U.S. Department of the Interior
Bureau of Land Management

Final Environmental Impact Statement
Alkali Creek Reservoir Project

DOI-BLM-WY-R010-2017-0004-EIS

U.S. Department of the Interior
Bureau of Land Management
Worland Field Office

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
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Worland, WY 82401-3743
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Dear Reader:

The final environmental impact statement (EIS) for the Alkali Creek Reservoir Project (ACRP) is hereby submitted for your review. The Bureau of Land Management (BLM) prepared the final EIS to analyze the potential impacts of and alternatives to the ACRP proposed by the Wyoming Water Development Office (WWDO). The proposed ACRP is on BLM-administered lands and private lands in Big Horn County, Wyoming, northwest of Hyattville.

Under the Proposed Action, the WWDO proposes to construct a new reservoir on Alkali Creek. The reservoir would have a capacity of 7,994 acre-feet at normal high-water level (NHWL). The reservoir area would inundate approximately 294 acres of land when it is at NHWL. The proposed construction of a dam and reservoir on Alkali Creek would overlap both private and BLM-administered lands. The project area is 806.8 acres and comprises all proposed project elements (e.g., dam, reservoir, spillways, ditches, bypass pipeline, access roads, recreation area, instream improvements, borrow areas, fence line). Temporary and permanent disturbance areas for the proposed project elements that occur in the project area would encompass approximately 602.9 acres, of which 203.6 acres is BLM-administered lands and 399.3 acres is privately owned lands.

This final EIS analyzes three alternatives in detail:

- No Federal Action: Under the No Federal Action, the current operation practices within the Nowood River watershed would continue. Under the No Federal Action, late-season irrigation water shortages would continue.

- Proposed Action: Under the Proposed Action, the WWDO proposes to construct a new reservoir on Alkali Creek. The reservoir would have a capacity of 7,994 acre-feet at NHWL. The reservoir area would inundate approximately 294 acres of land when it is at NHWL.

- Modified Proposed Action: Under the Modified Proposed Action, the elements and activities would be the same as under the Proposed Action with two potential modifications: 1) reducing the length of the auxiliary spillway by approximately 3,375 feet and 2) modifying the reservoir fill time from 30 to 50 days.

Unirrigated lands with water rights could be left unirrigated, irrigated partially, or irrigated fully in the future under any of the alternatives, depending upon the seniority of those water rights and available stream flows in the absence of storage.

The final EIS also contains a discussion of other alternatives that were considered but eliminated from detailed analysis. The BLM has identified the applicant's Proposed Action as the Agency's preferred alternative in this final EIS. The identification of a preferred alternative does not constitute a commitment or decision in principle, and there is no requirement to select the preferred alternative in the Agency's record of decision (ROD). If warranted, the BLM may select a different alternative than the preferred alternative in its ROD.

The final EIS was prepared in accordance with the National Environmental Policy Act of 1969, as amended (NEPA) as well as the Council on Environmental Quality's NEPA Regulations (40 Code of Federal Regulations Part 1500), BLM Handbook H-1790-1, and BLM Wyoming or national guidance to address possible environmental and socioeconomic impacts that could result from implementation of the ACRP. In developing the final EIS, the BLM considered public comments on the draft EIS and revised the document accordingly. Newly inserted text is underlined and lines that contained deleted text are identified by a mark in the margin. Responses to public comments can be found in Appendix F of the final EIS.

This final EIS is not a decision document. The publication of the notice of availability (NOA) in the *Federal Register* for the final EIS initiates a 30-day availability period. Following the conclusion of that period and in accordance with the One Federal Decision policy established in Executive Order 13807, a single ROD will be prepared and signed to disclose the BLM's and U.S. Army Corps of Engineers' final decision. The decision by the Wyoming Department of Transportation will also be based on the analyses presented in this final EIS but will be published as a separate decision document.

Thank you for your interest in this project. The final EIS may be accessed by visiting the ACRP webpage at https://go.usa.gov/xUsam or by contacting Holly Elliott, BLM ACRP Project Manager, at 307-347-5193 or at helliott@blm.gov.

Sincerely,

Kimber Liebhauser
District Manager

FINAL ENVIRONMENTAL IMPACT STATEMENT
ALKALI CREEK RESERVOIR PROJECT

Lead Agency:	U.S. Department of the Interior, Bureau of Land Management
Project Location:	Worland Field Office, Wyoming
Comments and Further Information on the Final Environmental Impact Statement:	Bureau of Land Management, Worland Field Office Attn: Project Manager – Alkali Creek Reservoir Project Environmental Impact Statement 101 South 23rd Street Worland, Wyoming 82401 blm_wy_AlkaliCreekReservoirEIS@blm.gov
BLM Authorized Office Responsible for Preparing the Final Environmental Impact Statement:	Kimber Liebhauser, District Manager

ABSTRACT

The Wyoming Water Development Office proposes to construct a 294-acre reservoir on Alkali Creek and ancillary facilities across public and private land near Hyattville, Wyoming. The reservoir is intended to provide late-season irrigation water for portions of the Nowood River watershed. The reservoir is also intended to provide recreation opportunities through a minimum pool, provide flood attenuation, improve downstream water quality, and provide both direct and indirect economic benefits to the local community and state. The Bureau of Land Management (BLM) must decide whether and under what conditions to grant a right-of-way (ROW) for the portion of the reservoir that would be constructed on BLM-administered land. This decision constitutes a federal action necessary to determine, based on the selected alternative, whether construction of the proposed reservoir could take place and will be made in accordance with the Federal Land Policy and Management Act of 1976. The BLM's and U.S. Army Corps of Engineers' decision will be communicated through publication of a single record of decision.

