



Investigation and Analyses Report for the Wellsville Canyon Watershed Project

Appendix D

Wellsville Canyon Watershed

Cache County, Utah



The purpose of the Investigation and Analysis Appendix is to present information that supports the formulation, evaluation, and conclusions of the Watershed Plan and Environmental Impact Statement (EIS). Refer to the Administrative Record or Appendix E for the copies of the studies referred to in this Appendix.

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D.1.0 Introduction

This document summarizes the investigations and analysis completed for the planning and engineering of the flood prevention, agricultural water management, and recreation activities in preparation for the Wellsville Canyon Watershed Plan–Environmental Impact Statement (Plan-EIS). This information includes a summary of the design and criteria, analysis for agricultural water management, hydrologic and hydraulics, and flood protection, alternatives formulation and preferred alternative costs, economic evaluations, and economic benefits. Additional information relevant to each of the sections provided in this report is available in Appendix E and as part of the administrative record for the project.

The Wellsville Canyon Watershed Project (Proposed Project) is located within the Wellsville Canyon Watershed in portions of the City of Wellsville, City of Mendon, and unincorporated Cache County, Utah. The Proposed Project consists of three project purposes: Flood Prevention, Agricultural Water Management, and Public Recreation. See Technical Memoranda (TM) 0010 Alternatives, prepared by Franson Civil Engineers Inc., in Appendix E for more details on the Proposed Project.

D.2.0 Flood Prevention

Cache Water District (CWD) aims to implement the following flood prevention measures within the service area. The existing Lower Canal would be improved to carry floodwater by cleaning the cross-section and improving the capacity of the canal, lining it with concrete-canvas lining (long life, low maintenance, and hydraulically efficient) to carry the 100-year flood flow without overtopping and add open channel overflow systems at 200 West (Wellsville), 2900 South and 3400 South (unincorporated Cache County), and 200 South (Mendon). This would be accomplished through a combination of conduits and channel improvements to convey floodwater from the foothills of the Wellsville Mountains to the natural floodplain of the Little Bear River east of the communities. This would also include the abandonment of the existing Murray Spring overflow system due to the insufficient channel and culvert capacities, construction of flow diversion structures in the channels, and piped overflow systems at 200 West (Wellsville), 3400 South and 2900 South (unincorporated Cache County) and 200 South Mendon. Additional flood control pipelines capturing flood flows from Wide Canyon (Wellsville), Bird Canyon (Mendon), Thimbleberry Canyon (Mendon), 300 North (Mendon), and 400 North (Mendon) would also be constructed.

D.3.0 Agricultural Water Management

The Proposed Project would continue to divert the water for WMCD from below Hyrum Reservoir at the existing diversion points. However, the project would then convey the irrigation water of the Wellsville-Mendon Lower Canal through a pressurized piped system in Wellsville and Mendon cities and part of unincorporated Cache County, Utah. The Proposed Project would also pipe and enclose a portion of the Wellsville Eastfield Canal, beginning near the edge of the Bureau of Reclamation's property near the existing diversion at the base of Hyrum Dam and passing through Hyrum and parts of unincorporated Cache County.

The Proposed Project would completely pressurize Wellsville City Irrigation Company's irrigation system within Wellsville City and Mendon City's irrigation system managed by the Mendon North, Mendon Central, Mendon South, Mendon Second North, Greater Mendon irrigation

companies, and other irrigation companies and would install regulating ponds to stabilize peak demands on the pressurized irrigation systems.

D.4.0 Public Recreation

The recreation component of the Proposed Project consists of a new access ramp limited to non-motorized personal watercraft which would be built at Wellsville Reservoir for recreational activities and a reflection pond and walking trail to be installed at Mendon Cemetery.

D.5.0 Design Criteria

The Wellsville Canyon Project will be designed to meet the NRCS and Utah state requirements and other applicable design requirements and standards, as shown in Table 5-1 by project purpose. See Appendix E, TM004 Design Criteria, prepared by Franson Civil Engineers Inc., for more details on the design criteria for the Proposed Project. Other Utah or NRCS codes as applicable would also be followed along with the City of Wellsville, Mendon City, and Cache County's Public Works standards for construction and stormwater management.

Table 5-1. Design Criteria Used for Each Project Element

Design Criteria & Practice Standards	Flood Prevention	Agricultural Water Management	Public Recreation
Cache County Floodplain Development Permit	X	X	
Cache County Manual of Roadway Design & Construction Standards (2021)	X	X	
Cache Valley Storm Water Design Standards (2017)	X	X	X
FEMA CLOMR and LOMR	X	X	X
Mendon City Design Standards	X	X	
Wellsville City Design Standards	X	X	X
NRCS Critical Area Planting (Code 342)	X	X	X
NRCS Dust Control on Unpaved Roads and Surfaces (Code 373)	X	X	X
NRCS Irrigation Pipeline (Code 430)		X	
NRCS Irrigation Reservoir (Code 436)		X	
NRCS Access Control (Code 472)	X	X	
NRCS Pumping Plant (Code 533)		X	
NRCS Drainage Water Management (Code 554)	X		
NRCS Access Road (Code 560)		X	X
NRCS Recreation Area Improvement (Code 562)			X

Design Criteria & Practice Standards	Flood Prevention	Agricultural Water Management	Public Recreation
NRCS Recreation Land Grading and Shaping (Code 566)			X
NRCS Stormwater Runoff Control (Code 570)	X	X	X
NRCS Open Channel (Code 582)	X		
NRCS Structure for Water Control (Code 587)	X	X	
NRCS National Engineering Handbook (NEH)	X	X	X
NRCS National Engineering Manual (NEM)	X	X	X
Pollution Discharge Elimination General Construction Permit	X	X	X
Union Pacific Railroad	X		
UDOT Drainage Standards and Specifications	X	X	
UDOT Roadway Standards and Specifications	X	X	
Utah Chapter of APWA 2017 Standards and Specifications	X	X	
Utah Division of Water Rights Dam Safety Rules	X	X	
Utah DWQ TMDL for Cutler Reservoir	X	X	
Utah DWQ TMDL for Little Bear River	X	X	
Utah Pollutant Discharge Elimination System MS4 Permit	X	X	X

D.6.0 Analysis

The following Technical Memoranda (TMs) have been prepared to document the current conditions and the effects of activities within the Project Area. Table 6-1 displays the number, name, and key information contained in the TMs in Appendix E.

