Swan Creek Watershed Project Team

RCPP/PL 566 WATERSHED PLANNING

Planning Results

June 11, 2018

Prepared by Moore Engineering for the
Cass County Joint Water Resource District and the Swan Creek Project Team

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Project Team

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Certification
I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Registered Professional Engineer under the laws of the State of North Dakota.

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Date: 6/11/18

Executive Summary

The Cass County Joint Water Resource District (District) entered into a cooperative agreement with the Natural Resource Conservation Service (NRCS) to engage in watershed planning within the Swan Creek Watershed. Swan Creek is a tributary of the Maple River in Cass County, North Dakota. The purpose of this report is to summarize the work completed by the District and their appointed project team for the Swan Creek Watershed RCPP/PL566 watershed planning effort. The planning effort was to evaluate alternatives with the primary focus of flood damage reduction (FDR) in the watershed and secondary focuses including natural resource enhancements (NRE). The ultimate goal for the planning effort was for the project team to evaluate alternatives and provide a recommendation to the District for flood damage reduction projects to be implemented within the watershed. This report does not provide any final recommended projects as the project team, in conjunction with the District, chose to terminate the planning effort. This decision was made on the basis that the problems and resource concerns in the watershed did not warrant continued planning.

While the planning effort was terminated, the project team did complete a substantial amount of work during the planning effort. This report details the work completed including alternative analysis and planning for an environmental assessment (EA). This report notes the development of a wide array of potential FDR and NRE strategies (alternatives) and perform an initial evaluation of each categories' ability to accomplish the "Purpose and Need". The project team used a two-step approach to review, evaluate, and narrow alternatives. This report contains the initial screening of alternatives. After screening each alternative strategy and determining whether the solution will meet (or partially meet) the "Purpose and Need" of the project, the categories are then evaluated based on their anticipated environmental effects and their practicality. Some example alternative strategies include reducing flood volume, increasing conveyance capacity, increasing temporary flood storage, or protection and avoidance. This multi-level screening process allowed the project team to eliminate some alternative strategies from further investigation to concentrate efforts on further detailed analysis of alternatives that will ultimately contribute toward meeting the watershed "Purpose and Need" as identified in the first concurrence point submittal. Justification for the elimination of each strategy is also documented in this report. As discussed previously, this report does not reach a conclusion as the project team and the District chose to terminate the planning effort.

TABLE OF CONTENTS

List of FIGURES

List of TABLES

Appendixes

1. BACKGROUND

1.1 INTRODUCTION

The Cass County Joint Water Resource District (District) was established to address the common issues related to the four water resource districts in Cass County, which include the Maple River Water Resource District, the Southeast Cass Water Resource District, the North Cass Water Resource District and the Rush River Water Resource District. A map is included in **Appendix B** which indicates the location of the four districts that make up the CCJWRD. The District is also tasked with developing impoundments or water detention projects in Cass County on behalf of the four individual water resource districts.

The District is the sponsoring local organization (SLO) and entered into a cooperative agreement with the Natural Resources Conservation Service (NRCS) to engage in watershed planning in the Swan Creek watershed, a subwatershed of the Maple River. The cooperative agreement is funded under the Regional Conservation Partnership Program (RCPP) as authorized in the 2014 Farm Bill.

These watershed plans require the development of physically, environmentally, socially, and economically sound watershed projects. The District utilized guidance included the Watershed Protection and Flood Prevention Act of 1954 (PL-566) to help facilitate the watershed planning. The goal for this planning effort was for the watershed projects identified in the plan to ultimately move forward as a project action, which are formally planned undertakings carried out within a specified geographic area by sponsors for the benefit of the general public. Using the PL-566 planning framework as a guide, the planning effort in the Swan Creek watershed included the following steps:

- Initial Planning Deliverables
- Agency Meeting – Bismarck, ND held on December 10th, 2015
- Public Meeting – Governor's Inn, Casselton ND held on January 6th, 2016.
- Project Team Creation
- Problem Identification and Purpose and Need
- Environmental Assessment Draft Scope
- Preliminary Economics
- Effected Environment
- Alternative Strategies
- Alternative Screening & Review
- Alternatives Selected for further analysis
- Project Planning Ceases

A project team was created to identify watershed problems and determine alternatives that could be implemented in the Swan Creek watershed to alleviate the identified problems. The project team was comprised of members that included local landowners and local, regional, state and federal agency representatives.

Swan Creek Watershed RCPP Planning Team

Josh Monson: NRCS Cass County District Conservationist
Mike Hargiss: North Dakota Department of Health

Bruce Kreft: North Dakota Game and Fish
Patsy Crook & Patricia McQuery: United States Army Corps of Engineers
Eric Dahl & Jeff Miller: Cass County Soil Conservation Service
Jason Benson: Cass County Engineer
Jerry Melvin: Maple River Water Resource District
Mike Faught: Landowner
Harvey Morken: Chairman – Casselton Township Supervisors/Landowner
Bob Satrom: Landowner
Dean Giermann: Landowner
Randy Gjestvang: ND State Water Commission
Mike Opat: Moore Engineering – Engineer for the Maple River Water Resource District
Keith Weston: NRCS Red River Basin Coordinator/Red River Retention Authority

1.2 LOCATION

The District's planning area for the Swan Creek watershed study is shown in **Appendix A**. The study area includes the upper portion of Swan Creek lying north and west of Casselton. The watershed is rural in nature and the land use in the watershed planning area is almost 95 percent agricultural.

