSTIFICATION

- Highway embankments were not originally designed and constructed for (and thus are ill-suited to) performing as a levee or other flood control facility.
- The fill material used in the construction of a typical highway embankment is not a sufficient barrier against water; therefore, a highway embankment is subject to piping, seepage, and infiltration.
- Using highway embankments as part of a flood control project could pose a significant and unacceptable risk to the public; and subjects the DOT and FHWA to an untenable position with respect to costs, liability and damages.
- Typical highway embankment construction does not require the same level of geotechnical engineering analysis as required for flood control structures.
- This would indirectly place the FHWA into a flood control role for its Federal-aid highway program. For nearly all projects, the FHWA does not have the authority to engage in flood control activities.

Each component of the structure (e.g., embankment, conduit, etc.) will need to be designed to meet dam safety criteria.

The ownership and operations and maintenance (O&M) for a large and complex system of small dams is a concern. The owner of a dam is ultimately responsible for all aspects of operation, maintenance, and repair of the dam and appurtenant structures. The owner is also responsible for all associated liability from a failure or uncontrolled loss of water. To minimize the potential risks associated with a dam, the owner must have a comprehensive dam safety program in place. A single robust dam safety organization will be needed to ensure that the necessary inspections and maintenance are performed and repairs and rehabilitations are implemented for the continued safe function of the entire system. A typical dam safety program, which complements the routine operations and maintenance that must be performed, consists of the following:

1. For a typical impoundment that is classified as a dam, the following are required:

- Routine Surveillance and Monitoring
- Instrumentation Data Collection
- Data Management, Reduction & Plotting
- Data Evaluation & Analysis
- Instrument Design/Installation
- General Maintenance to ensure dam safety and ease of inspection
- Instrument Maintenance, if appropriate
- Investigation of Abnormal Data
- Evaluating Proposed Project Modifications for Dam Safety Impacts
- Annual Inspection Program
- Periodic Inspection Program
- Emergency Action Planning
- Dam Safety Training
- Coordination with Federal, State and Local Agencies
- Special Inspections or Studies
- Project Modifications and Repairs

DISCUSSION/JUSTIFICATION

2. For a small impoundment that is not classified as a dam, the following are required:

   - Routine Surveillance and Monitoring
   - Data Evaluation & Analysis
   - General Maintenance to ensure dam safety and ease of inspection
   - Investigation of Abnormal Observations/Data
   - Evaluating Proposed Project Modifications for Dam Safety Impacts
   - Routine Inspection Program
   - Emergency Action Planning
   - Coordination with Federal, State and Local Agencies
   - Special Inspections or Studies
   - Project Modifications and Repairs

822 independent impoundment structures would be difficult to maintain; increasing the potential for failure of parts or all of the system should one significant component or several components of the system be improperly maintained. In addition, this puts a significant financial and manpower burden on the City should it be assigned the responsibility for maintenance.

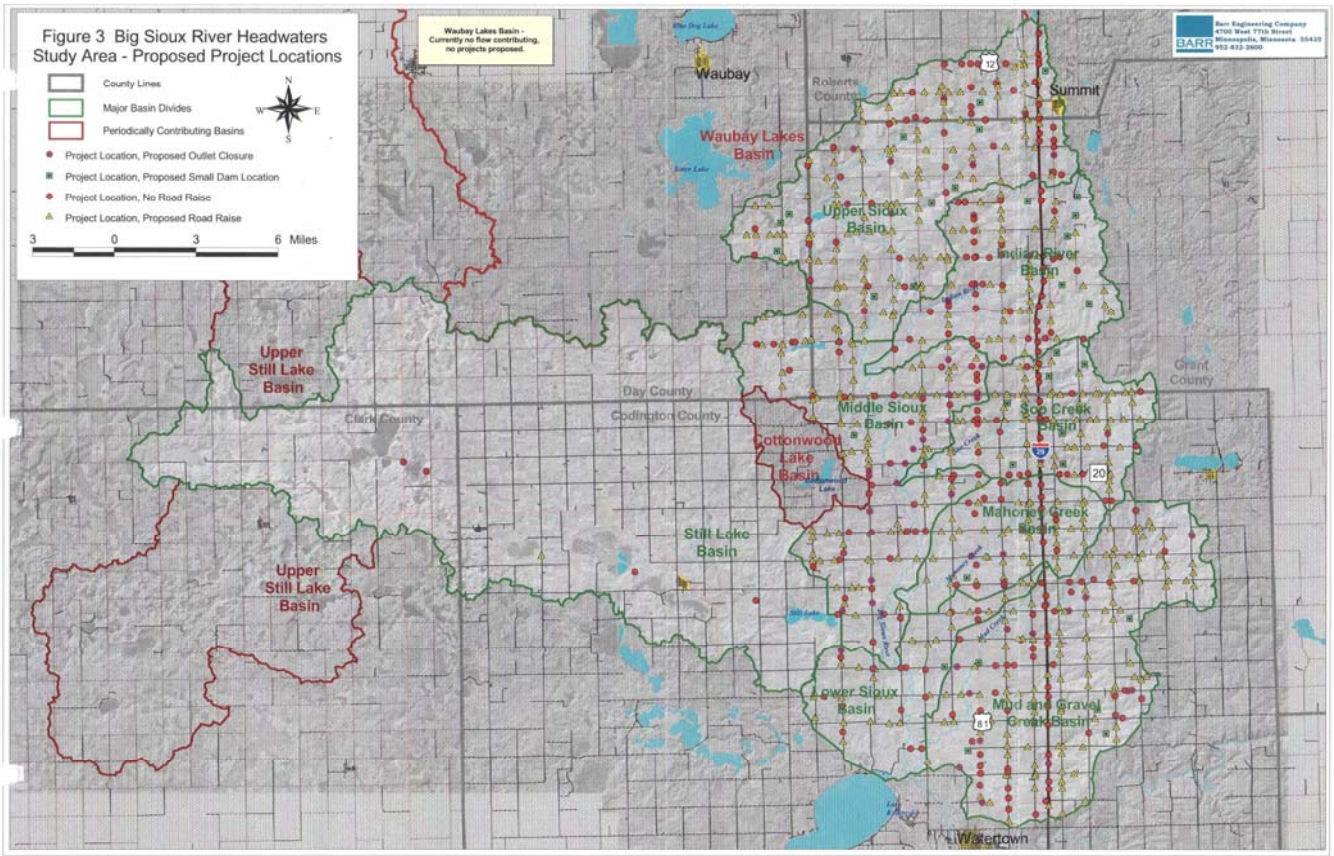
Implementation requires substantial cooperation from up to 822 land owners:

b. In order to incorporate the implementation of the proposed alternative into the NFIP program, the Chief Executive Officer for the community will be required to certify that the necessary storage capacity of each impoundment in the system will be maintained throughout the life of the project according to an established operations and maintenance plan. The necessity to provide an operation and maintenance plan for proposed changes to an altered watercourse is required by law and is set forth in 44 CFR 65.6

The Corps would need to investigate and design up to 32 dams, each requiring state permits. The State wants a plan for entire system, not for each individual dam.

The design for this alternative would be very costly to verify, and overall, the impacted area is larger than that for Mahoney Creek Dry Dam.

DRAWING/SKETCH CURRENT DESIGN



COST ANALYSIS – INITIAL COSTS

CONSTRUCTION ELEMENT		ORIGINAL CONCEPT			ALTERNATIVE CONCEPT		
Description	**Unit**	**Quantity**	**Cost/Unit**	**Total**	**Quantity**	**Cost/Unit**	**Total**
Low-Head Dam	EA			$0	32	$200,000	$6,400,000
Road Raise (Gravel-Surface Road)	EA			$0	437	$25,000	$10,912,500
Road Raise (Paved Road)	EA			$0	49	$50,000	$2,425,000
Culvert Size Reductions	EA			$0	697	$15,000	$10,455,000
New Culvert Installation	EA			$0	34	$25,000	$850,000
Culvert Size Increases	EA			$0	10	$25,000	$250,000
Diversions to Adjacent Crossings	EA			$0	49	$60,000	$2,940,000
Real Estate (Flowage Easement)	AC			$0	16,482	$1,800	$29,668,200
				$0			$0
Mahoney Dam Construction	LS	1	13,866,662.00	$13,866,662			$0
Mahoney Real Estate	LS	1	13,152,150.00	$13,152,150			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
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				$0			$0
				$0			$0
TOTAL CONSTRUCTION COST:				$27,018,812			$63,900,700
Owner Mark-Up Excluding Real Estate	48%			$6,655,998			$16,431,600
TOTAL CWE:				$33,675,000			$80,332,000
						SAVINGS	-$46,657,000

COST ANALYSIS – LIFE CYCLE COSTS

Life Cycle Period 50 Years	Real Discount Rate 2.83%			ORIGINAL	ALTERNATIVE
A. INITIAL COST				$33,675,000	$80,332,000
Service Life-Original 50 Years Service Life-Alternative 50 Years			**INITIAL COST SAVINGS:**		**($46,657,000)**
B. ANNUAL RECCURENT OPERATING, MAINTENANCE & INSPECTION COSTS					
Annual Inspection (3,288 man hrs @ $100.00/hr)					$ 328,800.00
Annual Mowing (16,482 ac @ $25.00/ac)					$ 412,050.00
Annual Inspection (250 man hrs @ $100.00/hr)				$25,000	
Annual Mowing (6,000ac @ $25.00/ac)				$150,000	
			Total Recurrent Costs:	175,000	740,850
			Present Value Factor (P/A):	26.581	26.581
			PRESENT VALUE OF RECCURENT COSTS (Rounded):	**$4,652,000**	**$19,693,000**
C. FUTURE MAJOR MAINTENANCE COSTS	**Year**	**Amount**	**PV Factor (P/F from tables)**	**Present Value**	**Present Value**
Periodic Inspection (500 man hrs every 5 yrs)	5	50,000	0.87	$43,500	
Periodic Inspection (6,576 man hrs every 5 yrs)	5	657,600	0.87		$572,112
Periodic Inspection (500 man hrs every 5 yrs)	10	50,000	0.756	$37,800	
Periodic Inspection (6,576 man hrs every 5 yrs)	10	657,600	0.756		$497,146
Periodic Inspection (500 man hrs every 5 yrs)	15	50,000	0.658	$32,900	
Periodic Inspection (6,576 man hrs every 5 yrs)	15	657,600	0.658		$432,701
Periodic Inspection (500 man hrs every 5 yrs)	20	50,000	0.572	$28,600	
Periodic Inspection (6,576 man hrs every 5 yrs)	20	657,600	0.572		$376,147
Periodic Inspection (500 man hrs every 5 yrs)	25	50,000	0.498	$24,900	
Periodic Inspection (6,576 man hrs every 5 yrs)	25	657,600	0.498		$327,485
Periodic Inspection (500 man hrs every 5 yrs)	30	50,000	0.433	$21,650	
Periodic Inspection (6,576 man hrs every 5 yrs)	30	657,600	0.433		$284,741
Periodic Inspection (500 man hrs every 5 yrs)	35	50,000	0.377	$18,850	
Periodic Inspection (6,576 man hrs every 5 yrs)	35	657,600	0.377		$247,915
Periodic Inspection (500 man hrs every 5 yrs)	40	50,000	0.327	$16,350	
Periodic Inspection (6,576 man hrs every 5 yrs)	40	657,600	0.327		$215,035
Periodic Inspection (500 man hrs every 5 yrs)	45	50,000	0.285	$14,250	
Periodic Inspection (6,576 man hrs every 5 yrs)	45	657,600	0.285		$187,416
				$0	
					$0
				$0	
					$0
				$0	
					$0
			PRESENT VALUE OF FUTURE MAJOR MAINTENANCE (Rounded):	**238,800**	**3,140,698**
D. PRESENT WORTH OF RECURRENT ANNUAL O&M AND FUTURE MAJOR MAINTENANCE COSTS (B+C)				**$4,891,000**	**$22,834,000**
E. TOTAL PRESENT VALUE COST (A+D)				**$38,566,000**	**$103,166,000**

ASSUMPTIONS & CALCULATIONS

1. Low-Head Dam: assumption of $200K per dam based on cost of similar low-head dams included in Sand Creek, NE ecosystem restoration project.