Table 6-1. Technical Memoranda by Number, Name, and Key Information Content

TM Number	Name	Key information Content
<i>TM-001</i>	<i>Water Rights</i>	Summarizes the existing water rights within the Wellsville Canyon Watershed Plan-EIS project area, detailing ownership, source, and quantity for both surface water and groundwater rights. It identifies key right holders, including Wellsville and Mendon Cities, several irrigation companies, and the U.S. Bureau of Reclamation on behalf of the Wellsville-Mendon Conservation District. Many rights are supplementary and cannot exceed the total basin duty when combined.

TM Number	Name	Key information Content
		The memo includes tabulated rights by entity and maps showing points of diversion (PODs) across the watershed, providing foundational data for understanding current water use and availability.
<i>TM-002</i>	<i>Hydrology</i>	Provides a detailed hydrologic analysis for the Wellsville Canyon Watershed Plan-EIS, focusing on flood risks and runoff patterns in the 31,090-acre project area. Using NRCS procedures and local data, it models both summer thunderstorms and more damaging late winter rain-on-snow events—ultimately identifying rain-on-snow events as the controlling floods for design purposes at lower recurrence intervals (2–25 year). The analysis includes land cover, soils, precipitation, and flow data, and calibrates runoff estimates using the 2017 flood. The results inform floodplain mapping and design criteria for flood mitigation infrastructure.
<i>TM-003</i>	<i>Existing Flood Inundation</i>	Evaluates existing flood inundation conditions in the Wellsville Canyon Watershed under both the FEMA Effective Floodplain and a calibrated NRCS model representing the Future Without Federal Investment (FWOFI) condition. The FWOFI model, based on NOAA Atlas 14 summer storm data, better captures the area's alluvial fan hydrology and canal influences. Flood extents were mapped for the 2- through 500-year events, with the 100-year event serving as the primary planning benchmark. Modeling revealed that under the FWOFI condition, significant overbank flooding threatens homes and infrastructure, particularly in Mendon. Comparisons with Action Alternatives showed that Alternative 1 (Structural) would substantially reduce flood extents and protect developed areas, while Alternative 2 (Non-Structural) provided only marginal improvements.
<i>TM-004</i>	<i>Design Criteria</i>	Outlines the design standards used for the Wellsville Canyon Watershed Plan-EIS, addressing flood control, irrigation, and recreation improvements. It identifies applicable local, state, and federal criteria—including NRCS practice codes, FEMA floodplain requirements, UDOT specifications, and stormwater permits—and applies them to project components like pressurized irrigation systems, small reservoirs, culverts, access roads, and a non-motorized boat ramp. The memo ensures all designs meet regulatory standards and

TM Number	Name	Key information Content
		environmental goals, including TMDL limits for the Little Bear River and Cutler Reservoir.
TM-005	<i>Canal Transmission Losses</i>	Evaluates canal seepage losses in the Wellsville Canyon Watershed to quantify potential water savings from system improvements. Seepage studies on the Wellsville-Mendon Lower Canal and Wellsville Eastfield Canal revealed annual losses of 3,514 acre-feet (39%) and 1,746 acre-feet (27%), respectively. Additional estimated losses include 1,960 acre-feet from Wellsville City's open ditch irrigation and 857 acre-feet from Mendon's irrigation systems. These losses result from seepage, evaporation, and operational spills. Total potential water savings range from 6,951 acre-feet (Lining & Buyouts Alternative) to 8,077 acre-feet (Piping Alternative), supporting the case for irrigation system upgrades across the watershed.
TM-00 6	<i>Culinary Water Savings</i>	Evaluates culinary water savings from implementing pressurized irrigation (PI) systems in Wellsville and Mendon, Utah, as part of the Wellsville Canyon Watershed Plan-EIS. During summer months, most outdoor watering currently uses culinary water, increasing system demand and energy costs. By shifting this demand to PI systems, Wellsville is projected to save 615 acre-feet and Mendon 214 acre-feet of culinary water annually, for a combined total of 829 acre-feet. The memo also compares existing and proposed energy consumption, showing both cities would significantly reduce strain on their culinary systems and defer costly infrastructure expansions.
TM-007	<i>Operation & Maintenance Costs</i>	Analyzes the current and projected annual operations and maintenance (O&M) costs for flood control, irrigation, culinary water, and recreation in the Wellsville Canyon Watershed. Under existing conditions, O&M costs total \$566,338 annually. With either the Piping or Lining & Buyouts alternatives, total costs would drop to around \$211,000 and \$208,000, respectively. The memo attributes these savings mainly to reduced culinary water demand from outdoor irrigation, lower canal maintenance needs, and efficiencies in secondary water systems. While flood control and recreation O&M remain stable, the switch to pressurized irrigation significantly reduces costs for both Wellsville and Mendon.

TM Number	Name	Key information Content
<i>TM-008</i>	<i>Capital Cost Evaluation</i>	Presents the capital cost estimates for proposed improvements in the Wellsville Canyon Watershed Plan-EIS. It itemized costs for pipelines, canal lining, turnouts, regulating ponds, pump stations, and recreation facilities. The total installation costs are estimated at \$139,176,000. The memo includes cost assumptions, construction contingencies, and unit pricing derived from recent bids and NRCS guidance, forming the basis for economic comparisons and funding strategies.
<i>TM-009</i>	<i>Crop Water Use & Yields</i>	Analyzes crop yields, water use, and potential agricultural benefits associated with improved irrigation delivery efficiency in the Wellsville Canyon Watershed. It evaluates historical cropping patterns, develops yield curves linking water use to productivity, and shows that improved water delivery can significantly increase crop yields—especially for alfalfa, corn, and grass hay. The Preferred Alternative is projected to reduce pumping costs for 193 acres of farmland and boost annual crop income by 135% over No Action. The memo also notes that water savings could enable a shift to higher-value, late-season crops, increasing economic benefits beyond those directly quantified.
<i>TM-010</i>	<i>Alternatives</i>	Outlines and evaluates the three primary alternatives considered for the Wellsville Canyon Watershed Plan-EIS: No Action, the Piping Alternative, and the Lining & Buyouts Alternative. The No Action Alternative maintains existing conditions and highlights current flooding, inefficiencies, and water losses. The Piping Alternative proposes replacing open canals with pressurized pipelines, optimizing irrigation efficiency, and expanding sprinkler use. The Lining & Buyouts Alternative involves lining select canals and acquiring flood-prone properties. TM010 details the physical features, costs, benefits, and implementation considerations of each alternative, providing the foundation for environmental, economic, and engineering comparisons used in the broader EIS.
<i>N/A</i>	<i>Economic I&A Report</i>	Compares the economic performance of the No Action, Piping, and Lining & Buyouts Alternatives using quantified benefits, costs, and benefit-cost (B/C) ratios. The Piping Alternative produces the highest total average annual benefits at \$11,807,525, followed by Lining & Buyouts at \$11,574,684. Average annual costs

TM Number	Name	Key information Content
		are \$6,016,158 for Piping and \$7,957,080 for Lining & Buyouts, resulting in positive B/C ratios of 1.96 for Piping and 1.45 for Lining & Buyouts. Major economic benefits include reduced flood damages, increased crop income, culinary water savings, O&M reductions, and recreational enhancements. The economic tables also show significant water savings and land use improvements that support the long-term viability of agriculture and infrastructure in the watershed. Based on this analysis, the report identifies the Piping Alternative as offering the highest net economic return.