2. ALTERNATIVE DEVELOPMENT AND INITIAL SCREENING

2.1 ALTERNATIVES DEVELOPMENT BACKGROUND

The project team developed a draft "Purpose and Need" statement. This statement sets the framework for the planning effort and is the basis for eliminating or prioritizing alternatives within the watershed. The project team started with the need portion of the statement. They used information provided by the economists which indicated that there were significant damages to crops, transportation systems and other public infrastructure over the past ten years. Once the need was established, the project team identified the purpose for the alternatives identified during the planning effort. Ultimately, the purpose of the alternatives would be to address the problems identified as a need. As the project team proceeded further in the study, they were able to compare the impact of each alternative in the watershed and if they did not meet the "Purpose and Need", they would be eliminated from further review.

The draft "Purpose and Need" statement developed by the project team was submitted to the NRCS for concurrence in April of 2016, with NRCS concurrence received on August 2, 2016. The "Purpose and Need" statement was as follows:

> Purpose:
> The purpose of the project is to reduce flood damages within the Swan Creek watershed associated with spring snow melt and rains in order to minimize erosion, crop losses, damage to transportation systems and other public infrastructure, and homes and businesses.

Need:
Within the Swan Creek Watershed, excessive spring runoff and intense rain events cause overland and overbank flooding causing damages. This flooding causes damages to fields due to erosion, crop losses, delayed planting which reduces yields, roads are washed out and overtopped, damages to bridges and culverts and transportation disruptions.

Additionally, the project team identified the following goals and objectives to help frame their planning efforts:

Swan Creek Watershed Goals/Objectives for planning outcomes or desired conditions:

- Reduce flood impacts to agriculture
- Reduce flood impacts to roads, bridges, and culverts
- Reduce flood impacts to communities and residences (personal property)
- Improve water quality (by reducing sedimentation and erosion)
- Reduce flood impacts to the existing dam & water management systems (drains)
- Consider environmental resources

The project team also referenced the following information as the basis for identifying the need for the project:

- Inundated cropland acres and acres experiencing damages are substantial during flood events, but totals have not been quantified for the whole watershed at this time. Plans are to quantify the acres during the alternative analysis in the areas where a project may be proposed. Public comments have noted cropland damages and modeling efforts will define the inundation depth and duration of run-off water based on the event.
- The range of events hoping to have improved conditions are from the 2 year run-off event to the 100 year run-off event. The area noted by the project team is the portion of the watershed upstream of Casselton, ND.
- Since 1953 there have been 56 Presidential Disaster Declarations (FEMA disasters) for Cass County and 38 of those declarations identified flooding as a major component.
- Township roads within the Swan Creek watershed experienced FEMA disaster damages amounting to $235,766 for the years of 2009, 2010, and 2011. Some damages don't qualify for FEMA assistance and are not included in the total. Other years have had significant damage as well, but were not quantified as part of a FEMA disaster.
- Agricultural crop damages in 1975 amounted to $3,125,281 (in 2015 $) during the summer excessive rain event. Many years of summer excessive rain damages have occurred since the historic 1975 event.
- Emergency services have been disrupted numerous times, notably during 2009, 2010, and 2011 with many road washouts and/or closures. Emergency services took alternate routes that added to their response times.
- The ND National Guard was called into Cass County in 2009, 2010 and 2011 (throughout the whole county) for many aspects of flood operations such as dike construction, traffic control points, quick reaction teams, dam monitoring operations, sandbagging, rescue operations, and aerial 1-ton sandbag placement.
- Using the Rusle2 model for crop rotations, slopes, tillage patterns, soil types to measure average sediment loss per acre, for the Swan Creek area is yielding about 0.92 tons of sediment delivered per acre per year. More technical detail on the Rusle2 calculation is located in Appendix G.

During the development of the "Purpose and Need" statement, the project team narrowed the watershed planning effort to a priority area within the overall watershed. This priority area was defined during the problem identification meeting and then incorporated into the "Purpose and Need". The information utilized for problem identification included maps of historic road damages within the watershed and preliminary inundation mapping for various rainfall events. The project team utilized colored arrow to identify the problem areas. These maps are included in **Appendix C**.

2.2 EVALUATION OF CATEGORIES/STRATEGIES

2.2.1 INITIAL LIST OF CONSIDERED STRATEGIES

The initial set of flood damage reduction (FDR) strategies considered were established from the FDR strategies identified in the Red River Basin Flood Damage Reduction Work Group Technical and Scientific Advisory Committee's *Technical Paper 11 (TP 11).* Though not an exhaustive list, *TP 11* provides a variety of FDR strategies that have proven track records of success within the Red River Valley. These strategies are divided within *TP 11* into four distinct categories representing four unique methodologies to alleviate flooding. The full list of strategies by category is presented in Figure 1A & Figure 1B below.

Figure 1 A: Flood Reduction Strategies

Category 1 – Increase Temporary Flood Storage	Category 2 – Increased Conveyance Capacity
1A - Dams and Impoundments	2A - Channelization of existing natural water ways and flowages (Floodway) & Surface Drainage
1B - Create or Restore Wetlands/With Controls + added storage	2B - Diversions
1C - Alter ground water through drainage (Drainage Water Management)	2C - Set-back Levees (move existing)
1D - Culvert sizing to meter runoff	2D - Increasing road crossing capacity
1E - Overtopping Levees	

Figure 1 B: Flood Reduction Strategies (Cont.)