The BLM is analyzing two action alternatives and a no action alternative for the environmental impact statement (EIS). Under the no action alternative (No Federal Action), current land management and agricultural practices within the project area would continue. Under the Proposed Action, a new reservoir would be constructed with a storage capacity of 7,994 acre-feet. This would include a reserve pool for a fisheries and recreation activities. Additional features of the Proposed Action would include the construction of a parking area and boat ramp and the expansion of the existing Anita Ditch and Anita Supplemental Ditch. Under the Modified Proposed Action, all elements would remain the same except the length of the auxiliary spillway would be reduced, allowing for farming practices to continue on the private land. The reservoir fill time would also be expanded from 30 days to 50 days. Unirrigated lands with water rights could be left unirrigated, irrigated partially, or irrigated fully in the future under any of the alternatives, depending upon the seniority of those water rights and available stream flows in the absence of storage. The BLM has identified the Proposed Action as the agency's preferred alternative in the final EIS. This does not constitute a commitment or decision. If warranted, a different alternative than the preferred alternative may be selected in the record of decision.

Based on the resource impact analyses, recommended mitigation measures to minimize potential adverse impacts are provided in **Chapter 3** of the final EIS. Mitigation measures may be included as conditions of BLM's ROW grant (if issued).

EXECUTIVE SUMMARY

INTRODUCTION

The Wyoming Water Development Office (WWDO), a State of Wyoming agency, has a primary purpose of developing and preserving Wyoming's water and water-related land resources and encouraging development of facilities for irrigation, reduction of flood damage, and other purposes (Wyoming Statute 41-2-112(a)). The WWDO is proposing to develop a water storage reservoir on Alkali Creek to reduce late-season irrigation shortages. The proposed Alkali Creek Reservoir is approximately 3 miles northwest of Hyattville, in Big Horn County, Wyoming. Alkali Creek is an intermittent creek that flows into Paint Rock Creek, which is a tributary of the Nowood River, all of which are in the Nowood River watershed.

The proposed Alkali Creek Reservoir requires approvals from the Bureau of Land Management (BLM) Worland Field Office (WFO), the U.S. Army Corps of Engineers (USACE), and the Wyoming Department of Transportation (WYDOT). A right-of-way (ROW) for access roads and the reservoir area on public lands would need BLM approval. Because dredged or fill material would be discharged into waters of the U.S. (i.e., Alkali Creek), the USACE would need to grant approval for a Clean Water Act (CWA) Section 404 permit. An encroachment permit to administer access facilities on the state highway system would be necessary from WYDOT. The applicant for the ROW grant, Section 404 permit, and highway encroachment permit is the WWDO. USACE and WYDOT are also participating in the National Environmental Policy Act (NEPA) process as cooperating agencies.

The BLM WFO has prepared this environmental impact statement (EIS) pursuant to NEPA to analyze the potential direct, indirect, and cumulative effects of potentially granting a ROW, a CWA Section 404 permit, and a highway encroachment permit for the construction and operation of the proposed Alkali Creek Reservoir and the construction of associated roads and other structures.

PURPOSE OF AND NEED FOR THE ACTION

The WWDO's ROW application considers the need for late-season irrigation use and public recreational opportunities. The purpose of the BLM's federal action is to respond to the WWDO's application for a ROW to construct, operate, and maintain access roads, a reservoir, and recreation site on public lands. The need for this action is to fulfill BLM's responsibility under the Federal Land Policy and Management Act and BLM ROW regulations to manage the public lands for multiple use (43 Code of Federal Regulations 2800).

The overall purpose of the project (i.e., the Proposed Action), as preliminarily determined for the USACE permitting process, is to provide a firm yield of 5,638 acre-feet of late-season irrigation water 8 out of 10 years to lands in the lower portion of the Nowood River watershed, including the Paint Rock Creek watershed. The project is needed to meet a portion of the late-season irrigation water shortages within the service area of the proposed reservoir. The overall project purpose and need will be finalized after a Section 404 permit application is submitted to the USACE Wyoming Regulatory Office and will be subject to the 404(b)(1) guidelines (40 Code of Federal Regulations 230).

WYDOT's purpose for the proposed project is to provide safe, direct, and regional access from Wyoming Highway 31 (WY 31) to the Alkali Creek Reservoir recreational facilities, and secondary access for reservoir construction and maintenance. WYDOT's need for the proposed project is established by Wyoming Administrative Rules, Chapter 13 (Access Facilities), which is approved by the Transportation Commission of Wyoming and promulgated by authority of Wyoming Statute (WS) 24-2-105 and WS 24-

6-101 through WS 24-6-111 to administer access facilities on the state highway system. WYDOT's need is also demonstrated by the issues of public safety during construction and subsequent recreational use, and by traffic control during construction.