D.7.0 Hydrologic and Hydraulic Analysis

The Wellsville Canyon Watershed, located in southwestern Cache County, Utah, encompasses approximately 70,846 acres and is a key tributary drainage of the Little Bear River, which ultimately contributes to the Bear River Watershed. The defined project area within this watershed is 31,090 acres, focused on areas surrounding the cities of Wellsville and Mendon, where flooding risks, infrastructure limitations, and hydrologic variability intersect. Technical Memorandum 002 (TM002) details the hydrologic modeling approach used for this Plan-EIS, which included delineating 29 subwatersheds and applying NRCS methods to determine curve numbers and time of concentration values based on land cover, soil type, and slope. Rain-on-snow events were identified as controlling the hydrology for lower-frequency events (2-, 10-, and 25-year return intervals), while high-intensity summer thunderstorms dominate the larger events (50-, 100-, and 500-year return intervals). The 2017 flood was selected as a representative calibration event, with its spatial extent and field observations helping to validate the model outputs.

Technical Memorandum 003 (TM003) presents the hydraulic analysis of existing flood conditions under these return intervals. Using HEC-RAS modeling, the study quantified flood depths, water surface elevations, and inundation extents throughout the watershed. Results showed that significant areas within Mendon and Wellsville are currently subject to shallow, dispersed flooding during even moderate storm events, with notable flooding pathways at Deep Canyon, Wide Canyon, Threemile Canyon, and other local drainages. The analysis demonstrates that existing channels and conveyance infrastructure are insufficient to route floodwaters safely through developed areas, leading to recurring flood hazards. These findings underscore the need for effective flood mitigation alternatives that improve conveyance, reduce inundation extent, and protect residential and agricultural areas. Further details are documented in Appendix E, TM002 Hydrology and TM003 Existing Flood Inundation, prepared by Franson Civil Engineers, Inc.

D.8.0 Flood Prevention Analysis

A detailed flood prevention analysis was performed for the Wellsville Canyon Watershed as part of the hydrologic and hydraulic investigations documented in TM002 and TM003. The purpose of the analysis was to characterize the nature and extent of existing flood hazards in the watershed

and evaluate the efficacy of conceptual alternatives in reducing those hazards. The study focused on the tributary drainages entering the cities of Mendon and Wellsville from the Wellsville Mountains, with particular emphasis on Deep Canyon, Wide Canyon, Threemile Canyon, and other contributing ephemeral streams.

The hydrologic analysis used NRCS methods, including curve number and time of concentration procedures outlined in the National Engineering Handbook. Rainfall distributions were developed using NOAA Atlas 14 data, and separate hyetographs were prepared for both rain-on-snow events and high-intensity summer thunderstorms. Modeling was performed for the 2-, 10-, 25-, 50-, 100-, and 500-year events. Subwatersheds were delineated across 29 distinct drainage areas to calculate runoff and peak flows into the flood-prone zones of Mendon and Wellsville. The 2017 flood was used as a calibration benchmark to validate the modeled runoff depths and inundation extents.

The hydraulic modeling was performed in HEC-RAS using 2D flow simulation, capturing the topographic influence of developed infrastructure and natural terrain. TM003 presents the flood extents and depths associated with each modeled storm frequency, clearly showing that even relatively frequent storm events produce nuisance flooding in both communities. For example, the 10-year event generates overland flooding across key streets and agricultural fields, while the 100-year event results in widespread inundation exceeding 1.5 feet in many areas of Mendon. Identified flood pathways include overbank flow from Deep Canyon, lateral spills near the Lower Canal, and ponding at under-capacity culverts and drainage channels.

Alternatives evaluated in TM010 include a suite of flood mitigation measures, such as detention basins, canal improvements, and channel stabilization. Modeled alternatives were shown to significantly reduce the spatial extent and depth of flooding. In particular, the Preferred Alternative demonstrates substantial improvements in Mendon, reducing inundated areas by nearly half during the 10- and 25-year events and substantially decreasing flow velocities and flood hazard exposure for residential parcels. Additional details on the alternatives modeling and flood reduction outcomes can be found in Appendix E, TM002, TM003, and TM010.

D.9.0 Alternative Formulation

The alternative formulation process for the Wellsville Canyon Watershed Plan-EIS followed a structured, multi-phase methodology rooted in NRCS planning protocols and federal water resource planning guidance, including the USDA-NRCS NWPM, Watershed Program Handbook, and the Principles, Requirements, and Guidelines (PR&G). Alternatives were developed to address the three core PL 83-566 purposes identified in the project area: flood prevention, agricultural water management, and public recreation. A total of nine deficiencies across the watershed were identified based on flooding patterns, canal inefficiencies, limited secondary water access, and inadequate recreational amenities.

Management measures were formulated in response to each identified deficiency and screened for pairwise compatibility, resulting in a broad Initial Array of alternatives. These alternatives were then subjected to two rounds of screening. The first screening evaluated alternatives against the federal and project-specific objectives and constraints. The second screening assessed both qualitative ecosystem service improvements and quantitative economic viability, including Benefit-Cost Ratios (BCRs) and net economic benefits.

Ultimately, three alternatives were carried forward into the Final Array: the No Action (or Future Without Federal Investment) Alternative, the Piping Alternative, and the Lining & Buyouts Alternative. The Piping Alternative achieved the highest BCR of 1.97 and offered the most significant gains in ecosystem service delivery and flood protection. The Lining & Buyouts Alternative, while not as economically favorable, was retained to satisfy the requirement for a nonstructural alternative and due to its improvements to cultural and regulating services. The Lining Alternative was screened out for failure to provide adequate ecosystem service gains and safety improvements.