Category 3 – Reduce Flood Volume	Category 4 – Protection/Avoidance	Category 5 – Additional Alternatives
3A – Create or Restore Wetlands (natural function)	4A - Urban levees	5. Roads - rebuilt to original standards
3B - Cropland BMPs	4B - Farmstead levees	
3C - Cropland Conversion (Back to grass or Forest)	4C - Agricultural levees	
3D - Other Beneficial Uses (irrigation - municipal/industrial-flow augmentation)	4D - Evacuation of the floodplain	
	4E - Floodproofing	
	4F - Flood Warning System	

One additional strategy was identified and discussed by the project team that could meet the "Purpose and Need". That alternative was rebuilding roads to their original standard since washouts have reduced road heights and emergency repairs reduced the quality of the road bed and have not brought the roads back to their original heights, meaning roads overtop sooner than they did when they were built.

2.2.2 STRATEGY EVALUATION CRITERIA

Each of the FDR categories listed in Figure 1A & Figure 1B underwent several evaluations by the project team in order to eliminate some from further consideration and analysis. The first evaluation considered whether or not the strategy would fundamentally address the "Purpose and Need" of the project. The second evaluation weighed the environmental effects of the strategy. The third evaluation considered the practicality of each strategy. For each evaluation, each strategy was either designated to be carried forward for further evaluation or not be carried forward. A justification for each 'do not carry forward' designation was documented as part of the evaluation.

2.2.3 STRATEGY EVALUATION

Strategies were evaluated based on whether the alternative could fully or partially accomplish the established project goals (i.e. "Purpose and Need"), whether the alternative would cause a drastic negative impact to the environment, and whether the alternative is practical. It is unlikely that one alternative can meet all of the goals of the "Purpose and Need", but some strategies would likely have a greater negative impact to the environment. Strategies that were found to be most likely to address the "Purpose and Need" are shown below in Figure 2A & 2B as green. Strategies that would likely not address the "Purpose and Need", would negatively affect environmental concerns, or were determined to be impractical are shown in Figure 2A & 2B as red. These strategies were not carried forward for further analysis as discussed in 2.2.3.1.

Figure 2 A: Strategy Evaluation based on "Purpose and Need", Environmental effects and Practicality

Category 1 – Increase Temporary Flood Storage	Category 2 – Increased Conveyance Capacity
1A - Dams and Impoundments	2A - Channelization of existing natural water ways and flowages (Floodway) & Surface Drainage
1B - Create or Restore Wetlands/With Controls + added storage	2B - Diversions
1C - Alter ground water through drainage (Drainage Water Management)	2C - Set-back Levees (move existing)
1D - Culvert sizing to meter runoff	2D - Increasing road crossing capacity
1E - Overtopping Levees	

Figure 2 B: Strategy Evaluation based on "Purpose and Need", Environmental effects and Practicality (Cont.)

Category 3 – Reduce Flood Volume	Category 4 – Protection/Avoidance	Category 5 – Additional Alternatives
3A – Create or Restore Wetlands (natural function)	4A - Urban levees	5. Roads - rebuilt to original standards
3B - Cropland BMPs	4B - Farmstead levees	
3C - Cropland Conversion (Back to grass or Forest)	4C - Agricultural levees	
3D - Other Beneficial Uses (irrigation - municipal/industrial-flow augmentation)	4D - Evacuation of the floodplain	
	4E - Floodproofing	
	4F - Flood Warning System	

Color Representations:

Green – Considered to meet the "Purpose and Need" – carried forward
Red – Ruled out for further consideration, does not adequately meet the "Purpose and Need" - not carried forward.

2.2.3.1 JUSTIFICATION FOR NOT CARRIED FORWARD STRATEGIES

- Measure 1E – Overtopping Levees: This strategy was deemed not applicable because this technique would allow water to overtop levees once a specified event is exceeded. At that point, there would be no difference between existing conditions and post project conditions. Keeping in mind the purpose of the alternatives is for flood damage reduction. Therefore, this strategy would be counter to the "Purpose and Need".

- Measure 2B – Diversions (Floodways): This strategy was deemed not applicable because this technique would likely cause negative hydraulic downstream impacts unless another project such as an impoundment were included upstream to mitigate those impacts. Costs then become a concern because two projects are then needed instead of one. Diversions would not provide assistance to watershed wide agricultural land flooding issues.
- Measure 2C – Set-back levees – or move existing ones: This strategy was deemed not acceptable because this strategy would be further impacting agricultural land. Additionally, there is flooding in the watershed from both channel breakouts and overland flooding which was noted as the primary flooding problem. This strategy only addresses the channel breakout portion of the problems. Therefore, the project team believed the addition of set-back levees would not meet the "Purpose and Need" as well.
- Measure 2D - Increasing road crossing capacity: This strategy was deemed not applicable because increasing culvert sizing would result in higher peak flows and impacts downstream in the watershed. This alternative would have to be done consistently across the entire watershed in order to avoid pushing one problem onto the next landowner. The WRD does not have the authority to install culverts through township roadways unless a project such as a legal assessment drain crosses the roadway. Therefore, this alternative would require all townships to address the issue and follow the same standard. In addition to coordination concerns, costs also become a concern as most townships barely have enough funds to maintain or repair the roads let alone try to replace all of the culverts through their roadways. This made this alternative impractical and not feasible.
- Measure 4A – Urban Levees: All urban areas in the watershed currently have the flood protection they need. No additional communities have come forward requesting assistance. Therefore, this strategy was deemed not applicable for this watershed.
- Measure 4B - Farmstead Levees: This strategy was removed from further consideration because no farmsteads were identified as needing any protection. There is no current FEMA Flood Insurance Rate Map noting any potential threats to farmsteads.
- Measure 4C - Agricultural Levees: Agricultural land flooding in this watershed is more closely related to overland flooding as the primary problem rather than from water breaking out of a defined channel. It was deemed that this strategy will not meet the "Purpose and Need".
- Measure 4D - Evacuation of the Floodplain. This strategy was assumed to be the relocation of people from the floodplain to avoid damages. The evacuation of farmland for the creation of a project is inherent with those other projects and not considered as part of this strategy. This strategy was deemed impractical since the majority of the floodplain is cropland. Additionally, the cities and towns in need of flood protection currently have protection in place.
- Measure 4E - Flood proofing: This strategy was deemed not applicable because it is only practical for implementation for individual structures, homesteads or roads. This strategy would not improve agricultural flood damage, or improve environmental conditions watershed wide.
- Measure 4F – Flood warning system: The WRD currently has an Emergency Action Plan (EAP) in place for Absaraka Dam which is in the watershed. The EAP covers notifications