ISSUES IDENTIFIED THROUGH SCOPING

The BLM identified issues to be addressed in the EIS through public and internal scoping and through outreach to cooperating agencies and tribes.

Four issues were considered but dismissed from detailed analysis in this EIS:

- How would surface disturbance or changes in water flow affect the federally threatened Ute ladies'-tresses (*Spiranthes diluvialis*)? The project area was found to have limited amounts of suitable Ute ladies'-tresses habitat, and no individuals or populations of the Ute ladies'-tresses were found during 2 years of surveys (Trihydro 2017a, 2018e).
- How would surface disturbance affect bat species hibernacula or maternity roosts? The project area was found to have limited potential roosting habitat with only a few areas identified that could provide temporary night or possible day roosts for bat species. No known hibernacula or maternity roosts occur in the area, and it is unlikely that any potential roosts sites in the project area function as maternity roosts or hibernacula (Trihydro 2017g).
- How would surface disturbance affect the northern leopard frog (*Rana pipiens*) and other reptile and amphibian species? The project area was found to have no terrestrial habitats uniquely suited to reptiles and amphibians. Additionally, SWCA Environmental Consultants (SWCA) conducted a survey for northern leopard frog and other amphibians throughout the analysis area in 2017. No amphibians were observed (SWCA 2017b).
- Would soils beneath the proposed Alkali Creek Reservoir leach selenium into reservoir water, and would selenium from seleniferous geologic formations be transported and accumulated by Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek? Surface water and sediment in Alkali, Paint Rock, and Medicine Lodge Creeks were sampled for selenium, and selenium was not detected in any of the samples (Trihydro 2016a). Subsequent soil sampling in July 2018 indicated that selenium was present above method detection limits at only one of the 13 tested locations. The soil sampling results (Trihydro 2018d) indicate that equilibrium selenium concentration in the proposed reservoir is not expected to exceed the standards in Chapter 1 (Wyoming Surface Water Quality Standards) of the Wyoming water quality rules and regulations. Because selenium concentration in the reservoir water is expected to be below surface water quality standards, this issue is not carried forward for detailed analysis in the EIS.

Table ES-1 presents the primary issues identified during scoping. The affected environment of each resource area and the impacts from implementing any of the alternatives are described in Chapter 3.

Table ES-1. Issues and Related Resource Areas

Resource Area	Issues
Air quality	Would construction-related vehicle emissions affect air quality? Would fugitive dust from construction activities affect air quality?
Cultural resources	How would inundation of the reservoir area affect cultural resources? What are the effects of clearing/excavating disturbance areas on eligible or unknown cultural resources? How would visual intrusions from the project affect integrity for eligible or potentially eligible historic or prehistoric cultural resources? How would increasing recreational opportunities and the number of people visiting the area affect cultural resources near the reservoir and access roads? How would the disturbance areas and associated visual impacts affect cultural resources of religious, cultural, and traditional concern to tribes?
Geology and minerals	How would inundating the reservoir area affect mineral claims and oil and gas interests in the area, including deferred or unissued lease parcels? How would inundating the reservoir area affect the stability of the surrounding slopes and landslide potential? What would be the potential for structural failure from earthquake, ground movement, or other geologic events, and what would be the likely downstream effects?
Land use	How would the project affect other ROWs or land use authorizations? How would the project affect adjacent or nearby private property?
Noise	How would noise from construction, operation, recreation, and maintenance activities affect nearby residents, livestock, and wildlife?
Paleontological resources	How would inundation of the reservoir area affect paleontological resources? What would be the effects of clearing and excavating disturbance areas on known or unknown paleontological resources? How would an increase in human activity during construction, recreational activities, and operations affect paleontological resources?
Public health and safety	What would be the effects to soils, surface waters, or groundwater if spills or releases of chemicals or petroleum products occur? What would be the potential for structural failure of the dam due to earthquake, ground movement, or other geologic events, and what would be the likely downstream effects?
Recreation	How would water impoundment, downstream channel improvements, and changing water flows in Paint Rock Creek and Medicine Lodge Creek affect recreation use in the area, including fishing opportunities? How would providing recreational facilities (boat ramp, comfort station) affect local recreational opportunities and public access?
Socioeconomics	How would the construction workforce affect the local economy in terms of housing availability, services, transportation, and revenue generation? How would the project affect agricultural productivity and expenses for adjacent landowners? How would the project affect property values? What would be the economic effects from increased recreation on the local community? Would there be a disproportionate effect on disadvantaged communities?
Soils	What would be the effects to topsoil from clearing and excavating disturbance areas, and how would that affect mitigation, restoration, and reclamation efforts? What would be the effects of building impervious surfaces on soils with erosion and pollution runoff potential near those areas?
Transportation	How would temporary traffic during construction affect local traffic safety and conditions? How would increasing recreation opportunities at the reservoir affect traffic safety, access, mobility, and congestion?
Vegetation	How would construction affect the potential for the introduction or spread of noxious weeds?
Visual resources	How would surface-disturbing activities and construction of the embankments and associated facilities affect the viewshed, including the viewshed of the Red Gulch/Alkali National Backcountry Byway? Would the project exceed the management objectives for visual resource management (VRM) classes?