2. Road Raises:
   - Assumed 90% of road raises would be gravel-surface roads and 10% of road raises would be paved roads.
   - Assumed each road raise would be approximately 50 ft long with approximately 100 ft taper on each side, for a total length of 250 ft.
   - 250 ft length x 24 ft width = 6,000 ft^2 / 9 = 667 yd^2.
   - Cost per yd^2 (Includes Road Prep) = $30/$yd^2$ for gravel road. Therefore (667 yd^2 X $30/$yd^2$) = $20,010. For possible unknown structure and miscellaneous costs use $25,000/Road Raise.
   - Cost per yd^2 (Includes Removal) = $65/ yd^2 for paved road. Therefore (667 yd^2 X $65/$yd^2$) = $43,335. For possible unknown structure and miscellaneous costs use $50,000/Road Raise.

3. Culvert Size Changes: Assumed new culvert installation and culvert size increases would both require the same level of effort and that culvert size reductions would require a lower level of effort.

New and Increased Culverts:

48” RCP $200/LF X 36LF		=	$7,200
Headwalls:	(2 EA)	=	$8,000
Surface Remove/Replace 134 yd^2 X $65/$yd^2$		=	$8,710

	TOTAL	=	$23,910
	USE:		$25,000/Culvert

New and Increased Culverts:

24” RCP $60/LF X 36LF		=	$2,160
Headwalls:	(2 EA)	=	$4,000
Surface Remove/Replace 134 yd^2 X $65/$yd^2$		=	$8,710

	TOTAL	=	$14,870
	USE:		$15,000/Culvert

4. Diversions: assumed each diversion would be approximately 1 mile long x 5 ft bottom width x 5 ft deep, with 3 to 1 side slopes, for a total of 528,000 ft^3 = 19,556 yd^3 at $3 per yd^3 = $58,667 ≈ $60,000.

5. Real Estate:
   - Assumed that 822 impoundments would need to retain the same amount of water in the 1% chance event as Mahoney Creek Dry Dam (49,447 acre-ft).
   - Assumed that each impoundment would be inundated to an average depth of 3 ft; therefore, the total surface area of the impoundments would be 16,482 acre.
   - Each impoundment area would require a flowage easement at 80% of appraised value per acre. Current property value is approximately $2,250 per acre, so total cost of flowage easement would be 16,482 acre x 0.8 x $2,250 = $29,667,600.

6. Annual Inspections:
   - Assumed a team of 2 personnel would take 2 hours to inspect each structure. Total inspection time = 2 personnel x 2 hours x 822 structures = 3,288 man hours.
   - Assumed total burdened labor rate of $100 per hour.

7. Annual Mowing: assumed mowing cost of $25 per acre based on City of Watertown Public Works experience.

8. Periodic Inspections:
   - Assumed a team of 4 personnel would take 2 hours to inspect each structure every 5 years. Total inspection time = 4 personnel x 2 hours x 822 structures = 6,576 man hours.
   - Assumed total burdened labor rate of $100 per hour.

VALUE ENGINEERING COMMENTS

INTRODUCTION

In addition to the VE Alternatives presented above, the VE team developed a series of comments or suggestions to address flooding in the Watertown and Vicinity Area, South Dakota. These suggestions present ideas generated by the team that are felt to add value to the project. The VE team encourages the Project Design Team to consider these comments for opportunities to improve the quality of the project. The reader may also find that a review of the comments presented herein will awaken new and/or modified ideas that they may wish to investigate further or implement.

DESIGN COMMENTS

Presented below are the comments put forth by the VE team. It should be noted that, where commonality of thought prevails, speculation ideas have been combined into a single comment.

1. Carry out a public information and outreach effort (Creative Ideas Nos. 9, 24, 34, 61) -

The flood control issue has been controversial in the City of Watertown and Codington County, due to the concern that the needs of the potentially displaced owners have not been adequately considered. The value engineering study involved a neutral and thorough consideration of the benefits and consequences of the alternatives presented, and includes a summary of findings. A public information and outreach effort to convey these findings is listed as an activity which may improve public acceptance of whichever alternative is selected by the community. This effort could include the following elements:

- The City of Watertown could engage a mediator. This would ensure clear communication, avoid misconceptions, improve public buy-in, and keep the community informed of project progress. A professional firm would be proficient in assuring factual representations of the issues and offering opportunities for the community to provide input.
- A computer graphic model could be created to demonstrate how the selected alternative would operate under differing flow conditions for the benefit of the public. The model would illustrate the footprint of the floodplain in a birds-eye view, and could be overlain upon an aerial photo to show inundation at various stages of flooding, both with and without a structure(s) in place. The model would help people to envision the upstream and downstream effects of the selected alternative on the community, and thereby improve understanding.
- A stakeholders advisory group could be formed to bring interested parties together to hear about progress and provide feedback in the process of selecting and implementing one of the proposed alternatives. The advisory group

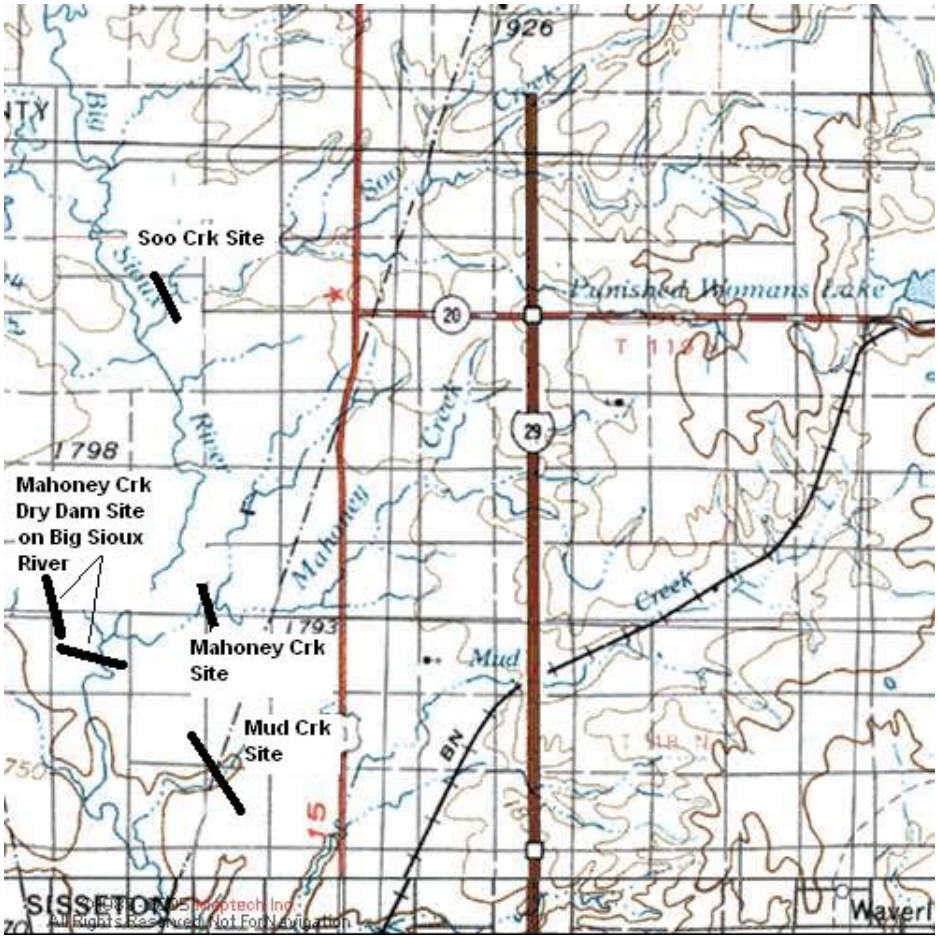
meetings would be a forum for expression and consideration of diverse opinions, and would help to elicit beneficial suggestions and promote consensus.

- The public should be educated about the limits of the selected alternative. For example, if a large dry impoundment/dam near the confluence of the Big Sioux River and Mahoney Creek is selected, it would provide flood protection for events with severity equal to or less than a flood with a 1% chance of occurring within any given year. Impacts from more severe events may occur, and would still cause flooding. It is important that the community understand that each of the alternatives has unique limitations.

Any combination of the listed elements could be incorporated into a public information and outreach effort, with effectiveness improved by each. Although the entire expense would be borne by the City of Watertown, the potential rewards of such an effort are significant.

2. Build 3 to 5 medium-size dry dams instead of or in addition to a single Mahoney Creek Dry Dam (Creative Idea Nos. 17 & 18) -

This recommendation suggests constructing 3 to 5 medium-size dry dams on tributaries to the Big Sioux River located upstream of Watertown, South Dakota. The named tributaries located upstream of Watertown within Codington County are Mud Creek, Mahoney Creek, and Soo Creek. The tentatively selected dam sites for the medium–size dry dams are shown below in comparison to the proposed site for the Mahoney Creek Dry Dam across the Big Sioux River and across an adjacent shallow drainageway. The Mud Creek Tributary enters the Big Sioux River in the vicinity of the inlet to Lake Kampeska.



In general, the disadvantages for this idea outweigh the advantages. However, further studies are needed to develop the details necessary to fully evaluate this alternative. Constructing 3 to 5 medium-size dry dams on the tributaries may provide the capability to manipulate the dam site locations to reduce impacts to landowners.

The drawbacks for this idea are that there may not be 3 to 5 suitable sites within the County to construct medium-size dams on tributaries to the Big Sioux River. More detailed analyses, including thorough review of topographic maps, review of geologic conditions, and estimating water storage volumes, will be required to determine if there are a sufficient number of suitable sites. Also, if the sites are able to provide enough storage volume needed to capture the 1% flood event, the area of inundation may include land occupied by Interstate 29, which is located approximately 5 miles east of the proposed tributary sites.

Having 3 to 5 medium-size dams will increase project maintenance costs compared to one impoundment/dam site on Big Sioux River; however, maintenance costs would be lower than if multiple embankments throughout the basin were used to capture the 1% flood event. The 3 to 5 medium-size dams will increase the number of structures involved, including outlet works, emergency spillways, etc. compared to one dam site.

Another option to consider is to construct 3 to 5 medium-size dry dams in addition to a smaller Mahoney Creek Dry Dam across the Big Sioux River. The plus and minuses for this idea are the same as above, but additional costs will be incurred to construct the dam across the Big Sioux River. The benefit to cost ratio for this increment would be low due to having a wide valley to span and not using the full storage capability when using a lower embankment height.

3. Protect Watertown through a system of levees, floodwalls and/or control structures (Creative Idea Nos. 15, 20, 21, 50, 51) -

Levee systems were evaluated for flood protection for the City of Watertown and Lake Kampeska in the March 2000 General Re-evaluation Report (GRR). The only complete system that protects both the town and lake requires both right and left bank levees, a gated closure structure on the inlet/outlet for Lake Kampeska, and typical closures on six road bridges and two railroad bridges. The levee system must extend to the north past the Lake Kampeska inlet/outlet to prevent flows from flanking the levee and entering the town from the west. The gate on the lake is required for the same reason. Placement of a gate on the inlet/outlet eliminates the effect the lake has on attenuating flood flows, and thus greatly increases the discharges through the town (i.e. 100-year discharge becomes 15,000 cubic feet per second (cfs)). The levee and gate system work together to provide 1% protection with three feet of freeboard.

The right bank levee (looking downstream) starts near the intersection of the former Chicago and Northwestern Railroad track and South Dakota Highway 20. The alignment proceeds to the southeast along the abandoned railroad grade until it reaches the Big Sioux River inlet to Lake Kampeska. A closure structure at this point diverts the flood flows downstream, away from Lake Kampeska. The right bank levee then continues along the old railroad grade toward the southeast until entering the city. The levee then follows along the river until crossing over US Highway 212. The right bank levee is approximately 40,000 feet long and has an average height of six feet.