This comprehensive process ensured that the selected alternatives were not only economically justifiable but also sustainable, environmentally responsible, and aligned with the guiding principles of the PR&G. The formulation process, including measure compatibility, screening matrices, and final alternative selection, is documented in detail in Appendix E and summarized in Appendix E in the *PR&G Alternative Formulation & Screening Matrix* and the *PR&G Ecosystem Services Worksheet*, as well as in TM010 Alternatives.

D.10.0 Economic Analysis

The Wellsville Canyon Watershed Plan-EIS Economic I&A Report and Ecosystem Services Framework documentation is included in Appendix E. Report findings are summarized here.

D.10.1 Federal Guidelines of National Economic Efficiency Analysis

The Benefit-Cost Analysis (BCA) conducted for the Wellsville Canyon project adhered to the federal guidelines outlined in the USDA *Principles, Requirements, and Guidelines* (PR&G) (USDA 2017), the NRCS *Natural Resources Economics Handbook* (NRCS 1998), and the *National Watershed Program Manual* (NRCS 2024). These standards provided the framework for evaluating the economic justification of the No Action and Action Alternatives in compliance with NRCS watershed planning requirements.

While multiple ecosystem service categories were identified and considered as part of the broader planning effort, the economic analysis did not rely on monetizing these benefits to justify the project. The Action Alternatives demonstrated high Benefit-Cost Ratios (BCRs) based solely on quantifiable economic benefits—primarily flood damage reduction and water conservation. As such, the project met the economic feasibility threshold under NRCS criteria without needing to include unquantified or non-market ecosystem service values.

D.10.1.1 Ecosystem Services

The Wellsville Canyon Watershed Plan-EIS integrates an ecosystem services framework consistent with the Principles, Requirements, and Guidelines (PR&G) for Federal Investments in Water Resources (USDA 2017), ensuring that economic, environmental, and social values are given equal standing in decision-making. The project emphasizes the importance of protecting and enhancing ecosystem functions as part of achieving national economic efficiency—not solely through monetary returns, but through a broader understanding of public value. This approach allows the proposed alternatives to be evaluated for their capacity to improve the well-being of people within the watershed while maintaining or restoring ecological integrity.

The framework used follows the four recognized categories of ecosystem services: provisioning, regulating, cultural, and supporting. In the Wellsville Canyon watershed, regulating services include flood attenuation, sediment and nutrient retention, and erosion control—functions which are essential in reducing flood risk, protecting downstream water quality, and limiting damage to agricultural lands. Cultural services are affected through changes in visual quality, increased or restricted public recreation access, and community character. The provisioning services impacted include water availability for irrigation and, to a lesser extent, non-irrigation uses such as livestock. Supporting services—like soil retention, hydrologic connectivity, and aquatic habitat continuity—are foundational to sustaining long-term ecological health and enabling the provision of the other service types.

Causal chains were developed for a wide array of measures to evaluate the links between physical changes to the landscape (such as canal modifications, detention basins, and pond retrofits) and downstream effects on ecosystem services and human well-being. Each alternative was assessed in terms of its effects on specific ecosystem functions, including connectivity, surface water detention, infiltration capacity, groundwater recharge, and geomorphic stability. The final analysis characterized the anticipated positive and negative ecosystem service impacts of each alternative, even though the formal benefit-cost analysis (BCA) did not require monetized values from these services due to already favorable BCRs. Nonetheless, identifying and evaluating these ecosystem services adds transparency and depth to the decision-making process and provides a foundation for ensuring long-term sustainability of the watershed's resources.

The analysis found that several of the action alternatives would provide measurable benefits to regulating and cultural ecosystem services. For example, the piping alternative improves regulating services by reducing canal seepage and flood risk while also enhancing public safety. The Lining & Buyouts Alternative supports cultural services by removing vulnerable structures from flood-prone areas, improving visual and recreational quality in Mendon and Wellsville. These effects, though not directly monetized in the final BCR calculations, illustrate the broader public value provided by the project in addition to its economic returns.

D.10.2 Alternatives Evaluated

This section provides a brief discussion of the alternatives and measures carried forward through the EIS process. Each measure was incrementally evaluated for engineering efficacy, modeled hydrologically and hydraulically (H&H), and then evaluated in detail for economic feasibility as part of this process. Each measure was also evaluated as a complete part of an entire alternative package for these same conditions, as well as all of the PR&G and NEPA criteria and constraints. Additionally, all corridors and easements have been verified and confirmed, and property owner agreements are in place with the Sponsors.

D.10.2.1 No Action/Future Without Federal Investment (FWOFI)

Taking no action would consist of activities carried out if no federal action or funding were provided. This alternative would not address the flooding that has occurred historically. The canals would be maintained in their existing condition as earthen and worn out HDPE-lined channels. The WMCD Lower Canal and existing flood drainages within the communities of Wellsville and Mendon as well as unincorporated Cache County and would continue to overtop during flood events and flooding in the Wellsville Canyon watershed would continue. It was this flooding that

led Cache County Public Works, in cooperation with the WMCD, to strategically breach the WMCD Lower Canal during the 2017 rain-on-snow event referenced in the Hydrology tech memo located in Appendix E to the Plan-EIS. Additionally, erosion and sedimentation from the alluvial plains above the canals would continue under this alternative. There would be no improvements to recreational access installed.

The No Action Alternative would not meet the project's Purpose and Need and would not solve the Problems (PL-566 authorized purposes) or meet the objectives identified in Chapter 1 as the existing infrastructure would continue to operate in its current condition and would not improve flood prevention, conserve irrigation water, or improve recreational access. Residents would continue to use culinary water for irrigation (that is, watering lawns and gardens), putting stress on existing water supply and infrastructure. This alternative would not meet the Federal Objective to protect the environment and promote sustainable economic development. Additionally, the No Action Alternative would not successfully meet the PR&G Guiding Principles of Healthy and Resilient Ecosystems, Sustainable Economic Development, Floodplains, Public Safety, or Watershed Approach.