Resource Area	Issues
Water resources	Would an increased surface water area from the reservoir affect local water resources? How would the project affect stream flows in Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek? How would changes in stream flow and in-channel structures affect stream morphology and channel stability, including changes to sediment transport? How would altering the ditches affect erosion potential and sediment transport in Paint Rock Creek and Medicine Lodge Creek? How would the dam affect sediment loads downstream of the reservoir? How would the dam affect sediment deposition on Alkali Creek upstream of the reservoir? How would surface disturbances affect water quality? How would normal releases from the reservoir affect downstream water quality? How would maintenance of sediment deposition behind structures affect water quality? What would the potential be for leaching of sulfate, salts, fertilizer, and pesticides into reservoir water, and what would be the potential short-term and long-term risks to water quality and human health? Would water quality meet standards for recreational purposes? Would the source water quality be affected? Would the project affect water treatment providers? Would the project affect source water protection areas? Would inundation affect groundwater volume, storage, flow, or quality? What would the potential be for accelerated bank erosion leading to an increase in *Escherichia coli* downstream?
Water rights and irrigation	How would a release of water from the proposed reservoir affect existing water rights and prioritization of exchanges? What would be the effects on supply and delivery of irrigation water for all users on the watershed? What would be the effects of increasing supplemental irrigation water on cropping and irrigation practices, crop production rates, and acres of irrigated lands?
Wetlands	How would changes to, or fluctuations in, water flow (diversions, water releases) affect the quality and quantity of wetlands along Paint Rock Creek and Medicine Lodge Creek downstream of the reservoir? How would reservoir inundation affect existing wetlands? What would be the effects of surface disturbance, including altering ditches and streams, on the hydrology of existing wetlands? How would the downstream improvements change the vegetation community along Paint Rock Creek and Medicine Lodge Creek? What would be the effects to vegetation from converting Alkali Creek to a perennial stream?
Terrestrial and aquatic wildlife	What would be the effects of habitat alteration or habitat loss associated with surface disturbance on bird species, big-game species, and other BLM sensitive species? What would be the effects of converting terrestrial habitat to aquatic habitat on bird species, big-game species, and other BLM sensitive species? Would proposed fencing affect big-game species? How would proposed surface disturbance affect occupied or suitable habitat and local populations of greater sage-grouse (*Centrocercus urophasianus*)? How would light, noise, dust, and visual intrusions during construction activities affect bird species, big-game species, and other BLM sensitive species? How would an increase in traffic and human activity during construction and operations affect bird species, small mammal species, and big-game species? What would be the effects of recreational activities on bird and wildlife species? How would stream disturbance from construction of diversion structures in Paint Rock and Medicine Lodge Creeks and culverts and rock grade control structures in Alkali Creek affect aquatic habitat? How would reservoir construction and the subsequent conversion of lotic habitat to lentic habitat affect fish and other aquatic species? How would changing the water flow regimes in Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek affect fish species and their habitats? In addition, how would these changes affect fish and aquatic species downstream in the Nowood River? Would the project introduce or increase the spread of aquatic invasive species? What would be the effects of recreational activities on aquatic species?

Alternatives Considered

The alternatives considered in the EIS address the issues identified through scoping. The comparative analysis between alternatives establishes a framework for decision-makers to understand important trade-offs and identify the most effective way to meet the purpose and need.

Alternative A (referred to hereafter as the *No Federal Action*) consists of the continued operation of the Nowood Watershed Improvement District (NWID) under current management conditions without additional storage or late-season water supplies. No BLM ROW, CWA Section 404, or highway encroachment permits would be issued under the No Federal Action. Late-season irrigation water shortages would continue.

Alternative B (referred to hereafter as the *Proposed Action*) consists of the construction of a dam and reservoir on Alkali Creek. The following primary elements would be included as part of the Proposed Action: a main embankment, a secondary (north) embankment, and a west embankment; reservoir; outlet works; principal and auxiliary spillways; primary and secondary access roads; enlargement of supply ditches and a bypass pipeline; public recreation parking and boat ramp; constructed wetlands; and bed and bank stabilization and rock grade control structures on Alkali Creek. Construction is anticipated to take between 1 and 2 years.

Alternative C (referred to hereafter as the *Modified Proposed Action*) consists of the same elements and activities as the Proposed Action with two potential modifications: 1) reducing the length of the auxiliary spillway by approximately 3,375 feet, and 2) modifying the reservoir fill time from 30 to 50 days. One or both of the modifications could be selected in the record of decision.

The BLM has identified Alternative B, the applicant's Proposed Action, as the agency's preferred alternative in this final EIS. The identification of a preferred alternative does not constitute a commitment or decision in principle, and there is no requirement to select the preferred alternative in the ROD. If warranted, a different alternative than the preferred alternative may be selected in the ROD.

Summary and Comparison of Environmental Consequences

Table ES-2 summarizes and compares environmental consequences anticipated from implementing the alternatives considered in the EIS. Detailed descriptions of environmental consequences are included in Chapter 3.