downstream should the dam begin to fail. Those landowners that would be impacted are included in that notification system. However, as most of the flood damages occurring in this watershed are to roadways and agricultural land, this strategy was deemed not applicable because it would not address any of the "Purpose and Need" statement. It was noted that this strategy should be handled by the County Emergency Management Office.

2.3 ALTERNATIVES DEVELOPMENT

After eliminating multiple strategies from further evaluation, 10 potential strategies remained, and are listed below:

1. Dams and impoundments
2. Create or restore wetlands with controls and added storage
3. Alter ground water through drainage (drainage water management)
4. Culvert sizing to meter runoff
5. Drainage
6. Create or restore wetlands (as they functioned naturally)
7. Cropland BMPs
8. Cropland Conversion (back to grass or forest)
9. Other Beneficial Uses
10. Roads rebuilt to original standards. (emergency repairs have reduced road heights and reduced the quality of the road bed)

The remaining strategies could be combined in many different ways to form project alternatives. There can also be multiple alternatives developed for certain strategies. The project team reviewed the above project alternatives to determine if additional technical analysis would be necessary.

2.4 HYDROLOGY AND HYDRAULIC (H&H) METHODOLOGY

Two dimensional HEC-RAS (2dRAS) hydraulic models and HEC-HMS (HMS) hydrologic models were the primary tool used to analyze these alternatives. The 2dRAS model utilized light detection and ranging (LiDAR) elevation data and rainfall runoff to display how the water runs through the watershed. This tool was especially useful in showing areas outside of the rivers, creeks and channels that are inundated during various events. A preliminary version of the model was created to assist the project team in identifying problem areas. The results of that modeling are included in **Appendix C**. It was noted that those results were preliminary because they only utilized LiDAR. Additional details such as culverts and bridge crossings could be added to further define the model. However, due to the termination of the project, these details were not added to the model. The preliminary model is available for use by the District and could be updated should the planning continue in the future.

The HMS model used was originally created in 2011 as part of the *Fargo-Moorhead Metro Basin-Wide Modeling Approach Hydrologic Modeling: HEC-HMS Model Development; Various Tributaries above the Red River of the North at Halstad, MN* effort. This model was updated and refined by the Maple River Water Resource District in 2014 during the development of the *Maple River Watershed Comprehensive Detention Plan* and again updated and refined further in 2014 for the Red River

Basin Commission's *Halstad Upstream Retention (HUR) Study*.

All updates to the models included basin breaks to create smaller subbasins and calibration at various locations through the watershed. In the Swan Creek watershed, there are no United States Geological Survey (USGS) gage stations to verify historic event calibration. Therefore, common points between the previous HMS model and the updated HMS model were compared for peak discharge, time of peak and volume. If the peak discharges and time to peak were significantly different after breaking the model into smaller sub basins, the time of concentrations and storage coefficients were lengthened or shortened to calibrate back to the original HMS model. For the Swan Creek HMS model, peak discharges at the outlet for the calibrated model used for the RCPP analysis varied from 3-4 percent lower (depending on the event & duration) than the peak discharge from the original model. Timing of the hydrographs at the outlet were within 12 hours of the original HMS model. However, most events were within five hours. With regard to volume, no adjustments to the calculated curve number were necessary as the difference in volume out of the model less than 0.1 percent.

2.5 ALTERNATIVES REVIEW

NRCS approved of the Swan Creek watershed draft "Purpose and Need" on August 2, 2016 as discussed in Section 2.1.

Once the preferred strategies were identified by the project team to meet the "Purpose and Need", the project team set an acceptable discharge in the rivers and streams as the goal to try to reduce flooding. The project team felt that a 10–year, 24-hour event was manageable from the standpoint of minimizing impacts to agricultural land and that impacts from larger events should be reduced as much as feasibly possible. With that information, the District's consultant, Moore Engineering, Inc., took those strategies and developed specific alternative concepts for the project team to review and evaluate.

Alternatives were developed for the 10 remaining strategies as noted below for the project team to review, discuss and then make selections for further review. Thirty-two alternatives were identified as listed in the Table 1. Maps and technical modeling results of all alternatives have been included in Appendix D. Of the 32 alternatives there are 19 impoundment alternatives, 1 created/restored wetland with controls, 6 channelization alternatives, 1 created/restored wetland functioning at its natural state, cropland best management practices (BMPs), cropland converted to grass or forest, altered ground water, other beneficial uses, and culvert sizing to meter or reduce run-off discharge rates. These alternatives were made available for the project team to review.