D.10.2.2 Proposed Action – Piping Alternative

The Piping Alternative would continue to divert the water for the WMCD from below Hyrum Reservoir at the existing diversion points. However, this alternative would then convey the irrigation water of the Wellsville-Mendon Lower Canal through a pressurized piped system in Wellsville and Mendon cities and part of unincorporated Cache County, Utah. The existing Lower Canal would be improved to carry floodwater by cleaning the cross-section and improving the capacity of the canal, lining it with a concrete-canvas lining (long life, low maintenance, and hydraulically efficient) to carry the 100-year flood flow without overtopping and add open channel overflow systems at 200 West (Wellsville), 2900 South and 3400 South (unincorporated Cache County), and 200 South (Mendon). This would be accomplished through a combination of conduits and channel improvements to convey floodwater from the foothills of the Wellsville Mountains to the natural floodplain of the Little Bear River east of the communities. This would also include the abandonment of the existing Murray Spring overflow system due to the insufficient channel and culvert capacities, construction of flow diversion structures in the channels, and piped overflow systems at 200 West (Wellsville), 3400 South and 2900 South (unincorporated Cache County) and 200 South Mendon. Additional flood control pipelines capturing flood flows from Wide Canyon (Wellsville), Bird Canyon (Mendon), Thimbleberry Canyon (Mendon), 300 North (Mendon), and 400 North (Mendon) would also be constructed.

This alternative would also pipe and enclose a portion of the Wellsville Eastfield Canal, beginning near the edge of the Bureau of Reclamation's property near the existing diversion at the base of Hyrum Dam and passing through Hyrum and parts of unincorporated Cache County.

The alternative would also completely pressurize Wellsville City Irrigation Company's irrigation system within Wellsville City and Mendon City's irrigation system managed by the Mendon North, Mendon Central, Mendon South, Mendon Second North, Greater Mendon irrigation companies, and other irrigation companies. This alternative would install regulating ponds to stabilize peak demands on the pressurized irrigation systems. A new access ramp limited to non-motorized personal watercraft would be built at Wellsville Reservoir for recreational activities and a reflection pond installed at Mendon Cemetery.

D.10.2.3 Proposed Action – Lining & Buyouts Alternative

The PR&G requires full consideration of at least one nonstructural or nonstructural-structural combination plan in the Final Array of alternatives. The nonstructural alternative may be combined with other structural measures as long as the benefits of the structural element are fewer or smaller than the benefits of the nonstructural measure(s). Under the Lining & Buyouts Alternative, the authorized purpose of flood prevention would be addressed using a nonstructural measure.

The principal difference between the Lining & Buyouts Alternative and the Piping Alternative is that the Lining & Buyouts Alternative would line WMCD Lower Canal with the concrete canvas liner (impermeable liner) to conserve irrigation water and reduce operational spillage. The channel would be cleaned to form a uniform cross-section but would not be increased in size for additional flood flows. Culvert crossings would not be improved for additional capacity.

The nonstructural element of this alternative would be to seek voluntary buyouts of the structures/properties within the 100-year (1% chance in any given year) existing conditions flood inundation area to eliminate the risks associated with flood events as reflected by the H&H analysis.

This alternative would also deliver the water of the Wellsville Eastfield Canal Company through a piped portion of the Wellsville Eastfield Canal beginning at the existing diversion at the base of Hyrum Dam passing through Hyrum and parts of unincorporated Cache County, Utah. The alternative would also construct improvements to completely pressurize the Wellsville City Irrigation Company's irrigation system within Wellsville City and the Mendon North, Mendon Central, Mendon South, Mendon Second North, and Greater Mendon Irrigation companies' irrigation systems within Mendon City. This alternative would also provide for regulating ponds of the secondary systems in Wellsville and Mendon to stabilize peak demands on the pressurized irrigation systems. A new access ramp limited to non-motorized personal watercraft would be built at Wellsville Reservoir for fishing and other recreational activities and a reflecting pond would be constructed at Mendon Cemetery.

D.10.3 Benefits of the Preferred Alternative

The Preferred Alternative for the Wellsville Canyon Watershed Plan-EIS—also designated as the National Economic Efficiency (NEE) and Federally Recommended Alternative—is the Piping Alternative. This alternative comprises a suite of structural measures designed to maximize public benefits, minimize risks to life and property, and support long-term agricultural, recreational, and environmental sustainability. The measures include piping the canal system to reduce flood risk and improve water delivery efficiency, installing various flood prevention improvements, secondary water systems in Wellsville and Mendon, and implementing two recreational increments: the Wellsville Reservoir Boat Ramp and the Mendon Cemetery Pond.

Summary of Economic Justification

The Piping Alternative was selected based on a robust economic analysis demonstrating high net public value. The Benefit-Cost Ratio (BCR) for the alternative is 1.96, with average annual benefits of \$11,807,525 compared to costs of \$6,007,158. This yields net benefits of \$5,800,367 annually, demonstrating that the project would provide a substantial return on federal investment. Notably, this high BCR was achieved without requiring monetized ecosystem services, underscoring the strength of the structural measures alone.

Methodology for Benefit Quantification

Benefits are determined as the difference between the without-project and the with-project condition. The planning policy used for this plan/environmental document (P&G and PR&G) state that Federal investments in water resources as a whole should strive to maximize public benefits, with appropriate consideration of costs. Public benefits (i.e., positive ecosystem services) encompass environmental, economic, and social goals; include monetary and non-monetary effects; and allow for the consideration of both quantified and unquantified measures. The preferred alternative will allow the Sponsors to reduce the potential for loss of life, and to continue protection of existing property and infrastructure, improve agricultural water management, and provide recreational opportunities to local communities. The preferred alternative maximizes public benefits.

The stream of monetary benefits was described in average annual equivalent terms. The average annual expected benefits were the difference between the No Action Alternative and each project Action Alternative. The expected average annual damages for each alternative, storm event (8 events), and damage category below were estimated with the following equation:

$$\sum (PFED_{i-1} + FED_i)/2 * (PPFE_{i-1} - PFE_i)$$

- $i = 1$
- $PFED_{i-1}$ - Previous Flood Event Damages
- FED_i - Flood Event Damages
- $PPFE_{i-1}$ - Probability of Previous Flood Event
- PFE_i - Probability of Flood Event

The damage (and benefit) categories used in this analysis are defined below.

Benefit Categories

Environmental and Social Benefits

Environmental and social benefits were not monetized but are further explained for each alternative studied in detail in the environmental consequences section of the Plan-EIS.

Environmentally adverse impacts will be minimized during construction. Long-term, there would only be negligible adverse impacts anticipated from any of the evaluated alternatives.

Socially, the threat of loss of life or property will be minimized with reduced flood depths at buildings with the irrigation canal and pipeline improvements. If the Recreation Alternative is implemented, there will be a significant increase in recreational activities

Structure, Content, & Vehicle Damages

Local tax appraisal district records were used to obtain the structural values of residences, commercial and public properties, and outbuildings that would be affected by project activities. The structure damages were estimated using the methodology described in the Structural Damages Calculations Template (Tim Goode, NWMC). The value of the structures was calculated by subtracting the depreciated replacement value (DRV) from the Tax Assessor's structure value. The structures in the project area that are affected by flooding are located in scattered rural areas. See Table 12 in the Economic I&A Report in Appendix E for the DRVs used for structures, which

was based on the year each structure was built.