Table ES-2. Summary and Comparison of Environmental Consequences

Resource Area	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
Air quality	Negligible	Exceedances of National Ambient Air Quality Standards or Wyoming Ambient Air Quality Standards are not anticipated from construction-related vehicle or fugitive dust emissions.	Same as the Proposed Action
Cultural resources	No effect	No known eligible sites would be directly adversely affected by reservoir inundation; possible permanent effects to or destruction of non-eligible sites. Direct adverse effects to three eligible cultural resources would be avoided by project design; chance for inadvertent discovery of unknown cultural resources. Permanent visual effects to five eligible resources. Potential for increased risk of unauthorized collection due to new recreation activities. No known resources of Native American concern would be affected by surface disturbance.	Same as the Proposed Action
Geology and minerals	No effect	Low effect to mineral claims and oil and gas interests in the reservoir area. Minor increase in the potential for landslides from reservoir inundation. Negligible potential for structural failure from an earthquake. Low potential for other types of ground movement, which could cause structural failure.	Same as the Proposed Action
Land use	No effect	No active oil and gas leases would be affected. Approximately 231 acres of existing mining claims would be affected. Approximately 362 acres of BLM-administered land would be unavailable for future ROWs or other land use authorizations and 445 acres of private land would be unavailable for potential future mining and other land uses. Increased visitation may cause a potential decrease in privacy for nearby private property, a potential increase in trespassing incidents, and a potential increase in safety issues and livestock mortality.	Same as the Proposed Action
Noise	No effect	Increased noise levels from construction activities exceeding 5 dBA above ambient conditions within 0.75 miles. Increased noise levels from operation/maintenance activities exceeding 3 dBA above ambient conditions within 0.5 miles.	Same as the Proposed Action
Paleontological resources	No effect	Reservoir inundation would affect 37 acres of Potential Fossil Yield Classification (PFYC) 3 and 239 acres of PFYC 5 for the life of the project. Soft PFYC 3 shale units would receive most of the erosion along the reservoir shores. Clearing/excavation would affect 33 acres of PFYC 3 and 206 acres of PFYC 5. Disturbance would occur to geologic units with the potential to contain important paleontological resources. Effects are likely from the increase in human activity during construction, recreational activities, and operations.	Same effects as the Proposed Action from reservoir inundation and increased human activity. Clearing/excavation would affect 33 acres of PFYC 3 and 173 acres of PFYC 5. Less ground disturbance than under the Proposed Action, which may reduce the likelihood of affecting previously undiscovered paleontological resources.
Public health and safety	Negligible	Releases of hazardous materials during construction could occur. Small hazardous materials releases could occur in the unlikely event of dam failure.	Same as the Proposed Action

Resource Area	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
Recreation	No effect	Negligible effects from loss of the dispersed recreation setting; no effect would occur to fishing opportunities in creeks. Beneficial long-term effects from increasing the developed recreation setting.	Same as the Proposed Action
Socioeconomics	Negligible	Short-term positive impacts on employment, income, and economic output. Negligible or minor short-term negative impacts to housing availability, services, and transportation. Long-term positive impacts on employment, income, and economic output. Negligible negative impacts to adjacent landowners. Minor positive impact on property values for farms receiving irrigation supply. Positive impact on resident welfare from improved access to recreation opportunities. No disproportionate effect on disadvantaged communities.	Same as the Proposed Action
Soils	No effect	Surface disturbance would occur in soils with properties that may affect mitigation, restoration, or reclamation success: 18.1 acres of soils with high degradation susceptibility, 33.3 acres of soils with low resistance to compaction, and 273.3 acres of soils with low restoration potential. Impervious surfaces would increase both wind and water runoff. 278.3 acres of soils with high surface runoff potential (hydrologic Group D) and 237.2 acres of soils with low to moderate wind erosion potential (WEG 3) would be permanently affected.	Reduction of permanent effects to soils with low resistance to compaction by 1.4 acres and soils with low restoration potential by 15.3 acres. Other permanent effects to soils would be the same as the Proposed Action. Reduction of permanent effects to soils with high surface runoff potential (hydrologic Group D) by 28.9 acres and soils with low to moderate wind erosion potential (WEG 3) by 31.1 acres.
Transportation	No effect	Potential increase in safety risks during construction, which could be addressed with temporary and/or permanent intersection controls and a safety program. Potential for minor increased roadway surface maintenance on roads that are not designed for heavy truck travel. Potential increased delays for vehicles traveling along WY 31.	Same as the Proposed Action
Vegetation	Existing weed management activities would continue. No additional effects would occur.	Greatly increased chance for spread of noxious weeds. Weed management would be done under a project-specific weed management plan, and increased weed management activities would occur. Effects would be minor.	Same as the Proposed Action
Visual resources	No effect	When viewed from the selected key observation points (KOPs), surface disturbance would be visible but would be consistent with the surrounding landscape. Views from the KOPs would only last for a few seconds and would not be likely to attract the attention of a casual traveler. The viewshed looking toward the proposed reservoir from the Red Gulch/Alkali National Backcountry Byway would not attract the attention of the casual observer. Consistent with VRM management objectives of the WFO RMP.	Same as the Proposed Action