The left bank levee starts by the Burlington Northern Railroad tracks between 10th Avenue North and 14th Avenue North. The alignment essentially follows the railroad through town until reaching US Highway 212. A 2000-foot section of Highway 212 would be raised to act as the left bank levee. The levee then separates from the highway and proceeds southward for approximately 1500 feet before gradually turning east. The levee continues eastward and ties into high ground near the Chicago and Northwestern Railroad tracks. The total left bank levee is 21,000 feet long and has an average height of six feet. The March 2000 GRR reports the levee and gate system costs in excess of $20.06 million with a benefit to cost ratio of 1.09. Costs not included in this analysis but still applicable to the design of this system include: utility relocations; internal drainage requirement and design; underseepage control; environmental mitigation costs; and the design and construction costs for the closure structure at the Lake Kampeska inlet/outlet.

The plan also causes significant environmental impacts on the Big Sioux River, especially to parks within the city limits. It causes abrupt changes to the transportation system when closures on bridges are in place, induced damages to structures on the riverward sides of the levees, and relocations of residences and/or businesses along the alignments. Flood forecasting measures must be implemented to allow for the Lake Kampeska gate and all other road and railroad closures to be installed with enough lead time so as to prevent damages. There may be some difficulty in constructing “tie-backs” due to the topography.

Floodwalls could be used in place of earthen levees. The alignment, distances, heights, would generally be the same as the earthen levee. Floodwalls are more expensive to construct, but would require less right-of-way. It is unknown how much the reduced real estate acquisition costs would offset the increased construction costs.

Traditional floodwalls are constructed out of concrete. Vinyl sheet piles are available that also perform as floodwalls. The cost of a vinyl sheet pile floodwall is significantly less than a concrete floodwall. Vinyl sheet piling is typically used in floodwalls less than four feet high. The average height of the needed protection for this system is six feet. It is also uncertain how the vinyl sheet pile will perform when subjected to ice or ice jams.

There is an existing system of levees/berms in Watertown. It may be possible to incorporate the existing system into a levee/floodwall protection system. The alignment, distances, heights, would generally be the same as the earthen levee except that the existing levees/berms would be utilized as much as possible. Vinyl sheet piles would be added to the top of the existing levees/berms to provide the needed protection. The height of sheet pile would be reduced from the vinyl sheet pile only alternative by placement on top of the existing berms reducing the cost from the vinyl sheet pile only alternative.

The existing levees/berms are not certified. Certification is an extensive and sometimes expensive process that includes geotechnical and hydrologic evaluation and analysis including borings and material testing. The levees/berms would need to be certified for use in conjunction with any floodwall built on top of them.

It is possible to combine channel improvement/widening with levee protection and/or removing structures from the floodplain. However, channel improvements alternatives were more expensive than the Mahoney Creek Dry Dam alternative; levee construction alternatives were more expensive than the Mahoney Creek Dry Dam alternative; and the removing structures alternative was more expensive than the Mahoney Creek Dry Dam alternative. It is unlikely that any combination of these alternatives can produce a hybrid alternative that is more cost effective than Mahoney Creek Dry Dam.

4. Utilize non-structural methods for flood proofing affected structures within flood prone areas within Watertown and vicinity (Creative Idea No. 3, 19, 45, and 54) -

There are multiple ways of flood proofing structures affected by the 1% annual chance flood. These methods may be used either as a standalone project or in conjunction with other flood control structures such as a dam, levees or bypass channel.

The following is a cursory discussion of the types and cost applied for the VE study (*Flood Proofing – How to Evaluate Your Options*, USACE National

Floodproofing Committee, July 1993 updated using ENR Construction Cost Index):

Assumed average of about 1,500 square feet per structure x 1,400 structures

Elevation of affected structure to the required 1 foot above the base flood elevation:

Wood frame buildings on foundation wall	$32 per square foot
Brick building	$52 per square foot
Slab on grad buildings - 2 foot raise ($1.6/foot above 2 feet)	$48 per square foot

(These costs include foundation, extending utilities and misc items such as sidewalks and driveways, but do not include the cost of fill or landscaping)

Fill includes hauling and compaction	$10 per cubic yard
Landscaping (No trees, brush or shrubs	$10 per cubic yard

Relocation:

Moving buildings (includes hauling and compaction)	$17 per square foot
Moving building	$8 per square foot

(Simple wood frame buildings moved a few hundred feet)

Additional costs for this measure may also include fill, lot, landscaping, and pertinent indirect costs.

Dry Flood Proofing (should not be used for depths of 3 feet or more):

Sprayed-on cement (1/8 inch)	$5 per square foot
Asphalt (2 coats below grade)	$2 per square foot
Periphery drainage	$46 per linear foot
Plumbing check valve	$ 1000 lump sum
Pump submersible	$800 lump sum
Flood Shields	
Wood	$35 per square foot
Metal	$110 per square foot

Example: cost to raise a 34-foot x 42-foot home, the final cost with contractor profit of 10% would be $122,000 for a home with an estimated value of $135,000.

Due to the number of structures affected in the community, elevation and relocation would be cost prohibitive with a total cost that would likely exceed **$150,000,000**. As suggested these measures could be used in conjunction with other structural methods if the number of affected properties were significantly reduced.

5. Increase channel capacity through town by excavating and reducing restrictions (Creative Idea No. 16) -

The floodplain area throughout the City of Watertown could possibly be reduced by increasing the channel capacity throughout town. This could be accomplished by excavating the channel, reducing restrictions such as bridges, clearing away all vegetation in the channel, or any combination of the three. However, there were many disadvantages associated with this alternative. In the 1994 Feasibility Study, it was found that the necessary channel width required to pass the 1% event was 340 feet, assuming an average channel depth of 6 feet. From Google Earth aerial photos, the Big Sioux River channel appears to have a current width between 55 feet and 65 feet throughout town. Increasing the Big Sioux River channel to 340 feet would require significant infrastructure and real estate changes. Many homes and businesses along the river would need to be relocated. Railroad and roadway bridges would need to be

extended significantly. Altering the channel to pass the 1% event seems infeasible for these reasons, but the channel could be altered slightly to improve capacity and used in conjunction with another alternative. Increasing the channel capacity slightly (without requiring railroad and roadway bridge adjustments or significant relocations) could make other alternatives more feasible.

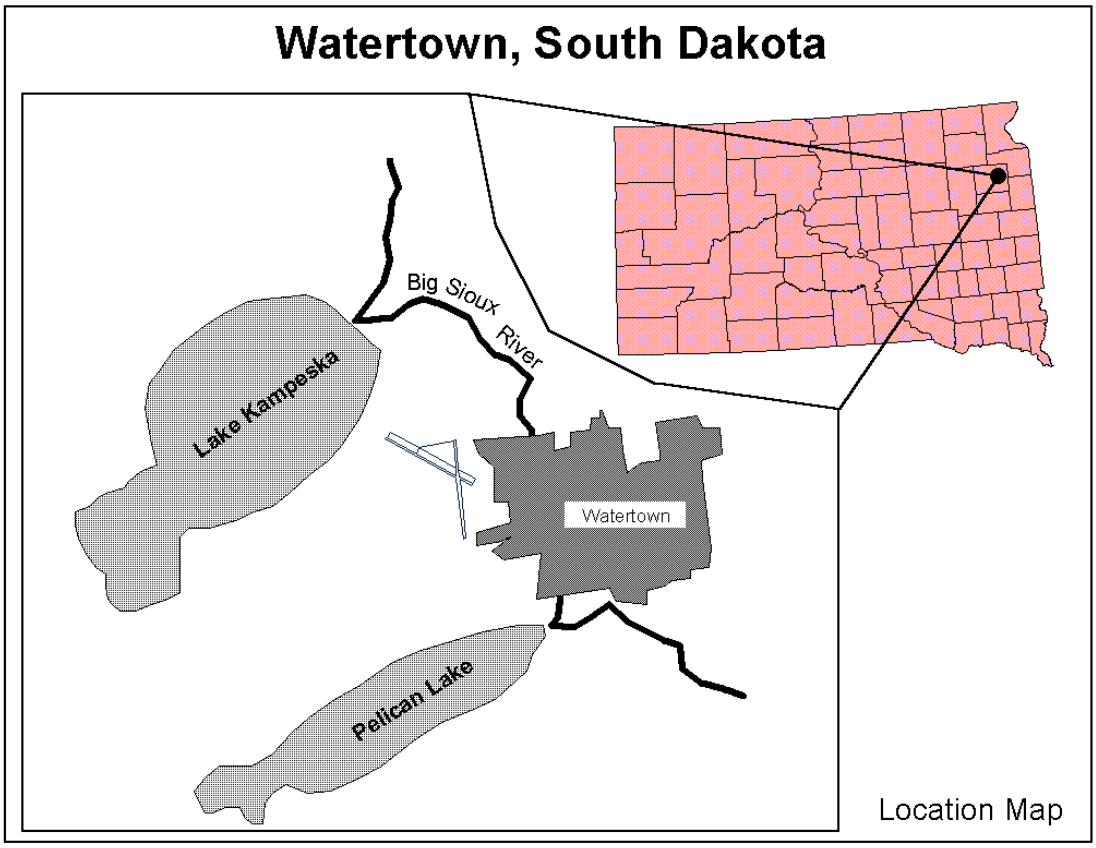
Yellow line indicates a 340-foot channel width

6. Disconnect river from Lake Kampeska and/or Pelican Lake and recharge with well water (Creative Idea No. 59) -

Lake Kampeska and Pelican Lake are natural lakes formed during the glacial period with natural outlets to the Big Sioux River. Low flow weirs were installed to assure water supply to the lakes and prevent quick drainage during extended droughts. The inflows from the Big Sioux River during high water events have the potential of flooding properties and increasing sediment deposits in both Lakes. Disconnecting the Big Sioux River from the two lakes has the potential of reducing flooding on the lakes during high water events while improving the water quality.

Separation of the Big Sioux River inflows from the two lakes may require supplemental water sources to maintain the current pool levels in the lakes. Groundwater wells may be a viable alternative to supplement the lakes natural water supply during extended drought periods. Further investigation may be necessary to determine how much the disconnection at Lake Kampeska would increase Big Sioux River flows through the City of Watertown during high water events. This idea needs to be considered in conjunction with other alternatives such as the construction of the Mahoney Creek Dry Dam. This idea would not be a stand alone solution for the 1% flood event but could reduce partial flooding, supplementing water quality improvements while enhancing the overall integrity of the water resources of the Watertown community. A refined design, construction costs and funding sources will need further investigation to implement such a plan, and would

need to consider the cost associated with installation and maintenance of wells and associated pumps.



7. Increase wetlands in river to reduce contaminants in river under normal flows; assess alternate ways to increase ecological benefits (Creative Idea No. 56) -

While increasing wetlands to reduce contaminants in the Big Sioux River under normal flows and increasing ecological benefits in Lake Kampeska would not provide flood protection to the City of Watertown and the surrounding community, the community would like these issues taken into consideration while developing alternatives. Mitigation is not currently required for this project since no final alternative has been selected yet, but increasing wetlands and ecological benefits would be an excellent mitigation opportunity should mitigation be required once the final design is chosen.

Increasing wetlands in the area above Lake Kampeska could help remove a portion of the sediment load from the river before it reaches the lake. Once the sediment load to Lake Kampeska has been reduced, the lake would need to be dredged to remove the existing deposited sediment and improve the water quality. If any of the alternatives that include impoundments is constructed, much of the sediment load in the river would be captured prior to reaching the lake. In addition, the Mahoney Creek Dry Dam design includes wetland construction immediately downstream of the dam. Water quality and sediment load will be considered in conjunction with all other alternatives as well.

8. Stop studying the issue, make a decision, and construct a project (Creative Idea No. 41) -

The issue of providing flood risk management for Watertown and its vicinity has been studied multiple times by the Corps of Engineers over the past two decades. During that time, the community has experienced two major flood events that caused extensive property damage and disruption. The Corps has recommended the Mahoney Creek Dry Dam project in both its 1994 Feasibility Study and its 2000 General Reevaluation Report (GRR). The Corps is currently engaged in a second GRR in cooperation with the City of Watertown and other local stakeholders, addressing new data associated with recent flooding and incorporating updated hydrologic, economic and floodplain data. This current effort will reevaluate the Mahoney Creek Dry Dam in light of new flood data from 2001 and will also analyze several new alternatives.