Based on the Life Cycle Chart (swiftestimator.com, building cost reports online 2/2007) the Depreciated Multiplier ranged from 18% to 30%. The structure value used in the flood damage analysis was estimated as: The County Tax Assessed Value * (1- Depreciated Replacement Value Factor) (see: WellsvilleBenefitsCosts.xls for calculations—available upon request). This estimate DRV is also consistent with the USACE National Structure Inventory documentation: “Structure Valuation – These replacement values for structures are then depreciated in order to obtain depreciated replacement value; each structure is depreciated by 1% per year for the first 20 years, after which it is assumed that routine maintenance would keep structure values at 80% of their replacement values”.

(<https://www.hec.usace.army.mil/confluence/nsi/technicalreferences/latest/technical-documentation>)

Total value of structures in the 500-year floodplain was estimated at about \$60 million. One commercial building and 266 residences were in the floodplain.

Content values were estimated as a percentage (about 75%) of assessed property values (FEMA). Estimated floodwater depths where flood damage occurs, for various storms (including the 500-year storm), for each structure were based on the results of the hydrology and hydraulics (H&H) simulation modeling (Franson Civil Engineers). Floodwater data was then used with water depth to damage functions (FEMA) to estimate structural and content damages based on the point of entry where damages would begin. These depth to damage functions were specific for (1) different types of residences (i.e., one or two story homes with or without basements; split level homes; mobile homes; apartments; etc.); and (2) different types of commercial and public properties, and businesses in the floodplain area. For vehicles, local project managers estimated the typical vehicle replacement dollar value. Using the same source as mentioned above, floodwater damages to vehicles located at affected properties were estimated, a conservative value of \$18,000 per vehicle was used. Damages to other vehicles not located at each building but possibly in harm’s way during a flood event were not included. Damage starts for vehicle was 0.5 feet above ground surface elevation. It was estimated that each affected residence would have a minimum of two vehicles, public properties three, small commercial properties five and large commercial properties ten vehicles.

The number of structures that could be flooded and their total structural value are displayed in Table 13 and Table 14 in the economic I&A report in Appendix E.

Flood Damage Reduction Benefits

Flood damage reduction benefits were quantified using an integrated hydrologic, hydraulic, and economic evaluation framework developed for the Wellsville Canyon Watershed Plan-EIS. The analysis follows a building-block approach beginning with storm characterization and progressing through hydraulic simulation, inundation mapping, structure exposure identification, and event-based damage estimation prior to aggregation into expected annual damages.

Hydrologic characterization documented in TM002 identifies the watershed’s dominant flood-generating mechanisms as rain-on-snow events, with extreme events also produced by localized summer monsoon thunderstorms. Storm frequency development and distribution selection were conducted in accordance with the National Engineering Handbook and PR&G requirements, with evaluation frequencies including the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year events. Summer

rainfall distributions were developed using NOAA Atlas 14 precipitation data processed through NRCS technical tools and verified for hydraulic modeling application. Because NOAA Atlas 14 does not represent winter precipitation processes, rain-on-snow events were independently characterized using precipitation records, stream gauge responses, snow water equivalent data, and weather observations to identify qualifying events and develop frequency relationships.

Evaluation of watershed conditions demonstrated that rain-on-snow events govern runoff response for lower-frequency storms, while higher-frequency events are controlled by convective rainfall mechanisms. Selected design storms therefore reflect this dual hydrologic regime. Additionally, FEMA floodplain mapping and life-safety considerations required evaluation of the 100-year event within floodplain reaches, and canal conveyance elements were designed and evaluated to verify non-overtopping performance under that condition.

Hydrologic outputs from the selected storm scenarios were used as inputs to hydraulic modeling described in TM003. Hydraulic simulations generated water surface elevations and flood depth grids for existing and with-project conditions across evaluated return periods. These modeled flood depths formed the basis of the economic exposure and damage calculations.

Structure inventories located within modeled inundation extents were compiled using local appraisal records and field verification. Structural values were adjusted to represent depreciated replacement value consistent with accepted federal methodologies, and content values were estimated as a percentage of structure value. Vehicle exposure assumptions were developed based on property type. Modeled flood depths for each storm event were applied to these inventories using FEMA depth-damage relationships differentiated by structure type and configuration to estimate damages to structures, contents, and vehicles for each frequency event.

Event-specific damages were then combined probabilistically using exceedance probabilities to compute expected annual damages representing the without-project condition. The same procedure was applied using hydraulic outputs representing project implementation to determine residual damages. Flood damage reduction benefits were calculated as the difference between these conditions.

Using this framework, average annual flood damages under existing conditions are estimated at approximately \$7.3 million. Implementation of the Preferred Alternative reduces expected annual damages to less than \$500,000, yielding approximately \$6.8 million in annual flood protection benefits. These reductions reflect modeled protection of residential structures, commercial property, and associated contents and vehicles located within flood-affected areas identified through hydraulic inundation mapping. *Agricultural Water Management*

The proposed canal piping improvements will improve irrigation water delivery reliability, increase conveyance efficiency, and allow water to be delivered in a manner more consistent with crop consumptive use requirements. Existing irrigation within the project area already includes a combination of flood irrigation and pressurized sprinkler irrigation systems (including wheel lines, hand lines, and pivots), and the project improves the efficiency and reliability of water delivery to existing farm turnouts rather than requiring conversion of on-farm irrigation systems. Improved delivery reliability and reduced conveyance losses allow more irrigation water to reach crops during critical growing periods, reducing deficit irrigation conditions and increasing yields.

Crop yield increases were estimated using crop yield response curves and water budget analyses developed specifically for the project area based on data from Utah State University Extension,

USDA National Agricultural Statistics Service, NRCS Web Soil Survey productivity estimates, and regional agricultural production studies, as documented in Appendix E, Technical Memorandum 009. These yield curves quantify the relationship between consumptive water use and crop yield under existing and improved irrigation delivery conditions. As documented in Appendix E, Technical Memorandum 009, “Yield curves describe the correlation between consumptive water use and yield quantity... [and] are used to estimate possible yield increase... based on changes to water supply with project.” Yield estimates under without-project and with-project conditions were developed using crop-specific consumptive use requirements, irrigation efficiency assumptions, and irrigation water availability calculations. Crop income under each condition was calculated using crop yield, crop acreage, and crop price assumptions, and the difference between without-project and with-project crop income represents the net agricultural benefit attributable to the project. As documented in Appendix E, the change in crop income was estimated by multiplying crop yield, crop price, and crop acreage under without-project and with-project conditions.