Resource Area	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
Water resources	Under Modelling Scenario 2 (without potentially irrigable permitted acreage in production), there would be no effects to stream flow. Under Modelling Scenario 1 (with potentially irrigable permitted acreage in production), stream flow changes would be as follows: Stream flow in Alkali Creek would increase up to 27% (1 cfs) and up to 87% (5 cfs) in July and August, respectively. Stream flow in Alkali Creek would decrease up to 33% (1 cfs) in May. Decreases in stream flow in Paint Rock Creek would occur in July, September, and October, ranging from 1 to 14 cfs. Decreases in stream flow in Medicine Lodge Creek would occur in May, June, July, September, and October, ranging from 1 to 11 cfs. Stream flow decreases up to 82% may occur in the lower Nowood River in June, July, August, and September. Increases in stream flow in Paint Rock Creek would occur in July and August, ranging from 1 to 14 cfs. Increases in stream flow in the lower Nowood River would occur in October, ranging from 1 to 21 cfs.	Additional depletion of 500 acre-feet of water from reservoir evaporation. The following stream flow changes would occur under Modelling Scenario 1 (with potentially irrigable permitted acreage in production): Stream flow in Alkali Creek would increase up to 533% (27 cubic feet per second [cfs]) and up to 423% (30 cfs) in July and August, respectively. The 0.4-cfs minimum bypass would remain in Alkali Creek in April and May, and therefore stream flow would decrease up to 98% (16 cfs) and 88% (3 cfs) in April and May, respectively. Decreases in stream flow in Paint Rock Creek would occur in April, May, August, and September, ranging from 1 to 71 cfs. Decreases in stream flow in Medicine Lodge Creek would occur in May, June, July, and September, ranging from 1 to 11 cfs. Stream flow decreases up to 71% may occur in the lower Nowood River in May, June, July, and August under Modelling Scenario 1. Increases in stream flow in Paint Rock and Medicine Lodge Creeks would occur in July, August, and September, ranging from 1 to 44 cfs. Increases in stream flow in the lower Nowood River would occur in August and October, ranging from 1 to 25 cfs. The following stream flow changes would occur under Modelling Scenario 2 (without potentially irrigable permitted acreage in production): Stream flow in Alkali Creek would increase up to 20% (1 cfs) July. Stream flow in Alkali Creek would decrease up to 77% (12 cfs) and 59% (1 cfs) in April and May, respectively. Decreases in stream flow in Paint Rock Creek would occur in April, May, and August, ranging from 1 to 20 cfs. Stream flow in Medicine Lodge Creek would not change. Stream flow decreases up to 3% may occur in the lower Nowood River in April and May. Increases in stream flow in Paint Rock Creek and in the lower Nowood River would occur in July, August, and September, ranging from 1 to 3 cfs. Under Modeling Scenario 3, stream flow effects attributed solely to the proposed reservoir (comparing the No Federal Action with potentially irrigable permitted acres to Proposed Action with potentially irrigable permitted acres) are as follows: Stream flow in Alkali Creek would increase up to 412% (26 cfs) and up to 265% (25 cfs) in July and August, respectively. Stream flow in Alkali Creek would decrease up to 98% (16 cfs) and 82% (2 cfs) in April and May, respectively. The 0.4-cfs minimum bypass would remain in Alkali Creek in April and May. Decreases in stream flow in Paint Rock Creek would occur in April, May, July, and August, ranging from 1 to 57 cfs. Decreases in stream flow in Medicine Lodge Creek would occur in May, July, and August, ranging from 1 to 7 cfs.	Same as the Proposed Action

Resource Area	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
		Stream flow decreases up to 6% may occur in the lower Nowood River in April and May. Increases in stream flow in Paint Rock Creek would occur in July, August, September, and October, ranging from 1 to 37 cfs. Increases in stream flow in the lower Nowood River would occur in July, August, September, and October, ranging from 1 to 15 cfs. Reduced transport capacity in Medicine Lodge Creek and potential deposition in Alkali Creek (upper segment), potentially leading to channel instabilities and a change in channel form. Impoundment of 2.1 miles of Alkali Creek. Change in channel type resulting from stabilization structures in Alkali Creek. Sedimentation in Paint Rock Creek and lateral adjustments in Medicine Lodge Creek. Decrease in sediment loads downstream of the dam. Upper and lower channel segments' morphology would change. Reduced slope and energy would likely widen the Alkali Creek channel upstream of the reservoir and increase deposition, potentially forming multiple channels near the reservoir mouth. Channel may destabilize. Negligible to minor, short-term effects would occur to water quality from surface disturbance. Minor effects would occur on temperature and dissolved oxygen concentrations in downstream water quality from normal reservoir releases. *E. coli* concentration during reservoir fill is predicted to increase, and load is predicted to decrease. Improvement in water quality parameters would occur from decreased turbidity, sulfate concentrations, and specific conductance. Negligible to minor effects on turbidity from maintenance of sediment deposition behind structures. Minor leaching of sulfate and salts into reservoir water; no risks to human health. Water quality would support recreational use because of sediment settling, large reservoir volumes, and long residence time. Minor increase in groundwater volume and storage. No effects to regional groundwater flow direction.	