If the community were to decide to implement the project recommended by the current GRR, the project could move forward to Design and Implementation, provided it is authorized and funded by Congress. Moving forward in this way would accelerate the implementation of a flood risk management project. Because construction costs generally increase with time, earlier implementation of a project will result in lower project cost. Additionally, the sooner a project is implemented, the less likely it is that the community will be adversely affected by a future flood event. Although some stakeholders will be adversely impacted by any of the alternatives under consideration, the positive effects of implementing an alternative will outweigh the negative impacts.

VALUE ENGINEERING PROCESS

GENERAL

This report section describes the procedures used during the Value Engineering Study. It is followed by the VE Study Agenda

A systematic approach was used in the VE study and the key procedures followed were organized into three distinct parts: (1) pre-study preparation, (2) VE study, and (3) post-study procedures.

PRE-STUDY PREPARATION

In preparation for the VE study, the facilitator (CVS) and VE team members reviewed the project documents provided by the Project Design Team to become better prepared for the study. The project documents consisted of:

- *Feasibility Report and Environmental Assessment, Flood Control for Watertown and Vicinity, South Dakota, U.S. Army Corps of Engineers Omaha District, August 1994.*
- *Big Sioux River Watertown Area, General Re-evaluation Report, U.S. Army Corps of Engineers Omaha District, March 2000.*
- *Draft Upper Big Sioux River Flood Control Project Economic Update, HDR, August 2002.*
- *Lake Pelican Water Project District, Comprehensive Water Resource Management Plan – Big Sioux River Headwaters Study Area, Barr Engineering Company, January 2003.*
- *Watertown, South Dakota Comprehensive Water Resources Management Plan (LPWPD), Big Sioux River Headwaters Study Area, 822 Projects Alternative, U.S. Army Corps of Engineers Omaha District.*
- *Omaha District Review of the Comprehensive Water Resources Management Plan for 822 Retention Structures Alternative near Watertown, South Dakota, U.S. Army Corps of Engineers Omaha District.*
- *Survey for the Presence of Topeka Shiner (Notropis Topeka); A Federally-Listed Endangered species in the Big Sioux River Basin North of Watertown, South Dakota, prepared for the US Army Corps of Engineers Omaha District, by DMA, Inc. and George Cunningham, Eco~centrics, November 17, 2003.*
- *Feasibility Study – General ReEvaluation Existing Conditions Hydrologic Analysis, Draft Report, Big Sioux River at Watertown, South Dakota, Draft Report, U.S. Army Corps of Engineers Omaha District, September 2005.*
- *Watertown GRR Summary of Existing Current EA, U.S. Army Corps of Engineers Omaha District.*

- *Existing Conditions Risk Analysis, Draft Report, Big Sioux River at Watertown, South Dakota, Draft Report, U.S. Army Corps of Engineers Omaha District, September 2005.*
- *Watertown Presentation, Army Corps of Engineers Omaha District, November 19, 2008.*
- *Without Project Conditions Economic Report, Draft Report, Big Sioux River at Watertown, South Dakota, Draft Report, U.S. Army Corps of Engineers Omaha District, January 2009.*
- *Big Sioux River, Watertown and Vicinity, South Dakota, Flood Damage Reduction General Reevaluation Report Project Management Plan, U.S. Army Corps of Engineers Omaha District, January 2009.*
- *Update of Watertown Estimate, U.S. Army Corps of Engineers Omaha District, June 24, 2009.*
- *Watertown and Vicinity Congressional Factsheet, U.S. Army Corps of Engineers Omaha District, August 1994, Updated June 26, 2009.*
- *Miscellaneous Photographs and Maps, U.S. Army Corps of Engineers Omaha District.*

These documents were provided by the Omaha District of the USACE.

VE STUDY

This value engineering workshop was a three-day study effort. The SAVE International Value Engineering job plan was followed, where applicable, to guide the team in developing alternative solutions and recommendations for consideration in resolving and managing the issues and problems associated with flooding in Watertown and Vicinity, South Dakota.

The standard, five job plan phases are:

- Information Phase (including Function Analysis)
- Creative Phase
- Evaluation Phase
- Development Phase
- Presentation Phase

Information Phase

At the beginning of the VE study, discussions by the project manager for the USACE in Omaha presented a more detailed review of the issues associated with providing flood damage reduction in the Watertown and Vicinity, South Dakota, and the alternatives being considered for reducing flooding problems. A field trip was not conducted of the project area. The presentation, and opportunity to obtain responses to questions, further enhanced the VE team's knowledge and understanding of the issues. The discussion clarified many questions of the VE team allowing the team to focus on developing alternatives for addressing and managing the issues and problems associated with 1% level flood protection in the community of the Watertown and Vicinity, South Dakota.

During this phase, the VE team further defined the project goals, key criteria, critical issues and project constraints during the information phase of the study (see **Appendix A**). This phase culminated in the team defining project functions and developing a Function Analysis System Technique (FAST) diagram (see **Appendix D**).

Creative Phase

This VE study phase involved identifying and listing creative ideas. During this phase, the VE team participated in a brainstorming session to identify as many means as possible to provide the necessary functions within the project. Judgment of the ideas was not permitted at this point. The VE team looked for a large quantity of ideas and association of ideas. The project functions developed by the VE team are listed in **Appendix D**.

The creative idea worksheets listing all ideas suggested during the study are provided in this report (see **Appendix E**). This list should be reviewed, since it may contain ideas that are worthy of further evaluation, and may be used as the problem solutions develop. These ideas could also help stimulate additional ideas by others.

Evaluation Phase

The purpose of the evaluation phase was to systematically reduce/combine the large number of ideas generated during the creative phase to a number of concepts/alternatives that appear promising in meeting the project objectives. The key criteria against which the ideas need to be evaluated were identified as Area of Coverage, Public Acceptance, Cost Effectiveness, Time Impacts and Reliability. Once each idea was fully evaluated, it was rated.

Based upon the rating, ideas rated positively where the VE team could assess significant impacts were developed further into Value Engineering Alternatives, and documented on the Value Engineering Alternative forms. Additional positive ideas, which are offered to the USACE and stakeholders, were written as Design Suggestions. The balance of the ideas that were found to add no value to resolving the issues were dropped from further consideration.

Development Phase

During the development phase, each idea was expanded into a workable solution. The development consisted of the recommended alternatives and a brief narrative describing the justification for the proposed alternatives. A cost estimate for this project was available to the VE team. The alternatives are included in the VE Alternatives section of this report.

Presentation Phase

The VE study concluded with a preliminary presentation of the VE alternatives that have been developed, along with a list of those ideas or combination of ideas that the VE team believed offered the most value to the stakeholders. This provides others impacted by the results of the study with an opportunity to preview the alternatives and develop an understanding of the rationale behind them.

GeoVal Inc.

Flood Control for Watertown and Vicinity, Watertown, South Dakota

U.S. Army Corps of Engineers - Omaha District

VE STUDY AGENDA

Wednesday, July 22nd

8:00 VE Team Setup
8:15 Introductions (All) and VE Agenda Review (VE Team Leader)
8:30 Project Overview, (Project Manager and Engineers)
10:15 Break
10:30 Stakeholder Issues and Concerns
11:30 Lunch
12:30 Performance Attribute Development and Analysis of Design Alternatives
2:00 Review Cost Estimate
2:30 Function Analysis/FAST Diagram
3:30 Team Brainstorming

Thursday, July 23rd

8:00 Team Brainstorming (Continued)
10:15 Break
10:30 Evaluation of Ideas
12:00 Lunch
1:00 Evaluation of Ideas, Team Assignments for Development
2:00 Alternative Development

Friday, July 24th

8:00 Alternative Development (Continued)
10:15 Break
10:30 Group Review and Ranking of VE Alternatives/Strategies; Presentation Preparation
12:00 Lunch
1:00 Finalize Alternatives and Prepare Presentation
2:00 ***Presentation of VE Alternatives Meeting***
(Presentation of VE Study Results to Management and Stakeholders)

PROJECT DESCRIPTION, PROJECT CONSTRAINTS AND CRITICAL ISSUES

PROJECT DESCRIPTION

The study area is Watertown and its vicinity, which is located in Codington County, South Dakota in the northeastern part of the state. The area includes the Big Sioux River, Lake Kampeska, and Lake Pelican, as shown on Figure 1.

The Big Sioux River basin originates in northeastern South Dakota, and has a length of 210 miles and a maximum width of 75 miles. It has a drainage area of 9,006 square miles, 6,150 square miles of which are located in South Dakota. The upper portion of the Big Sioux River is broad, largely without alluvial bottoms and bordering bluffs. The upper basin has a channel slope of approximately one foot per mile, while the average slope in the Watertown vicinity is seven feet per mile. The drainage area of the Big Sioux River (including Willow Creek) upstream from Watertown is 1,902 square miles, 1,391 square miles of which are usually non-contributing (213 square miles of the non-contributing area contributed runoff starting in 1994).

Lake Kampeska is a natural lake formed during the glacial period with a natural outlet to the Big Sioux River. The lake is located approximately two miles northwest of Watertown near the confluence of the Big Sioux River and Mud Creek. It has a normal water surface area of approximately 4,800 acres. Its maximum depth is 16 feet at a full pool of 1,717.8 feet above mean sea level (msl), with an average depth of 10 feet. A low weir has been installed in the channel between the lake and the Big Sioux River to ensure a water supply to the lake and to prevent it from draining too quickly during extended droughts.

Lake Pelican is also a natural, glacially formed lake, and it also has a natural outlet to the Big Sioux River. The lake is located approximately one mile southwest of Watertown just upstream of the confluence of the Big Sioux River and Willow Creek. It has a normal water surface area of approximately 2,800 acres. Its maximum depth is seven feet at a normal pool of 1,708 feet msl, with an average depth of six feet. As with Lake Kampeska, the Lake Pelican elevation is controlled by a weir, which diverts flows into the lake and also controls outflows.

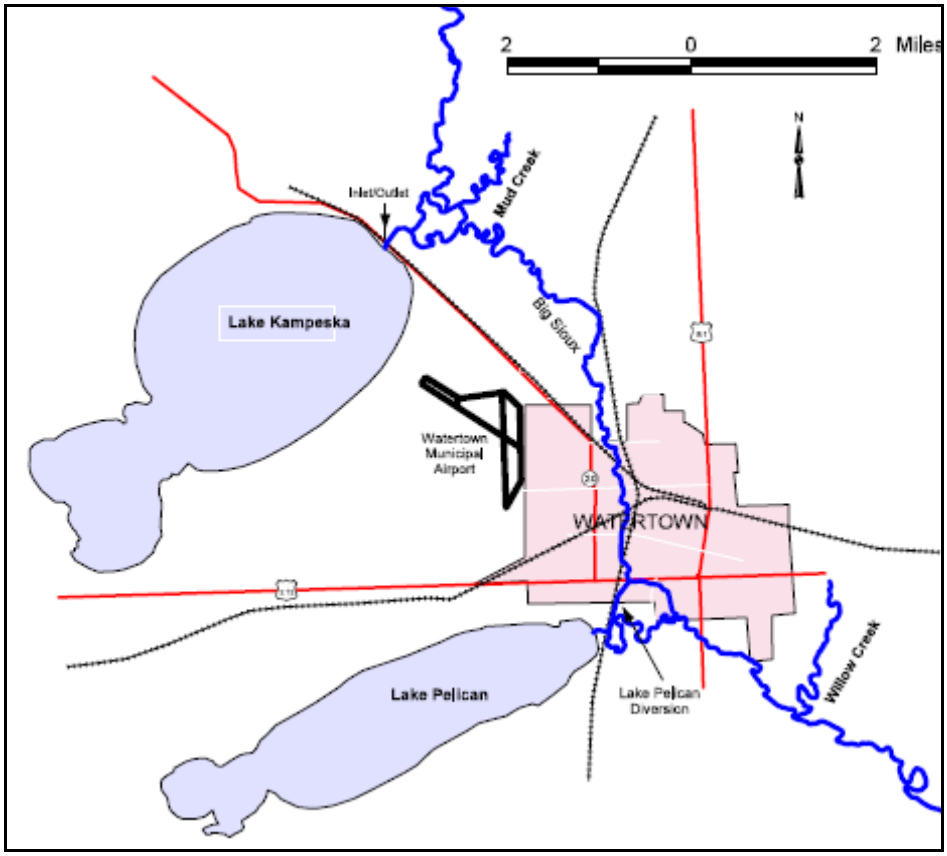


Figure 1 - Project Map for Watertown, South Dakota Flood Control Project

FEMA Floodplain Designation

A recent upgrade of the FEMA floodplain map for the community detailing the anticipated location of areas that might be inundated by the 1% flood event is shown as an overlay to an aerial photograph in Figure 2 below. As a result of this recent upgrade to the maps, a significant number of additional properties are now impacted by being located within the 1% floodplain.