The yield increases estimated for alfalfa, grass hay, wheat, and corn silage vary by crop type and project area and reflect the reduction in irrigation water shortages and improved irrigation delivery reliability provided by the project. These yield increases were calculated directly using crop-specific yield response curves and water availability analyses rather than applying a single uniform percentage increase. Based on this analysis, total annual crop income benefits were estimated at approximately \$4.4 million.

The majority of these agricultural benefits represent increases in crop income resulting from improved irrigation water delivery reliability, reduced conveyance losses, and improved irrigation scheduling across the irrigated acreage served by the project. These crop income benefits were calculated by comparing crop yields and crop income under without-project and with-project conditions, as documented in Appendix E. Irrigation pumping cost savings apply to approximately 193 acres and represent a separate and much smaller benefit component, estimated at approximately \$24,000 annually. All other agricultural benefits reflect changes in crop income expected as a result of improved irrigation delivery conditions rather than pumping cost savings.

The crop income benefits were calculated based on irrigated crop acreage and crop yield changes evaluated under without-project and with-project conditions for each project service area, as documented in Tables 8 through 11 of the Economic I&A Report (Appendix E). These tables present the irrigated acreage, crop yields, and crop income calculations used to determine the change in crop income attributable to the project.

The project also provides irrigation pumping cost savings in areas where the pressurized delivery system provides sufficient pressure at the turnout to operate existing sprinkler systems without supplemental pumping. These pumping savings affect approximately 193 acres and were included in the economic analysis. No on-farm irrigation pumps were assumed to be replaced or installed as part of the project, and no on-farm irrigation conversion costs were required to realize the estimated agricultural benefits.

The proposed pressurized irrigation system is expected to reduce pumping energy requirements associated with irrigation water delivery within the municipal secondary irrigation system. Under existing conditions, groundwater pumping is required to supply irrigation water for outdoor uses. Technical Memorandum 006 (Appendix E) documents historic pumping energy use and demonstrates that implementation of the pressurized irrigation system would substantially reduce

irrigation pumping energy requirements by allowing irrigation water to be delivered through the pressurized secondary irrigation system rather than requiring groundwater pumping. These reductions represent irrigation system operational efficiencies and are separate from agricultural crop income benefits, which were evaluated independently using without-project and with-project crop income comparisons, as documented in Tables 8 through 11 of the Economic I&A Report (Appendix E).

Under existing conditions, the irrigation district incurs ongoing and required operation and maintenance costs associated with maintaining open canal infrastructure, including vegetation control, sediment removal, structural maintenance, and operational labor. With the proposed project, replacement of open canals with pipeline conveyance reduces these required O&M activities. Changes in O&M costs were evaluated as part of the without-project and with-project economic comparison framework documented in Appendix E. These cost differences reflect reductions in required operation and maintenance resource use associated with irrigation delivery infrastructure and were evaluated consistently with NRCS economic evaluation guidance. Detailed O&M cost estimates and comparisons between without-project and with-project conditions are provided in Appendix E and the supporting economic analysis spreadsheet.

All capital costs necessary to provide improved irrigation delivery, including pipelines, pump stations, service connections, and turnout infrastructure, are included in the project cost estimate, as documented in Appendix E, Technical Memorandum 008. The agricultural benefits identified in this analysis result from improved conveyance efficiency, improved delivery reliability, and reduced irrigation water shortages, rather than from producer-funded conversion to pressurized irrigation systems. All assumptions, yield calculations, and crop income comparisons between without-project and with-project conditions are documented in the economic analysis spreadsheet and supporting technical memoranda included in Appendix E.

Recreation Benefits

The Wellsville Watershed Project includes two recreation increments: construction of a new boat access ramp at Wellsville Reservoir and development of public access improvements at Cemetery Pond. Recreation Use Days (RUDs) were not formally tracked at these locations; therefore, projected increases in recreation use were estimated based on consultation with the City Manager of Wellsville, Utah, who oversees the facilities and is familiar with existing recreation patterns and expected changes resulting from improved access.

At Wellsville Reservoir, current use was estimated at approximately two boats per day during the summer recreation season. Based on local knowledge of access limitations and expected behavioral response to improved infrastructure, it was estimated that installation of a formal boat ramp would approximately double boating use during the recreation season. The resulting increase in annual recreation use days was used to estimate recreation benefits associated with motorized boating.

At Cemetery Pond, public access improvements are expected to increase recreational visitation by approximately 900 recreation use days annually. These projected use days were allocated among sightseeing, wildlife viewing, and picnicking activities based on the types of recreation opportunities available at the site and the expected distribution of visitor activities.

Annual recreation benefits were calculated by multiplying the projected increase in recreation use days for each activity by the applicable recreation day value for that activity. Recreation day values

represent estimates of the economic value of a single day of participation in a specific recreational activity and are based on published recreation valuation studies and federally accepted economic recreation valuation guidance. Activity-specific recreation day values were applied for motorized boating, sightseeing, wildlife viewing, and picnicking, and total annual recreation benefits were calculated as the sum of the benefits across all activities.

Using this approach, annual recreation benefits were estimated at \$7,305 per year for the Wellsville Reservoir boat ramp and \$4,658 per year for Cemetery Pond, for a combined total annual recreation benefit of approximately \$11,963. These estimates reflect the expected increase in recreational opportunities resulting from improved public access and facility usability.

Although both recreation increments produced benefits exceeding their individual costs, the recreation increments alone did not meet the Federal Objective of the project. The primary Federal Objective is flood prevention and watershed protection, including improving public safety, protecting property, improving irrigation water management, improving water delivery reliability, improving water quality, and improving water conservation. Recreation benefits represent an ancillary benefit of the project rather than its primary justification.

Ecosystem Services Benefits

While not monetized, the Preferred Alternative supports important ecosystem services:

- **Provisioning Services:** Enhanced crop production, improved canal water quality, and recreational fishing/hunting opportunities
- **Regulating Services:** Reduced risk of flood damage and public safety hazards
- **Cultural Services:** Increased recreational access (e.g., walking, cycling, boating), scenic open space

Socially, the most critical benefit is risk reduction to human life. Although not assigned a dollar value, federal planning policy (P&G and PR&G) allows life safety considerations to supersede strict economic calculations. Reducing loss of life potential from flooding was a central objective in the development of the preferred alternative.