Resource Area	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
Water rights and irrigation	No effect	No effect on existing water rights and prioritization of exchanges. Shortages under Modelling Scenario 1 (with potentially irrigable permitted acreage in production) could be reduced by 2,310 acre-feet (38%) on average. Shortages in the exchange portion could be reduced by 1,040 acre-feet (23%) on average. Shortages under Modelling Scenario 2 (without the potentially irrigable permitted acreage in production; i.e., currently irrigated acreage) could be reduced by 230 acre-feet (10%) on average. Shortages in the exchange portion could be reduced by 180 acre-feet (8%) on average. Up to 3,150 additional acres may be irrigated. Increase in spring grains, dry beans, corn, and sugar beets; decrease in alfalfa and grass hay. Consumptive use would increase up to 7,800 acre-feet per year.	The Modified Proposed Action could be less effective at reducing shortages compared to the Proposed Action because of the smaller supply canal capacity, which could reduce the yield of the reservoir; however, the simulation model (which uses a monthly timestep and may not capture instantaneous flow rates of available water and canal capacity limitations) does not predict this. Changes to cropping patterns, irrigation practice, crop production (yield), and irrigated acres are expected to be the same as the Proposed Action.
Wetlands	No permanent effects to wetlands unless potentially irrigable permitted acreage goes into production (Modelling Scenario 1). If that occurs, some changes could occur. Reductions of bankfull flows in Medicine Lodge Creek may lead to reduced areas of wetlands along creek. Increased irrigation would lead to decreased flows in Nowood River. Increased stream entrenchment may adversely affect wetland and riparian areas along the channel by reducing overbank flow and depth of saturation.	Dam and reservoir construction would affect 2.11 acres of wetlands. Ditch improvements and Alkali Creek stabilization would temporarily affect 8.73 acres of wetlands; hydrology and wetlands would re-establish after construction. Conversion of Alkali Creek to a perennial stream may result in some increase in wetland area. Under Modelling Scenario 1 (with potentially irrigable permitted acreage in production), reductions in bankfull flows in Medicine Lodge Creek would lead to reduced areas of wetlands along creek. For Alkali Creek, increased high flows in late summer combined with channel stabilization measures would increase area of wetlands and riparian vegetation. Increased irrigation would lead to decreased flows in Nowood River. Increased stream entrenchment may adversely affect wetland and riparian areas along the channel by reducing overbank flow and depth of saturation. Under Modelling Scenario 2 (without potentially irrigable permitted acreage in production), there would be little or no changes to flows in Medicine Lodge Creek and to Paint Rock Creek from the diversion to Alkali Creek. Flows in Alkali Creek would be reduced in the spring, but to a lesser extent, and there would be only small increases in late summer. This would likely result in decreases in wetland area or quality along lower Alkali Creek. Wetlands along lower Paint Rock Creek and Nowood River are unlikely to be adversely affected. Under Modeling Scenario 3, wetland effects attributed solely to the proposed reservoir (comparing the No Action with potentially irrigable permitted acres to Proposed Action with potentially irrigable permitted acres) would be the same as above except there would be little or no impacts to Medicine Lodge Creek and the Nowood River because bankfull flows would not change. Late-summer increases in flows in the Nowood River may have minor beneficial impacts to streamside wetlands.	Same as the Proposed Action

Resource Area	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
Terrestrial and aquatic wildlife	Under Modelling Scenario 1, there would be substantial effects to fish and aquatic species related to flow increases in Medicine Lodge and Alkali Creeks and flow reductions in portions of Medicine Lodge, Paint Rock, and Alkali Creeks and the Nowood River. There would be no effects to fish and aquatic species under Modelling Scenario 2.	Surface disturbance would reduce the availability or quality of habitat for bird species, big-game species, and other BLM sensitive species. The health, reproduction, survivorship, habitat use, distribution, and abundance of those species could be temporarily harmed during construction. Individuals may be temporarily displaced. Conversion of terrestrial habitat to aquatic habitat would result in loss of habitat for most terrestrial wildlife species. However, game birds, waterfowl, shorebirds, fish-feeding raptors, and wading birds may increase. Big-game species may be deterred from using the project area or their movements across the project area may be impeded. Greater sage-grouse use of the project area may be reduced. Wildlife mortality or injury may increase because of collisions with vehicles, facilities, or construction equipment, and because of recreational activities. Nests, dens, or burrows could be destroyed. Habitat avoidance by bird and other wildlife species may increase. Short-term disturbance would occur in Paint Rock and Medicine Lodge Creeks for diversion structures, and Alkali Creek at two culvert sites. Short-term increases in sediment would occur in Alkali, Paint Rock, and Medicine Lodge Creeks in localized areas. Habitat quality would improve in the 1.5-mile segment of Alkali Creek and the 300-foot segment in Paint Rock Creek. Loss of 2.1 miles of stream habitat and associated species in Alkali Creek and creation of reservoir habitat. Fish species in Alkali Creek would adapt to lentic conditions and colonize the reservoir. Establishment of a minimum conservation pool in the reservoir would result in beneficial effects by providing consistent habitat for the development of a fishery. There would be substantial flow change effects on aquatic habitat and species in segments located above and below the Anita and Anita Supplemental Ditches under Modelling Scenario 1. Effects would be minor under Modelling Scenario 2. There would be minor effects on aquatic habitat and species in the upper portion of Paint Rock Creek located upstream and downstream of the Anita Supplemental Ditch under both Modelling Scenarios 1 and 2. There would be substantial effects on habitat and species in Paint Rock Creek segments located upstream and downstream of the Alkali Creek confluence under both Modelling Scenarios 1 and 2. There would be substantial habitat reduction in Alkali Creek downstream of the reservoir from flow reductions under Scenario 1. Effects would decrease to moderate levels under Scenario 2. Substantial effects to fish, macroinvertebrates, and special status species flathead chub, sauger, and shovelnose sturgeon in the Nowood River would occur under Modelling Scenario 1. Effects would decrease to minor levels under Modelling Scenario 2. Risk of introducing or spreading aquatic invasive species, which could be avoided by watercraft regulations and washing equipment. Potential long-term increase in fishing levels in the Alkali Creek Reservoir and a temporary increase in fishing pressure in local streams from the project workforce.	Same as the Proposed Action