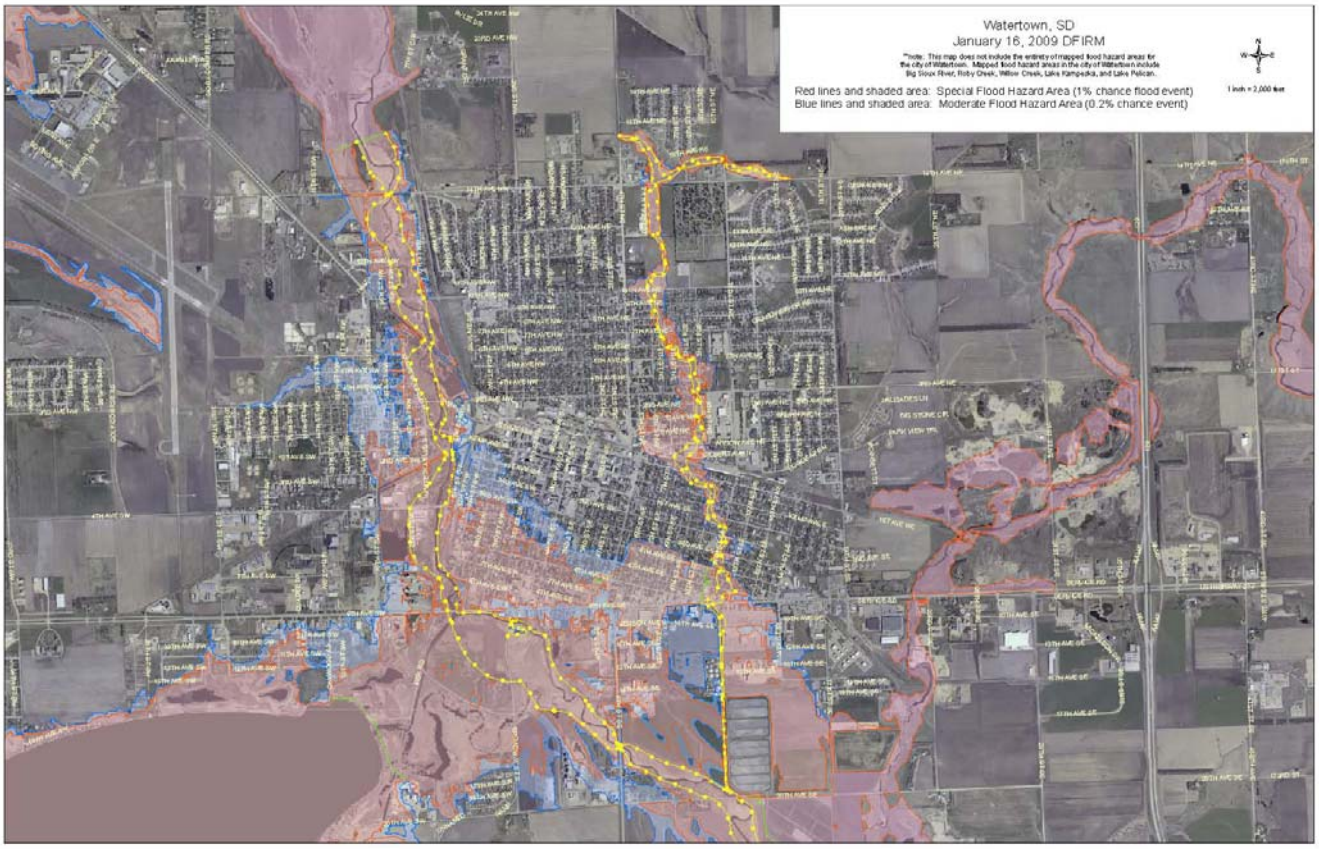


Figure 2 – FEMA 1% Floodplain for Watertown, South Dakota

Study Background

A Feasibility Study (FS) and Environmental Assessment (EA) for the project, completed in 1994, recommended implementation of the Mahoney Creek Dry Dam (referred to as the Upper Big Sioux River Flood Control Project by the City of Watertown (City)), which was included in the House Version of the 1996 Water Resources Development Act (WRDA). The dam was withdrawn from the WRDA due to lack of local support.

After severe flooding in 1997, the City requested that the Corps evaluate alternatives to the Mahoney Creek Dry Dam. The Corps completed a GRR for the Project in 2000 that again recommended implementation of the dam. However, due to lack of local support, the dam was not implemented. After severe flooding in 2001, the City again requested that the Corps reopen the study, and the Corps began work on the current GRR in 2003.

Work on the GRR was halted in 2006 and 2007 due to lack of Federal funding, but was resumed in 2008 when additional Federal funds were allocated to the project. The location of the proposed Mahoney Creek Dry Dam is shown in Figures 3 and 4.

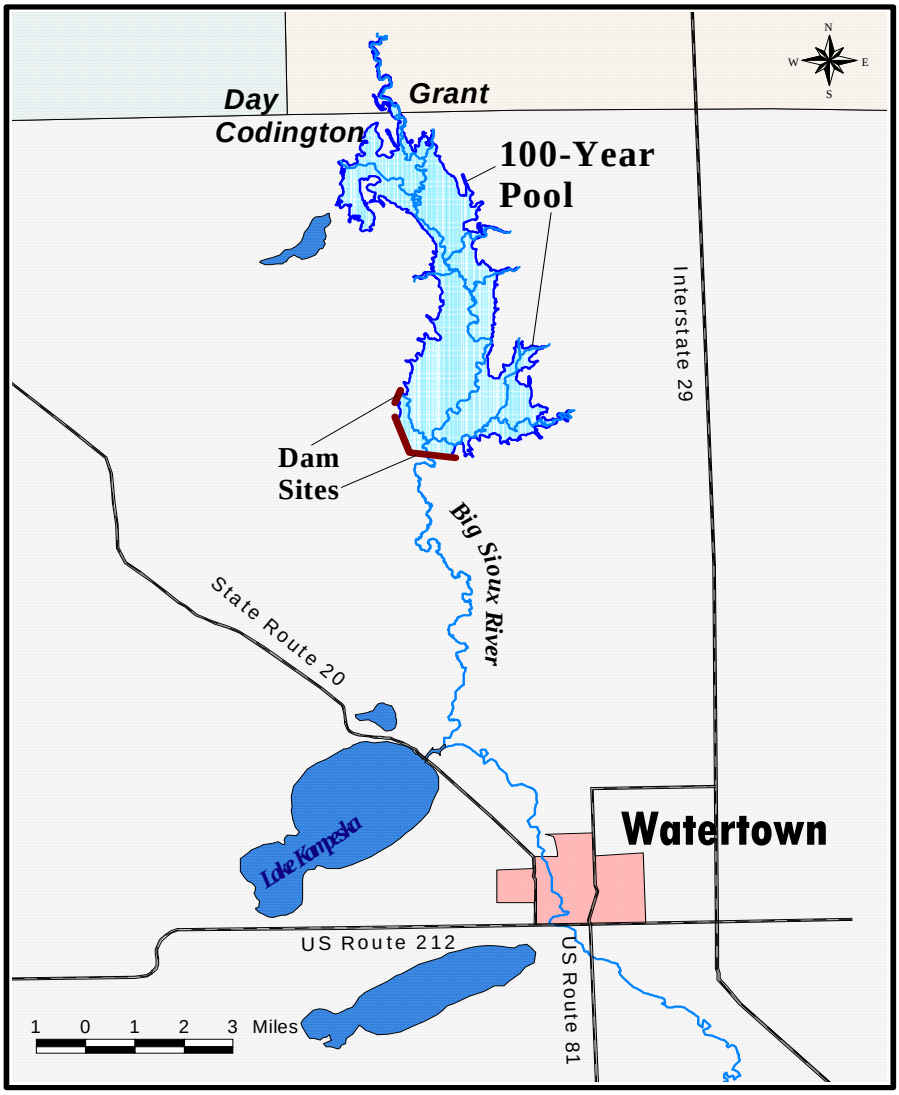


Figure 3 - General Location of Proposed Mahoney Creek Dry Dam North of Watertown, South Dakota

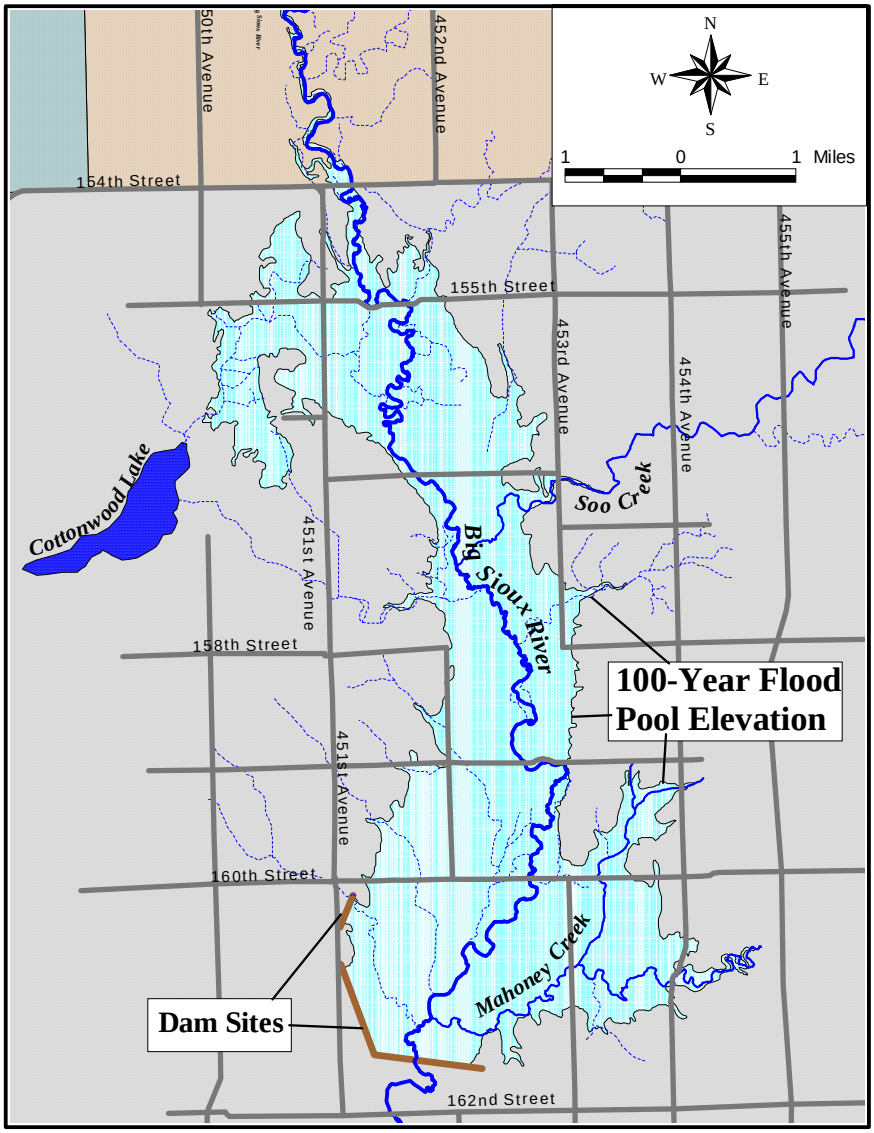


Figure 4 - 100-Year Flood Pool Elevation Map for Mahoney Creek Dry Dam

The Mahoney Creek Dry Dam project has faced considerable local opposition in the past, which has prevented its implementation. In late 2008, the City requested that the Corps expand the scope of the GRR to include evaluation of a flood damage reduction alternative proposed by the Lake Pelican Water Project District (LPWPD), a local stakeholder group. The LPWPD's proposal is intended to overcome local opposition to implementation of a flood damage reduction

project. Through discussions with the City and the LPWPD, the Corps has determined that it will evaluate the LPWPD proposal, as well as two other previously unevaluated alternatives, in the GRR.