Summary of Benefits by Increment (Preferred Alternative)

Benefit Type	Increment Name	Annual Benefit
Recreation	Reservoir Boat Ramp	\$7,305
	Mendon Cemetery Pond	\$4,658
Crop Irrigation	Increments 3–7	\$4,427,500
Canal O&M	Increments 3 & 6	\$14,750
Culinary O&M	Increments 4 & 5	\$525,510
Flood Damage Reduction	Structures, Contents, Vehicles (Increment 8)	\$6,827,802

Benefit Type	Increment Name	Annual Benefit
Total Annual Benefit		\$11,807,525

Broader Impacts and Implementation

Approximately 6,000 residents of Wellsville and Mendon will directly benefit from this project. Beyond property protection and ag enhancement, the project supports emergency access and continuity of services for the downstream community. Environmental impacts during construction will be temporary and minimal, while long-term ecological disruptions are expected to be negligible.

The implementation schedule spans five years, including design and construction, followed by a 50-year operational project life. This structure provides long-term certainty and stability for the communities, agricultural producers, and recreational users within the Wellsville Canyon watershed.

D.10.4 Costs of the Preferred Alternative

Project costs include all expenses incurred as part of the development, installation, operation, and maintenance of a project. Costs were estimated for each work of improvement included as part of the action alternatives. The Preferred Alternative—Piping Alternative—was costed by Franson Civil Engineers in 2025 and represents a comprehensive investment in flood prevention, irrigation efficiency, and community recreation. Cost estimates were developed following NRCS protocols in the *Resource Economics Handbook* (2014) and cost allocation was performed in accordance with NRCS funding rules as described in the *National Watershed Program Manual* (2024). All cost figures reflect the Fiscal Year 2025 price base, using a 3.00% discount rate over a 55-year period of analysis.

Project Cost Components

The Preferred Alternative includes both capital (installation) and annual operation and maintenance (O&M) costs across multiple functional areas. Each project increment—flood improvements, irrigation piping, and recreation infrastructure—was assigned to one of three NRCS-authorized purposes:

- Flood Protection (100% federal cost share)
- Irrigation Water Management (75% federal, 25% local)
- Recreation (50% federal, 50% local)

Using NRCS cost allocation methods, expenditures were converted to present values and then annualized across the project life. No replacement costs were required, as all structures were assumed to last the full 50-year design life.

Summary of Annualized Costs

Total average annual costs for Alternative 1 amount to \$6,007,158, comprising \$5.8 million in amortized installation and roughly \$211,000 in annual O&M. These costs reflect investments in eight primary increments, including both recreation features and major canal piping improvements. The following cost categories illustrate the scope of infrastructure being implemented:

Recreation Infrastructure

- Wellsville Reservoir Boat Ramp: \$700/year
- Mendon Cemetery Pond: \$1,700/year

Agricultural Water Management

- Wellsville East Field Piping: \$253,000/year
- Wellsville Secondary System: \$904,220/year
- Mendon Secondary System: \$540,660/year
- WMCD Lower Canal Piping: \$2,130,200/year

Flood Prevention Measures

- Lower Canal Flood Improvements: \$1,470,800/year
- Wellsville City Flood Routing & Spills: ~\$582,100/year combined
- Bird Canyon & Other Flood Control Pipes: ~\$123,780/year

Each of these components contributes to the long-term resiliency of the watershed by mitigating flood hazards, improving irrigation delivery and water use efficiency, and enhancing public access to outdoor spaces.

Cost Comparison Across Alternatives

For context, the non-preferred Alternative (Lining & Buyouts) would cost more and deliver less public value. Its annualized cost is \$7,957,080, exceeding the Preferred Alternative by nearly \$2 million per year. This includes significant one-time expenses associated with voluntary property buyouts in the floodplain (\$4.8 million amortized) and less effective structural irrigation improvements (e.g., canal lining without increased flood capacity).

Benefit-Cost Outcomes

Despite its upfront investment, the Piping Alternative demonstrates strong cost efficiency. It produces net annual benefits of \$5,800,367 and a Benefit-Cost Ratio (BCR) of 1.97, far exceeding the minimum required for federal investment. In contrast, the Lining & Buyouts Alternative's BCR is only 1.45, with lower net benefits.

Alternative	Avg. Annual Benefits	Avg. Annual Costs	B/C Ratio	Net Benefits
Alt. 1: Piping Canal	\$11,807,525	\$6,007,158	1.97	\$5,800,367
Alt. 2: Lining & Buyouts	\$11,574,684	\$7,957,080	1.45	\$3,617,604

Fiscal Responsibility and Implementation

All cost estimates were developed in coordination with design engineers, with careful attention to phasing, O&M feasibility, and NRCS cost-sharing structures. The Preferred Alternative meets not only the financial criteria of NRCS and federal partners but also aligns with long-term community goals for resilience, sustainability, and recreational access.

D.10.5 Economic and Structural Tables

All Economic and Structural Tables prepared for the Preferred Alternative are listed below and follow the format and definitions found in Title 390 – National Watershed Program Manual, Subpart B – Economic and Structural Tables (the tables themselves may be found in section 6.11 of the Plan-EIS and/or in Appendix E):

- Economic Table 1 (NWPM 506.11) – Estimated Alternative Installation Cost
- Economic Table 2 (NWPM 506.12) – Estimated Alternative Cost Distribution
- Economic Table 4 (NWPM 506.18) – Estimated Average Annualized Costs by Increment (above No Action baseline)
- Economic Table 5 (NWPM 506.20) – Estimated Average Annualized Watershed Protection Damage Reduction Benefits
- Economic Table 6 (NWPM 506.20) – Additional Detail on Damage Reduction Benefits
- Economic Table 7 – Comparison of Average Annual NEE Benefits and Costs

The economic analysis shows that the Preferred Alternative would generate average annual benefits of \$11,807,525 and average annual costs of \$6,007,158, resulting in net benefits of \$5,800,367 and a Benefit-Cost Ratio (BCR) of 1.97. These costs and benefits are assessed above the No Action baseline. In contrast, the Lining & Buyouts Alternative (Alternative 2) yields average annual benefits of \$11,574,684 and costs of \$7,957,080, producing net benefits of \$3,617,604 and a BCR of 1.45.

These results confirm that the Preferred Alternative is the most economically efficient investment and fulfills the federal objective to maximize national economic efficiency while addressing the project's authorized purposes of flood prevention, agricultural water management, and recreation.

D.11.0 Sources

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