Table 1: Alternatives for Review

Alt. No.	Alternative Location (Twp-Section)	Alternative Type
1	Sec 3 – Ayr Twp area	Impoundment/Dry
2-1, 2-1, 2-3	Sec. 25 Ayr Twp	Impoundment Dry
3	Sec. 24 Ayr Twp	Impoundment Dry
4 (1)	Sec. 13 Ayr Twp	Impoundment Dry
4 (2)	Sec. 19 Empire Twp	Impoundment Dry
4 (3)	Sec. 20 Empire Twp	Impoundment Dry
4 (4)	Sec. 28 Empire Twp	Impoundment Dry
5	Sec. 25 Empire Twp	Impoundment Dry
6	Sec. 27 Empire	Impoundment Dry
6 a	Sec. 2 Wheatland Twp	
7	Sec. 1 Buffalo Twp	Impoundment Dry
8	Sec. 4 Wheatland Twp	Impoundment Dry
9	Sec. 9/16 Wheatland Twp	Impoundment Dry
10	Sec. 16 Wheatland Twp	Impoundment Dry
10 a	Sec 5-6 Wheatland Twp	Impoundment Dry
11	Sec. 12/13 Wheatland Twp	Impoundment Dry
12	Sec. 18 Casselton Twp	Impoundment Dry
13	Sec. 34 Wheatland Twp	Impoundment Dry
14	Sec. 35 Wheatland Twp	Impoundment Dry
15	Sec. 21 Casselton Twp	Impoundment Dry
16	Sec. 7/8 Everest Twp	Impoundment Dry
17	Sec. 22 Everest Twp	Impoundment Dry
18	Sec. 14 Everest Twp	Impoundment Dry
19	Sec. 6 Durbin Twp	Impoundment Dry
20	Sec. 2 Ayr Twp	Wetland Created/Restored (impoundment)
21	Sec. 31/32 Empire Twp	Channelization
22	Sec. 34 Wheatland Twp	Channelization
23	Sec. 18 Casselton Twp	Channelization
23 a	Sec. 18 Casselton Twp	Channelization
24	Sec. 16 Casselton Twp	Channelization
25	Sec. 7 Durbin Twp	Channelization
26	Sec. 2 Ayr Twp	Wetland Created/Restored (natural function)
27	Watershed	Roads rebuilt to design standards

Table 1: Alternatives for Review (Continued)

28	Watershed	Alter ground water – tile water management
29	Watershed	Cropland BMP's
30	Watershed	Cropland conversion to grass/forest
31	Watershed	Other beneficial uses
32	Watershed – specific areas or reaches	Culvert sizing – meter or slow run-off

These alternatives were presented to the project team for analysis and review. The project team evaluated all the alternatives based on the ability to meet the "Purpose and Need". The project team used HMS model information, any known environmental concerns, any known financial considerations or barriers, public and agency comments, comments from the project team, any known permitting obstacles, cultural resource concerns, agricultural improvements, and any known impacts to threatened or endangered species to evaluate these alternatives.

Alternative Review:

Alternative #1: Impoundment – Located in Cass County, Ayr Twp – Sec 3 area.

This impoundment alternative was not carried forward for further review as the project team believed it did not meet the "Purpose and Need" by being able to improve agricultural land flooding and help protect infrastructure.

For this particular impoundment location, it does not adequately meet the "Purpose and Need", or the goal established by the project team to reduce larger event flows to the 10–year, 24-hour event. While there is a significant amount of storage provided by this impoundment when the storage volume is compared to the contributing area, it is situated on the upper end of the watershed and has a relatively small contributing area when compared with the watershed. The majority of the watershed is downstream of this alternative. Therefore, this alternative does not provide the improvement for agricultural lands or public infrastructure flood damages.

Alternative #2: Impoundment – Located in Cass County, Ayr Twp. – Sec 25 area.

The impoundment concept started as a single impoundment site, but an option was created having three smaller sites in this same area as (Outlined below with Alternatives: 2-1, 2-2, & 2-3). The impoundment strategy was considered for further review and generally meets the "Purpose and Need" by being able to improve agricultural land flooding and help protect infrastructure.

This alternative was considered for further review or study as it does generally address the "Purpose and Need". It was noted that this alternative is on the creek channel (i.e. "on-channel"). However, no additional study or modeling was completed due to the planning effort being terminated. Additional details on the planning termination can be found in Section 3: Planning

Closure.

Alternative #2-1, 2-2, 2-3: Impoundments – Located in Cass County, Ayr Twp. – Sec 25-26 and Sec 30 of Empire Twp area.

This alternative was asked to be reviewed after suggestions by the project team based on the information provided to them with Alternative #2. The project team felt there could be a cost savings by creating three impoundments on less valuable land versus one large impoundment on highly productive cropland.

The impoundment area was a series of three small impoundment working in unison as suggested by one of the landowners on the project team. One of these smaller impoundments would replace a previous impoundment in the same area that was removed or washed out many years ago. Additionally, this impoundment would provide benefit to the existing Absaraka Dam, which is a relatively small impoundment when storage volume is compared to the contributing watershed upstream. This impoundment strategy was considered for further review and generally meets the "Purpose and Need" by being able to improve agricultural land flooding and help protect infrastructure. It was noted that all three of these impoundments are also on-channel. However, no additional study or modeling was completed due to the planning effort being terminated. Additional details on the planning termination can be found in Section 3: Planning Closure.

Alternative #3: Impoundment – Located in Cass County – Ayr Twp. – Sec 24 area.

The impoundment strategy was considered for further review and generally meets the "Purpose and Need" by being able to improve agricultural land flooding and help protect infrastructure.