The purpose of the project – flood damage reduction for Watertown and its vicinity – has not changed. The PMP recognizes that considerable work for the GRR has already been completed under the previous PMP. The primary reason for updating the PMP is to reflect the expanded scope of the GRR, assess changed conditions such as those brought about by the latest FEMA 1% floodplain map, and to establish a collaborative approach to the project that will help build local consensus on implementation of a flood damage reduction project.

Project Alternatives

Since the first feasibility assessment completed in 1994, numerous alternatives have been evaluated. These include:

- Floodplain Management
- Flood Proofing
- Relocations
- Channel Improvements
- Levees
- Diversions
- Reservoirs (including Mahoney Creek Dry Dam)

After careful review and consideration of potential project costs, several alternatives were removed from further consideration because of their ineffectiveness and/or economic infeasibility. This has left four primary alternatives still under consideration as part of the current GRR/EA.

- Mahoney Creek Dry Dam Re-evaluation
- 3-5 Medium-Sized Dams
- Lake Pelican Water Project District (LPWPD) “822-Projects” Proposal
- Diversion between Lakes Kampeska & Pelican

PROJECT CONSTRAINTS AND CRITICAL ISSUES

The VE team identified the following critical issues and project constraints during the information gathering phase of the study. This information was used to guide the function analysis and speculation phases of the workshop.

Project Constraints:

- None apparent

Critical Issues:

- Cut off trench beneath dam for under-seepage control (stability) would block most of the groundwater flow to the south and may impact wells on farms.
- Objections exist from local land owners regarding the Mahoney Creek Dry Dam alternative.
- Project does not address all of the impacts from floods larger than the 1% event.
- Not certain if the project will have a Benefit Cost Ratio (BCR) greater than 1.0, which would be required for congressional authorization of federal funding.
- Dam breach analysis needs to be done for any alternative that contains a dam.
- FEMA needs to buy into the selected alternative.
- Highway departments need to buy into the selected alternative if roads are impacted or designated as an impoundment embankment.
- Any change in water flow near the airport needs to consider potential future impacts from birds.
- Diversion of water to Lakes Kampeska and Pelican could adversely impact water quality.
- Relief from expanded requirement for flood insurance is an issue.
- Topography is flat, there is a lack of adequate slope to permit efficient diversion of water between lakes or around Watertown.
- Removal of sediment from lakes to increase capacity would require lowering pool (pump station) prior to flood event so that storage would be available when needed; also need to avoid potential for a higher pool during a flood event.
- Need to determine how much additional water (pool elevation rise) each lake could handle without risk of flooding adjacent property or creating wind wave damage.

- Any recommended alternative must include a feasible O&M plan.

- Mahoney Creek Dry Dam may impact more than one county at the 1% impoundment level (Note: current full impoundment elevation is less than 1775 feet which should contain the temporary flood pool within Codington County).
- May need to mitigate for some cultural sites located near Mahoney Creek Dry Dam footprint; this may be an issue at other potential dam sites as well.
- USFWS has approved Mahoney Creek Dry Dam for Topeka Shiner; but this is not currently the case for any of the other alternatives.
- Additional geotechnical investigations are needed for Mahoney Creek Dry Dam once approval to access property is obtained.
- Some alternatives may impact existing wetlands requiring mitigation.
- A fish rearing pond/area/habitat is proposed south of the Mahoney Creek Dry Dam alternative for aquatic mitigation; terrestrial plantings are also proposed.
- Site constraints limit the height of the embankment and width of the spillway proposed for Mahoney Creek Dry Dam (can achieve 1% but may not be able to go much larger).
- Need to consider impacts of ice on lakes if there is an early snow melt.
- Given regions flat topography, there may not be 3 to 5 suitable sites for small to medium dams.
- There is some question as to whether there are actual suitable sites within the “LPWPD 822” plan.
- Timing and volume of flow may overwhelm the intended capacity of the “LPWPD 822” Plan, or for the “3-5 Medium-Sized Dams” alternative.
- A diversion plan would have a large impact on utilities and other infrastructure (railroads and highways).
- Feasibility of non-structural solutions is limited by cost as related to number of structures impacted.
- Need to assess real estate costs and title issues that would impact feasibility of using levees.
- Flat topography makes levee tie-offs a difficult design issue.
- Impacts to fish and wildlife needs to be considered if lake levels are altered.
- Fish kills under current lake conditions is a problem that could be further impacted by altering lake levels.
- Existing road crossings in the proposed Mahoney Creek Dry Dam impoundment (up to 12 of which are 2 abandoned railroad bridges) may be flooded and possibly damaged during a flood event.
- Need to assure that project complies with zoning requirements.

VE COST ASSUMPTIONS

The VE Team was provided with preliminary/planning level cost estimate for the Mahoney Creek Dry Dam alternative to use as a guide in making the general comparisons associated with individual alternatives. The VE team did not make any judgments as to the accuracy or completeness of the estimate, with the exception of the cost associated with real estate. The current total project cost estimate is $23,748,328.

The VE team evaluated this estimate and was of the opinion that the costs associated with real estate requirements were too low. Assuming a cost per acre of $2,250 for fee purchase (1,122 acres) and $1,800 for flow easement (4,878 acres) along with $205,000 per household (9 households) for purchase and relocation, the real estate costs are assumed to be approximately $13,152,150. This would increase the overall project cost to about $33,650,000. This revised estimate was used by the VE team as the baseline estimate for comparing all other alternatives.

The 22-page, Level 2 (with detail) cost estimate was provided to the team; however, it is lengthy and not reproduced in this report. The values used in this estimate (unit and lump sum), once revised for the higher real estate costs, were also used in the proposal cost estimates, supplemented by information provided by suppliers, contractors and/or available from similar applications revealed in other value engineering studies or completed projects, where needed.

Proposal cost estimates compare *relative* items of the current baseline alternative (assumed to be the Mahoney Creek Dry Dam in this study) and a proposed alternative for the sole purpose of estimating the net difference between the two options. In several cases, the estimates do *not* include the total feature cost but only those components that are changed by the proposal.

A cost model for the Mahoney Creek Dry Dam baseline alternative, showing how the individual cost items in the preliminary estimate was prepared, is reproduced below. This model shows that over 68% of the project costs are contained in three major items: common excavation for the spillway and embankment and trench fill for the main and secondary dams.

COST HISTOGRAM- Project Cost

PROJECT: Mahoney Creek Dry Dam Alternative, Watertown, South Dakota
ORIGINAL ESTIMATE

PROJECT ELEMENT		COST	PERCENT	CUMULATIVE PERCENT
Spillway - Common Excavation		$ 5,156,441.84	37.19%	37.19%
Main & Secondary Dams - Embankment Fill Imperivious, Pervious, Random		$ 2,851,012.98	20.56%	57.75%
Main & Secondary Dams - Trench Fill Impervious + Pervious		$ 1,481,513.43	10.68%	68.43%
Electrical Removal + New Work		$ 515,715.83	3.72%	72.15%
Environmental Features		$ 445,499.07	3.21%	75.36%
Main & Secondary Dams - Excavation Trench		$ 432,350.72	3.12%	78.48%
Roadway Embankment Fill		$ 354,595.42	2.56%	81.04%
Spillway - Topsoil		$ 338,560.72	2.44%	83.48%
Main & Secondary Dams - Dewatering		$ 317,318.97	2.29%	85.77%
Spillway - Soil Cement		$ 292,084.12	2.11%	87.87%
Main & Secondary Dams - Topsoil		$ 253,839.08	1.83%	89.70%
Spillway - Stripping		$ 243,836.65	1.76%	91.46%
Spillway - Fill		$ 188,945.00	1.36%	92.82%
Main & Secondary Dams - Stripping		$ 182,818.82	1.32%	94.14%
Roadway Gravel Surfacing		$ 100,469.00	0.72%	94.87%
Spillway - Seeding		$ 96,464.97	0.70%	95.56%
Main & Secondary Dams - Crest Surfacing		$ 93,126.35	0.67%	96.24%
Outlet Works Conduit (60"D.)		$ 92,458.76	0.67%	96.90%
Dike Across Drainway		$ 92,081.43	0.66%	97.57%
Main & Secondary Dams - Seeding		$ 73,110.29	0.53%	98.09%
Outlet Works Earthwork - Backfill Impervious		$ 52,921.80	0.38%	98.47%
Care & Diversion of Water		$ 40,545.05	0.29%	98.77%
Main & Secondary Dams - Clearing & Grubbing		$ 36,153.10	0.26%	99.03%
Stilling Basin		$ 35,057.25	0.25%	99.28%
Spillway - Clearing & Grubbing		$ 30,575.76	0.22%	99.50%
Outlet Works Earthwork - Riprap		$ 24,239.77	0.17%	99.68%
Outlet Works Earthwork - Trench Excavation		$ 21,062.75	0.15%	99.83%
Outlet Works Conduit (24"D.)		$ 9,940.31	0.07%	99.90%
Roadway Culvert		$ 7,962.00	0.06%	99.96%
Main & Secondary Dams - Spalls		$ 4,657.82	0.03%	99.99%
Outlet Works Earthwork - Topsoil		$ 1,303.41	0.01%	100.00%
	Subtotal Contract Cost	**$ 13,866,662**	**100.00%**	
E&D	**LS**	**$ 1,315,000**		
S&A	**LS**	**$ 1,217,000**		
Land & Damages	**LS**	**$ 3,250,000**		
	Total Contract Cost	**$ 19,648,662**		
Contingency	**25%**	**$ 4,099,666**		
	PROJECT COST	**$ 23,748,328**	**Comp Mark-up:**	48%

COST HISTOGRAM- Project Cost

PROJECT: Mahoney Creek Dry Dam Alternative, Watertown, South Dakota
INCREASED REAL ESTATE ESTIMATE

PROJECT ELEMENT		COST	PERCENT	CUMULATIVE PERCENT
Spillway - Common Excavation		$ 5,156,441.84	37.19%	37.19%
Main & Secondary Dams - Embankment Fill Imperivious, Pervious, Random		$ 2,851,012.98	20.56%	57.75%
Main & Secondary Dams - Trench Fill Impervious + Pervious		$ 1,481,513.43	10.68%	68.43%
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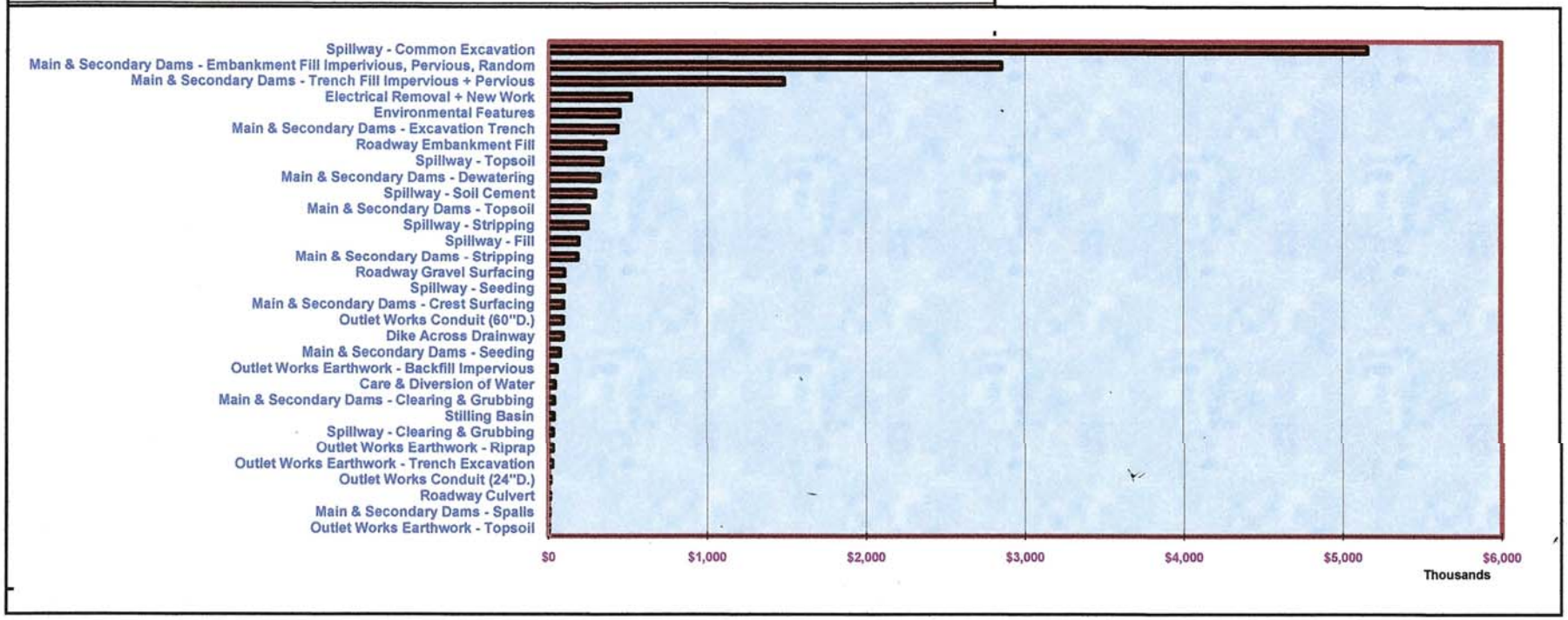
Main & Secondary Dams - Spalls		$ 4,657.82	0.03%	99.99%
Outlet Works Earthwork - Topsoil		$ 1,303.41	0.01%	100.00%
	Subtotal Contract Cost	**$ 13,866,662**	**100.00%**	
E&D	**LS**	**$ 1,315,000**		
S&A	**LS**	**$ 1,217,000**		
Land & Damages	**LS**	**$ 13,152,150**		
	Total Contract Cost	**$ 29,550,812**		
Contingency	**25%**	**$ 4,099,666**		
	PROJECT COST	**$ 33,650,478**	**Comp Mark-up:**	48%

COST HISTOGRAM- Project Cost

PROJECT: Mahoney Dry Dam Alternative, Watertown, South Dakota



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Flood Control for Watertown and Vicinity, Watertown, South Dakota

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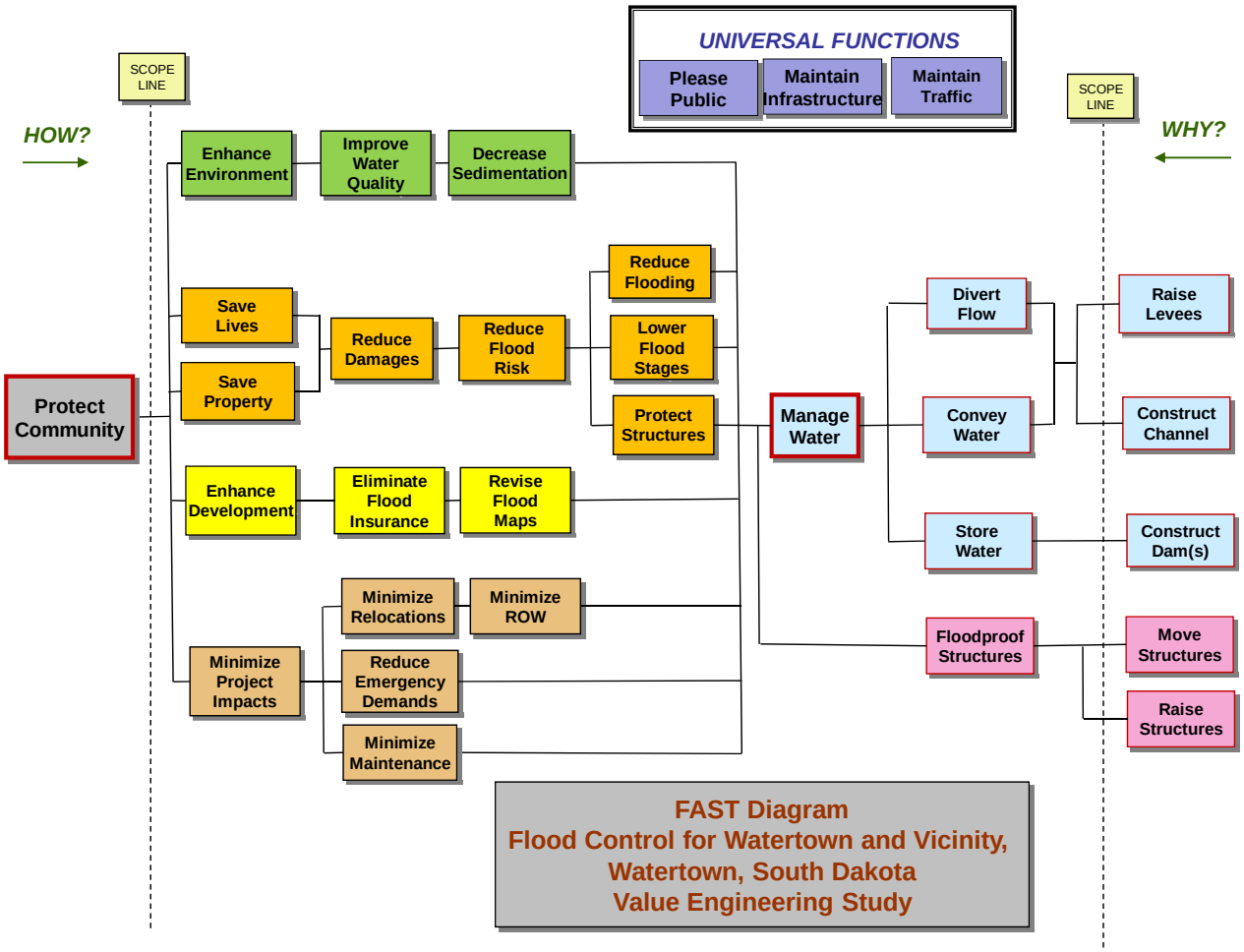
FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM

PROJECT FUNCTIONS

- Reduce Flooding
- Lower Flood Stages
- Manage Water
- Protect Structures
- Maintain Traffic
- Reduce Damages
- Please Public
- Save Lives
- Save Property
- Reduce Flood Risk
- Enhance Development
- Convey Water
- Maintain Infrastructure
- Span Creek
- Revise Flood-maps
- Enhance Environment
- Eliminate Flood Insurance
- Store Water
- Minimize Project Impacts
- Decrease Sedimentation
- Improve Water Quality
- Divert Flow
- Construct Dam
- Raise Levees
- Construct Channels
- Reduce Emergency Demands
- Minimize Maintenance
- Minimize Relocations
- Minimize ROW
- Protect Community
- Floodproof Structures
- Move Structures
- Raise Structures


UNIVERSAL FUNCTIONS
Please Public
Maintain Infrastructure
Maintain Traffic
SCOPE LINE
SCOPE LINE
HOW?
WHY?
Protect Community
Enhance Environment
Improve Water Quality
Decrease Sedimentation
Save Lives
Save Property
Reduce Damages
Reduce Flood Risk
Reduce Flooding
Lower Flood Stages
Protect Structures
Enhance Development
Eliminate Flood Insurance
Revise Flood Maps
Minimize Project Impacts
Minimize Relocations
Minimize ROW
Reduce Emergency Demands
Minimize Maintenance
Manage Water
Divert Flow
Convey Water
Store Water
Floodproof Structures
Raise Levees
Construct Channel
Construct Dam(s)
Move Structures
Raise Structures
FAST Diagram
Flood Control for Watertown and Vicinity,
Watertown, South Dakota
Value Engineering Study

SPECULATION LIST/ IDEA EVALUATION

The list of ideas created during the speculation phase of the workshop was recorded by the team facilitator. The Idea Evaluation Form containing all of the ideas, and the rating method applied to each idea, is presented in the following pages.

Those ideas that were considered by the team to be feasible were then assigned a recommendation for development as follows:

- P = Proposal
- C = Comment
- BD = Being Done
- X = Rejected or Outside Project Scope

In evaluating the suggestions during the development phase, each writer then expressed the advantages and disadvantages in the individual suggestions to better describe the characteristics of the alternative. The reader is encouraged to read each suggestion independently for complete information.

The reader will note that, as the evaluation process proceeded, many of the ideas were found to have common themes, and were therefore combined.

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
1	Build Mahoney Creek Dry Dam	• Eliminates 1% flood from vicinity • Protects most property/people • Reduces overall sediment below dam that enters lakes • Simple concept with single major component and not structures or gates • Proven technology; and acceptable to FEMA • Straightforward maintenance at minimal cost • Good construction materials nearby • Direct impacts to residents is minimal • Passed environmental review • ~2002 election supported this alternative	♦ Opposition from impacted land owners and LPWPD ♦ Dam is located in the County may require use of eminent domain; and those impacted by construction do not benefit from project ♦ Forms physical barrier in river to fish passage ♦ Cutoff trench, if built, may cut off groundwater flow to the south impacting wells ♦ During inundation, concern for rising groundwater ♦ May be considered poor aesthetic ♦ May impact some roads and railroads in pool area	P
2	Relocate Watertown outside flood zone	• Eliminates floodplain issue	♦ Not practical or cost effective	X

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
3	Raise structures within flood prone areas within Watertown and vicinity	♦ Eliminates floodplain insurance need	♦ Does not appear to be cost effective for the number of structures involved ♦ May have to be repeated if FEMA alters floodplain map in the future ♦ May lose use of basements	C
4	Divert water from Lake Kampeska and Pelican lake back to the Big Sioux River	• Water in channels would only be temporary during flood event; should not increase attraction to birds • Reduces size of required dam upstream and may eliminate need for dam	• FAA would need to approve concept due to concern over birds • Concern if lakes are iced over during flood blocking flow • Does not address increased sediment to lakes and reduced water quality and may exasperate the problem • Requires a number of structures to control flow • May not be a stand-alone solution • Need to address railroad trestle and highway bridge; plus other structures	P

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
5	Replace Mahoney Creek Dry Dam with a new dam further up river	• May not impact current landowners opposing project • In general, same as Mahoney Creek Dry Dam, but somewhat less effective	• Impact Grant County • Requires a longer embankment for the wider valley for impoundment • New landowners may be impacted	X
6	Replace Mahoney Creek Dry Dam with a new dam further down river, but above Lake Kampeska	• May trap more sediment • Would likely not impact Grant County • May be able to share structure with an east bypass channel • In general, same as Mahoney Creek Dry Dam	• More land owners likely impacted • No hydraulic advantage • Real estate is likely more expensive closer to town • May require longer dam due to flatter topography	X

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
7	Divert water to the east of Watertown	• May lessen size of or eliminate Mahoney Creek Dry Dam • Use Willow Creek as part of channel diversion • Eliminates floodplain issue • Helps with water quality in lakes • Eliminates concerns of landowner at Mahoney Creek Dry Dam site • Proven technology • Would likely be acceptable to FEMA • Could take advantage of lack of current development in area of Willow Creek	• Lot of dirt to move and dispose of • Lots of impacted utilities/infrastructure • May impact numerous landowners along project alignment • Requires diversion structures • Need to cut through up to 80' of material, for a distance of a couple of miles, to get down to river invert elevation • Does not appear to be cost effective	X
8	Create off channel storage closer to town but upstream of Lake Kampeska	• Eliminates on-river dam • Eliminates concerns of landowner at Mahoney Creek Dry Dam site • Could better control areas to be inundated • Closer to town so better efficiency	• Need control structures • May impact other landowners • Depth limited by distance to groundwater which may increase required impoundment area (several times that needed for Mahoney Creek Dry Dam) • Increased area may have greater environmental impacts	X