This impoundment provided very similar results as Alternative #2. However, this site would be considered an off-channel site and may have less environmental impacts. Also, this alternative would provide some agricultural land and public infrastructure protection. There are not any known environmental issues with this site nor will it cause any adverse downstream impacts. This alternative was considered to be moved forward for further review and study as it helps meet and address the "Purpose and Need". However, no additional study or modeling was completed due to the planning effort being terminated. Additional details on the planning termination can be found in Section 3: Planning Closure.

Alternative #4 (4-1, 4-2, 4-3, 4-4): Impoundment – Located in Cass County – Ayr Twp. – 24 Sec area.

These impoundments were not carried forward for further review as the project team believed they did not meet the "Purpose and Need" by being able to improve agricultural land flooding and help protect infrastructure. While the impoundments do provide some significant benefits for the smaller events (up to 32% peak flow reduction), there is not enough flood water storage for any noticeable improvement for agricultural lands or public infrastructure flood damages for larger events. Additionally, there are negative impacts downstream for some of the larger events. It was noted that four impoundments might be rather costly to build as compared to one impoundment as well. This alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #5: Impoundment – Located in Cass County – Sec. 21 Empire Twp. area.

The impoundment strategy was carried forward for further review and meets the "Purpose and Need" by being able to improve agricultural land flooding and help protect infrastructure.

This impoundment does provide some agricultural land and public infrastructure protection. There are not any known environmental issues with this site nor will it cause any adverse downstream impacts. This alternative was considered to be moved forward for further review and study as it does help meet and address the "Purpose and Need". However, no additional study or modeling was completed due to the planning effort being terminated. Additional details on the planning termination can be found in Section 3: Planning Closure.

Alternative #6: Impoundment – Located in Cass County – Sec. 27 Empire Twp. area.

The impoundment strategy was carried forward for further review and meets the "Purpose and Need" by being able to improve agricultural land flooding and help protect infrastructure.

This impoundment does provide some agricultural land and public infrastructure protection. There are not any known environmental issues with this site nor will it cause any adverse downstream impacts. This alternative was considered to be moved forward for further review and study as it does help meet and address the "Purpose and Need". However, no additional study or modeling was completed due to the planning effort being terminated. Additional details on the planning termination can be found in Section 3: Planning Closure.

Alternative #6a: Impoundment – Located in Cass County – Sec. 2-3 Wheatland Twp. area.

The impoundment strategy was carried forward for further review and meets the "Purpose and Need" by being able to improve agricultural land flooding and help protect infrastructure. This site was derived by suggestions from the project team.

This impoundment does provide some agricultural land and public infrastructure protection. There are not any known environmental issues with this site nor will it cause any adverse downstream impacts. This alternative was considered to be moved forward for further review and study as it does help meet and address the "Purpose and Need". However, no additional study or modeling was completed due to the planning effort being terminated. Additional details on the planning termination can be found in Section 3: Planning Closure.

Alternative #7: Impoundment – Located in Cass County – Sec. 1 Buffalo Twp. – area.

This particular impoundment location does not adequately meet the "Purpose and Need". While there is some benefit for smaller events, there is not enough flood water storage to reduce larger flood events to the discharge reduction goal established by the project team. This alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #8: Impoundment – Located in Cass County – Sec. 4 Wheatland Twp. area.

This particular impoundment location does not adequately meet the "Purpose and Need". This

impoundment does not provide much benefit to the smaller duration events because Absaraka Dam is just upstream. While there is some benefit to the larger volume events, the impoundment does not reduce flows down to the goal established for discharges in the river. This alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #9: Impoundment – Located in Cass County – Sec. 9/16 Wheatland Twp. area.

This particular impoundment location does not adequately meet the "Purpose and Need". The project team felt that while the impoundment does provide benefits, there is a significant impact to agricultural land and would likely come with a significant cost. The project team chose to move Alternative #10 forward instead of Alternative #9 because they provide very similar benefits and Alternative #10 has less impact on agricultural land.

Alternative #10: Impoundment – Located in Cass County – Sec. 16 Wheatland Twp. area.

This impoundment does provide significant benefits to some agricultural land and public infrastructure. Additionally, Alternative #10 is an off-channel impoundment. Therefore, there are not any known environmental issues with this site. This alternative was considered to be moved forward for further review and study as it does help meet and address the "Purpose and Need". However, no additional study or modeling was completed due to the planning effort being terminated. Additional details on the planning termination can be found in Section 3: Planning Closure.

Alternative #10a: Impoundment – Located in Cass County – Sec. 5-6 Wheatland Twp. area.

This alternative was asked to be reviewed by the project team based on the information provided to them with Alternative #10. The project team felt as though this alternative would impact less crop land and would be cheaper than Alternative #10. There are not any known environmental issues with this site nor will it cause any adverse downstream impacts. This alternative was considered to be moved forward for further review and study as it does help meet and address the "Purpose and Need". However, no additional study or modeling was completed due to the planning effort being terminated. Additional details on the planning termination can be found in Section 3: Planning Closure.

Alternative #11: Impoundment – Located in Cass County – Sec. 12/13 Wheatland Twp. area.

This particular impoundment location does not adequately meet the "Purpose and Need". This impoundment does not provide significant benefits to agricultural land or public infrastructure. This impoundment does not have enough flood water storage to provide those benefits. Therefore, this alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #12: Impoundment – Located in Cass County – Sec. 18 Casselton Twp. area.