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
9	City of Watertown should engage a public relations firm or person	• Ensures clear communication to public • Improves public buy-in • May reduce opposition to project • Keeps community informed of project progress • Offers community opportunities for input to project	• Added cost to City	C

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
10	Implement LPWPD “822” plan	• May eliminate need for Mahoney Creek Dry Dam • Would reduce some of the sediment load • Smaller individual areas of disturbance to construct project	• Would not likely be supported by FEMA • Would likely not be supported by highway departments • Would be difficult to impossible to maintain increasing potential for failure of system • May not take off peak flows at time needed • Requires very large cooperation from up to 822 land owners • Need to investigate and design up to 32 dams that would require state permits • State wants a plan for entire system, not for each individual dam • Very costly to verify design • Overall impacted area is larger than that for Mahoney Creek Dry Dam	P
11	Remove structures within 1% floodplain	• Eliminates flood insurance issue • Eliminates need for flow control structure	• Would anticipate significant public opposition • Likely not cost effective for large number of structures involved	X

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
12	Construct a Mahoney Creek WET Dam	• Increased benefits -- recreation	• Permanent inundation • Reservoir would have to be larger to still have flood benefits – which is not possible	X
13	Construct dry dam at the Still Lake as a replacement to Mahoney Creek Dry Dam	• Closer to town so more of basin flow is captured	• Does not provide adequate benefits • Spillway configuration not as suitable • Mahoney Creek Dry Dam abutments are better suited to a dam • Partially located on tribal lands	X
14	Construct dry dam at the Still Lake as an addition to Mahoney Creek Dry Dam	•	• Since both cross same river, no significant benefit • Partially located on tribal lands	X

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
15	Protect Watertown through a system of levees and control structures	• Eliminates need for Mahoney Creek Dry Dam • Gets majority of landowners out of floodplain • Some of this alternative could be used in conjunction with a selected alternative • Proven technology	• Does not provide 100% protection • Numerous closure structures • Excessive infrastructure modifications needed • Less reliable system to operate and maintain • 1994 feasibility study construction indicated a much higher cost than that anticipated for Mahoney Creek Dry Dam, and additional significant costs are yet to be included	C
16	Increase channel capacity through town by excavating and reducing restrictions	• Reduce size of floodplain area	• Significant infrastructure and real estate impacts • Altering railroad and roadway bridges to remove constriction would be highly costly • Does not provide complete protection at the lakes • Width could approach 350' (1200' north of town) • Would have to be designed to avoid draining Lake Kampeska	C

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
17	Build 3 to 5 medium size dry dams instead of single Mahoney Creek Dry Dam	• May be able to manipulate sites to reduce impacts to landowners	• Do not currently have 3 to 5 suitable sites available within County • May increase overall area of inundation and number of land owners impacted • Higher maintenance • More structures involved including outlet works, spillways, etc.	C
18	Build 3 to 5 medium size dry dams in addition to a smaller Mahoney Creek Dry Dam	• May be able to manipulate sites to reduce impacts to landowners	• Do not currently have 3 to 5 suitable sites available within County • May increase overall area of inundation and number of land owners impacted • Higher maintenance • More structures involved including outlet works, spillways, etc.	C w/17
19	Flood proof/raise structures located within 1% flood zone	♦ Eliminates floodplain insurance need	♦ Does not appear to be cost effective for the number of structures involved ♦ May have to be repeated if FEMA alters floodplain map in the future ♦ May lose use of basements	C w/3

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
20	Protect channels with flood walls to the 1% flood level	• Could use I-walls – but consider ice loads • Could be combined with levees or used to raise existing levees	• More expensive than levees unless save on real estate	C w/15
21	Develop a combination plan consisting of moving structures with channel widening and levee protection	•	•	C w/15
22	Construct bike trail as part of project	• Nice feature for public • Sponsor can add later	• May not apply to selected alternative • Does not add to flood protection	X
23	Do nothing	• No construction cost • Eliminates adverse impacts associated with constructing the project	• Flood problems will likely continue • Flood insurance required for impacted properties	X
24	Support developing a Stakeholders Advisory Group	• Ensures that diverse opinions are considered • Seeks consensus	•	C w/9
25	Construct Mahoney Creek Dry Dam in conjunction with diversions and channel improvements	•	•	P w/1
26	Raise homes impacted by Mahoney Creek Dry Dam construction so that they are above 1% impoundment level	•	• Likely not permitted	X

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)
No.	**Description**			
27	Pave channel to increase conveyance by improving Manning's 'n' value	•	• Would not gain enough • Adverse environmental impacts • Still have restrictions • Significant cost addition	X
28	Relocate airport in conjunction with diverting water to/from lakes	•	• Prohibitively expensive	X
29	Remove sediment from lakes to increase storage capacity and improve water quality	•	• Would have to drain/lower lake prior to flood to allow storage • Land owners may object • Need pump station	X
30	Channel floodwaters to the west to the next watershed	•	• Shifts problem to another County • Would only provide 10-year level of protection at a very high cost	X
31	Incorporate a pump station system to allow temporary lowering of lake levels to increase flood storage	•	• See 29	X
32	Lower pool elevation of lakes to promote water storage	•	• See 29	X
33	Confirm that City has eminent domain authority to construct a project within County	• State Law 9-36-16 gives City authority	•	BD

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)
No.	**Description**			
34	Construct a computer graphic model to demonstrate how Mahoney Creek Dry Dam would operate under differing flow conditions for the benefit of the public	• Improves public communication and acceptance	• Added cost to design	C
35	Ask FEMA Region 8 what they will require for the Mahoney Creek Dry Dam alternative	• Will continue to try	• FEMA does not respond	BD
36	Ask FEMA Region 8 what they will allow for the LPWPD “822” Plan alternative	•	• Indications are that FEMA will not accept this idea	BD
37	Design Mahoney Creek Dry Dam such that the impoundment does not extend north into Grant County	• May not be an issue • City has eminent domain authority • Will be addressed in final design if this is the selected alternative • Mahoney Creek Dry Dam will impound to about elevation 1773.4 feet; elevation contour 1775 feet is entirely within Codington County	•	BD
38	Pump Pelican Lake dry so as to make it available for flood storage	•	• Would have to drain/lower lake prior to flood to allow storage • Land owners may object • Need pump station	X
39	Pump Lake Kampeska dry so as to make it available for flood storage	•	• Would have to drain/lower lake prior to flood to allow storage • Land owners may object • Need pump station	X

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)
No.	**Description**			
40	Incorporate ring levees within impoundment area of Mahoney Creek Dry Dam to protect local structures	•	• Likely not permitted	X
41	Stop studying the issue, make a decision and construct a project	• Accelerates flood protection	♦ Some land owners will be adversely impacted by any of the selected alternatives	C
42	Examine details of the LPWPD "822" plan for workable components that would reduce size and impacts of the Mahoney Creek Dry Dam	• Some of the proposed small dams may help reduce flooding • Could experience some environmental improvement and help trap some sediment	• Would not be able to reduce size of Mahoney Creek Dry Dam • May be resisted by FEMA • Could be an ineffective expenditure of local community dollars	C w/10
43	Run river through town in a buried pipe system	•	• Prohibitively expensive	X
44	Create large underground storage reservoir for flood water	•	• Prohibitively expensive	X
45	Purchase all impacted structures within the 1% floodplain	• Eliminates floodplain issue	• Prohibitively expensive	C w/3

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)
No.	**Description**			
46	Have City purchase and maintain flood insurance for all impacted properties	• Eliminates impacts of constructing project	• All residents contribute to cost through taxes • Does not eliminate flood-related damage • Does not eliminate need for emergency response	X
47	Restore ancestral outlet channel from Lake Kampeska to the Big Sioux River	• Helps water quality in lake • Could reduce flood impact to homes around Lake Kampeska	• Runs through the airport property • Diverts water into downtown	X
48	Minimize or eliminate seepage cutoff wall below dam so as to reduce impacts to groundwater flow	• Will be assessed in design if alternative is selected	•	BD
49	Use a slurry wall/soil mix wall in lieu of a clay cutoff beneath dam	• Will be assessed in design if alternative is selected	•	BD
50	Use vinyl sheet pile for flood walls along channel	• Could be a low cost solution when compared to concrete walls	• May not work if wall exceeds ~4' in height • Needs to resist ice forces	C w/15
51	Increase existing levee heights using vinyl sheet pile	• Could be a low cost solution when compared to concrete walls	• May not work if wall exceeds ~4' in height • Needs to resist ice forces • Existing levee needs to be certified first	C w/15

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	**PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)**
No.	**Description**			
52	Build a bladder dam and widen channel north of Watertown	• Temporary dam only used during floods	• Channel is too wide to be cost effective • Subject to damage from ice and vandalism • Large ones no longer made	X
53	Replace Mahoney Creek Dry Dam with flood gate structure	•	• Too large to be feasible	X
54	Flood-proof each individual structure within flood plain (typically with three-feet of brick with floodgates at entrances)	• Should eliminate or minimize property damage • Lowers need for flood insurance • Eliminates or minimizes need to construct flood control project	• Does not prevent damage to community infrastructure • Would require approval from FEMA • Needs to be shown to be cost effective • May be difficult to resist hydrostatic forces from flood waters • May not meet project objectives	C
55	Improve farm management practices to reduce sediment in river	•	•	BD
56	Increase wetlands in river to reduce contaminants in river under normal flows; assess alternate ways to increase ecological benefits	• Would improve water quality • Would create habitat • Could get some NER benefits for ecosystem restoration	• Will not provide flood protection • Currently mitigation not needed	C

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)
No.	**Description**			
57	Investigate water treatment options for improving lake water quality (see Salton Sea Project)	•	• Will not provide flood protection	X
58	Install separator dike in Lake Kampeska to trap sediment near inlet	• Lake Kampeska inlet weir already in place	•	BD
59	Disconnect river from Lake Kampeska and/or Lake Pelican recharge with well water	• Provide higher quality water for lakes • Provides partial flood protection for the lake area • Would allow removal of contaminated sediment once an improved water quality option is proven • May be able to stabilize lake level	• Need structure at river • Need pumps and maintenance • Need water rights • More costly during droughts • May increase flood potential in City • The State has conservation water board that impacts choices made	C
60	Line reservoir to eliminate need for seepage cutoff beneath Mahoney Creek Dry Dam	• Allows free flow of groundwater to the south	• May negatively impact ability to farm land	X
61	Educate public on limits of flood protection to events smaller than 1%	•	•	C w/9
62	Assess impacts of selected plan on roads and highways as to acceptability, particularly if road is to serve as a temporary impoundment embankment	•	•	P w/10

IDEA EVALUATION *Flood Control for Watertown and Vicinity, Watertown, South Dakota*				
Ideas		**Advantages**	**DISADVANTAGES**	PROPOSAL (P), COMMENT (C), BEING DONE (BD), OR REJECT (X)
No.	**Description**			
63	For LPWPD "822" Plan, a feasible O&M plan must be provided in order to implement the plan	•	•	P w/10
64	Coordinate with City to gain access to property for geotechnical investigations as soon as practical	• Will be done when appropriate	•	BD
65	Need to consider impacts of ice on lakes if there is an early snow melt	• Would be done as normal part of hydraulics study • Actions to be taken could be part of O&M	•	BD
66	Request details on how "822" plan was developed	• Current report seems to handle each basin	•	X
67	Assess impacts of impounding water behind Mahoney Creek Dry Dam on existing road crossings and railroads	•	•	P w/1
68	Expand pipe at Roby Creek to reduce/eliminate flood plain along creek	• Would remove some of area around Roby Creek from floodplain • Increases "completeness" of desired 1% protection for community	• Too costly	X

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