This impoundment does provide significant benefits to some agricultural land and public infrastructure, but holds water on one of the priority areas where the project team would like to provide some benefit or protection. Additionally, the major benefits are provided for the shorter

duration and small volume events. This alternative does not have a significant amount of storage for the contributing watershed that is upstream. Therefore, this alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #13: Impoundment – Located in Cass County – Sec. 34 Wheatland Twp. area.

This particular impoundment location does not adequately meet the "Purpose and Need". There is not enough flood water storage for any noticeable reduction in agricultural land or public infrastructure damages. This alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #14: Impoundment Located in Cass County – Sec. 35 Wheatland Twp. area.

This particular impoundment location does not adequately meet the "Purpose and Need". The impoundment is situated on the lower portion of the watershed and does not impact the area identified as needing protection. This impoundment does provide some small benefits to the longer duration and larger volume event at the downstream reaches of the study, but not enough to reduce peak discharges to the goal established by the project team. Therefore, this alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #15: Impoundment Located in Cass County – Sec. 21 Casselton Twp. area.

This particular impoundment location does not adequately meet the "Purpose and Need". There is not enough flood water storage for any noticeable improvement for agricultural land or public infrastructure. This alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #16: Impoundment Located in Cass County – Sec. 7/8 Everest Twp. area.

This particular impoundment location does not adequately meet the "Purpose and Need". This alternative only provides benefit for large volume, long duration events. However, because of the location, it does not provide benefits to the areas identified by the project team as problem areas. This alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #17: Impoundment – Located in Cass County – Sec. 22 Everest Twp. area.

This particular impoundment location does not adequately meet the "Purpose and Need". This impoundment has negative impacts on areas downstream. There is not enough flood water storage for any noticeable improvement for agricultural land or public infrastructure. Therefore, this alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #18: Impoundment – Located in Cass County – Sec. 14 Everest Twp. area

This particular impoundment location does not adequately meet the "Purpose and Need". There is not enough flood water storage to provide any noticeable improvement for agricultural land or

public infrastructure. This alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #19: Impoundment – Located in Cass County – Sec. 6 Durbin Twp. area

This particular impoundment location does not adequately meet the "Purpose and Need". This impoundment has negative impacts on areas downstream. There is not enough flood water storage for any noticeable improvement for agricultural land damages or public infrastructure. Therefore, this alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need".

Alternative #20: Created/Restored Wetlands – with added storage and controls (impoundment) – Cass County – Sec. 2 Ayr Twp.

Restoring all the drained wetlands within the watershed is not practical or feasible on a large scale for long periods of time. Therefore, this alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need". However, it was noted that restoring or creating wetlands can be beneficial as a stand-alone landowner initiative or mitigation for another project. A map of this alternative has been included in Appendix E. No detailed analysis of this alternative was completed.

Alternative #21: Channelization - Sec. 31/32 Empire Twp. Area

Channelization of existing natural waterways and flowages (Floodway): This alternative was deemed not acceptable because the project team thought this strategy would likely cause downstream impacts unless there is an impoundment incorporated downstream of the channel work. This strategy as a stand-alone alternative was decided not to be carried forward for further analysis.

Alternative #22: Channelization - Sec. 34 Wheatland Twp. Area

Channelization of existing natural waterways and flowages (Floodway): This alternative was deemed not acceptable because the project team thought this strategy would likely cause downstream impacts unless there is an impoundment incorporated downstream of the channel work. This strategy as a stand-alone alternative was decided not to be carried forward for further analysis.

Alternative #23: Channelization – Cass County – Casselton Twp. – Sec. 18 area.

Channelization of existing natural waterways and flowages (Floodway): This alternative was deemed not acceptable because the project team thought this strategy would likely cause downstream impacts unless there is an impoundment incorporated downstream of the channel work. This strategy as a stand-alone alternative was decided not to be carried forward for further analysis.

Alternative #23a: Channelization – Cass County – Casselton Twp. – Sec. 18 area.

Channelization of existing natural waterways and flowages (Floodway): This alternative was deemed not acceptable because the project team thought this strategy would likely cause downstream impacts unless there is an impoundment incorporated downstream of the channel work. This strategy as a stand-alone alternative was decided not to be carried forward for further analysis.

Alternative #24: Channelization – Cass County – Sec. 16 Casselton Twp. area.

Channelization of existing natural waterways and flowages (Floodway): This alternative was deemed not acceptable because the project team thought this strategy would likely cause downstream impacts unless there is an impoundment incorporated downstream of the channel work. This strategy as a stand-alone alternative was decided not to be carried forward for further analysis.

Alternative #25: Channelization – Cass County – Lake Twp – Sec. 7 Durbin Twp. area.

Channelization of existing natural waterways and flowages (Floodway): This alternative was deemed not acceptable because the project team thought this strategy would likely cause downstream impacts unless there is an impoundment incorporated downstream of the channel work. This strategy as a stand-alone alternative was decided not to be carried forward for further analysis.

Alternative #26: Restored/Created Wetland – natural function – Cass County – Sec. 2 Ayr Twp. area. (or other areas)

Restoring all the drained wetlands within the watershed is not practical or feasible on a large scale for long periods of time. Therefore, this alternative was not chosen for any further review or study as it does not adequately meet the "Purpose and Need". However, it was noted that restoring or creating wetlands can be beneficial as a stand-alone landowner initiative or mitigation for another project. A map of this alternative has been included in Appendix E. No detailed analysis of this alternative was completed.

Alternative #27: Roads rebuilt to design standards and heights – Watershed wide area.

This strategy was moving forward for additional review or analysis at the time the project planning ceased. This alternative was included to make townships and the county aware of this concern. However, it was noted that roads washing are part of the damages in the watershed and that building the roads back to their original grade does not necessarily reduce the risk of that roadway washing out in the future. Additional details on the planning termination can be found in Section 3: Planning Closure.

Alternative #28: Alter ground water /tile water management– Cass County, various locations.

The project team would like to see sub-surface water management through drain tile encouraged and believe it can be better addressed by the District through the permitting process. There is not a currently accepted modeling methodology to determine impacts on peak flows for inclusion in this

plan. This alternative was not being carried forward for further analysis or review when the planning effort was terminated.

Alternative #29: Cropland Best Management Practices (BMPs)

The project team's review of this alternative concluded that BMPs should be encouraged and can be better addressed through NRCS efforts. For modeling purposes, it was assumed that BMPs resulted in agricultural land mimicking conditions as if cropland was returned to grassland. As such, a cursory analysis of this was completed in HEC-HMS by adjusting curve numbers from calculated values to a generalized number of 64. As this analysis was cursory, it did not take into account the condition or specific soil types. Results of this analysis are included in Appendix F and indicate that BMPs reduced peak flows at the outlet of the watershed from 3% to 64%, depending on the event. While this alternative does show benefits to the watershed, it is not practical or feasible to be completed by the SLO on a watershed wide scale. Therefore, this alternative was not being carried forward for further analysis or review when the planning effort was terminated. However, the project team wanted the utilization of BMPs to be a general goal of the watershed.

Alternative #30: Cropland converted back to grass or forest.

The project team determined this alternative was not socially acceptable or economically feasible, since farming and ranching is the economic backbone of the local economy and agricultural activities make up more the 95% of the land use in the watershed. This alternative was not being carried forward for further analysis or review when the planning effort was terminated. The project team wants the utilization of grassland/CRP to be a general goal of the watershed. Results from analysis has been included in Appendix F.

Alternative #31: Other beneficial uses of water – irrigation, industrial or municipal.

This strategy was deemed not applicable because the need to store water for other uses was not addressed in the "Purpose and Need". It was also not noted as a need in the public scoping. This alternative was not being carried forward for further analysis or review when the planning effort was terminated.

Alternative #32: Culvert Sizing – meter runoff, downsize culverts.

This strategy was deemed not practical due all the various township, county and state jurisdictions that have permitting and approval authority of road crossings. It may also create new problems for roadways that would be holding back water. Roads that don't include design calculations concerning

geotechnical requirements are not meant to act as dams. This alternative was not being carried forward for further analysis or review when the planning effort was terminated.

Alternative review summary:
Concepts that were still under review and consideration by the project team when the project team decided to end the planning efforts are as follows:

1. Impoundment Alternative Site area: #2 & 2-1, 2-2, 2-3
2. Impoundment Alternative Site: #3
3. Impoundment Alternative Site: #5
4. Impoundment Alternative Site area: #6 & #6a
5. Impoundment Alternative Site area: #10 & #10a
6. Roads being upgraded to their original design standards
7. The project team has also concurred that the following strategies would not individually meet the stated "Purpose and Need" but would be good practices or beneficial to other projects.
    a. Restored or created wetlands
    b. Channelization – areas upstream of impoundments
    c. Cropland BMPs
    d. Cropland conversion to grass/forest or other appropriate cover (like CRP)

3. PLANNING CLOSURE:

During the RCPP planning process, the project team consisted of local landowners, local agency staff, and state and federal agency staff. Prior to further analysis of the alternatives selected for further analysis, the project team determined that the problems and resource concerns in the watershed did not warrant continued planning at this time.

The project team accomplished the following items during the planning process:

1. Held an agency scoping meeting to get feedback from agencies on their watershed concerns
2. Held a public scoping meeting to get feedback and priority resource concerns from the public within the watershed
3. Developed a "Purpose and Need" statement, which was review and commented on by NRCS and approved as a draft
4. Reviewed and narrowed flood damage reduction strategy categories that could address issues noted in the "Purpose and Need" statement. There were 20 general flood damage reduction strategies reviewed. The project team eliminated 10 of the strategies and carried 10 strategies forward to build possible alternatives around. Developed alternatives for the 0 remaining strategy categories carried forward. The project team was presented with 32 total alternatives to review. As the alternatives were developed extensive preliminary

hydraulic and hydrologic watershed models were created for the Swan Creek watershed. This model information is still available for the SLO for future needs.

5. Held numerous meetings to review and analyze the 32 alternatives. They narrowed the complete list of alternatives down to 9 alternatives. The project team also reviewed various combinations of alternatives.
6. Adopted 4 strategies that individually do not meet the "Purpose and Need", but they felt are valuable and complementary practices or features.
7. Discussed the array of alternatives and felt the existing damages or existing conditions did not warrant any potential alternatives at this time. The main concern was the potential cost of implementing any alternative. The project team thought that simpler projects could make small incremental improvements in local areas when implemented on a case by case basis over time through working with the District. At that point, the watershed planning process was suspended.

The SLO has all the planning information developed and reviewed by the project team. The SLO believes this information will be valuable in the future if the existing conditions or priorities change. Should existing conditions or priorities change, the SLO has some viable alternatives that could be reviewed and possibly implemented. The SLO also has the watershed models to use as tools for future analysis of the existing viable alternatives or new alternatives. Additionally, the models may also be used to assist the SLO in targeting key areas to focus efforts in flood reduction within the watershed, which is the general goal for the planning effort.