Summary of Consultation and Coordination

Council on Environmental Quality regulations implementing NEPA allow the lead agency to invite tribal, state, and local governments, as well as federal agencies, to serve as cooperating agencies during the NEPA process. To serve as a cooperating agency, the potential agency or government must have either jurisdiction by law or special expertise relevant to the environmental analysis. Entities that accepted the BLM's invitation and participated as cooperating agencies are listed in Table B-1 of Appendix B. Letters to initiate tribal consultation were sent to the Blackfeet Nation, Northern Cheyenne Tribe, Crow Tribe of Indians, Shoshone-Bannock Tribes, Eastern Shoshone Tribe, and Northern Arapaho Tribe on October 10, 2017. The letters notified the tribes of the proposed project and requested government-to-government consultation between the BLM and the tribes.

The formal public scoping process for the project began on October 11, 2017, with the publication of the notice of intent (NOI) in the *Federal Register*. The BLM also issued a media release and sent a mail and email announcement of the scoping period to the project mailing list. The mailing list was developed from the BLM's mailing list, tribal contacts, and other cooperating agencies. The 30-day public comment period concluded on November 13, 2017. A meeting of cooperating agency representatives was held in Hyattville, Wyoming, on October 24, 2017, at the Hyattville Community Center at 4:00 p.m., and a formal public scoping meeting followed at 6:00 p.m. The public scoping meeting provided information on the proposed project and gave members of the public and agency personnel the opportunity to ask questions or make comments. The BLM WFO received a total of 11 submissions from members of the public and the cooperating agencies during the scoping period.

The notice of availability for the draft EIS was published in the *Federal Register* on August 31, 2018. The 45-day public review period extended through October 15, 2018. A public meeting was held on September 20, 2018, at the Hyattville Community Center from 5:30 to 8:00 p.m. The BLM WFO received a total of 12 submissions from members of the public and cooperating agencies. Responses to the comments are in Appendix F.

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Abbreviations

µS/cm	micro Siemens per centimeter
AADT	annual average daily traffic
ADT	average daily traffic
AMP	adaptive management plan
Anderson	Anderson Consulting Engineers, Inc.
ANSI	American National Standards Institute
APE	area of potential effects
BLM	U.S. Bureau of Land Management
BMP	best management practice
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CIAA	cumulative impact analysis area
cfs	cubic feet per second
cfu	colony forming units
CO	carbon dioxide
CWA	Clean Water Act
dBA	A-weighted decibels
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FHWA	Federal Highway Administration
FLPMA	Federal Land Policy and Management Act of 1976, as amended
GHG	greenhouse gases
GHMA	general habitat management area
GIS	geographic information system
GMU	game management unit
H_2S	hydrogen sulfide
HAP	hazardous air pollutant
HUC	hydrological unit code
IM	instructional memorandum
IMPLAN	impact analysis for planning
KOP	key observation point
mg/L	milligrams per liter
MHWL	maximum high-water level
mL	milliliters
MOA	memorandum of agreement
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act

NHPA	National Historic Preservation Act of 1966, as amended
NHWL	normal high-water level
NISP	*Northern Integrated Supply Project Supplemental Draft EIS*
NO_2	nitrogen dioxide
NOI	notice of intent
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NWID	Nowood Watershed Improvement District
O_3	ozone
OHV	off-highway vehicles
ORV	off-road vehicle
PEM	palustrine emergent
PFC	proper functioning condition
PFO	palustrine forested
PFYC	Potential Fossil Yield Classification
PHMA	priority habitat management area
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 microns
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
PSS	palustrine scrub-shrub
RCYBP	radiocarbon years before present
ROD	record of decision
ROS	recreation opportunity spectrum
ROW	right-of-way
SESA	socioeconomics study area
SGCN	species of greatest conservation need
SHPO	State Historic Preservation Office or Officer
SO_2	sulfur dioxide
StateCU	consumptive use model
StateMOD	surface water allocation model
SWPPP	stormwater pollution prevention plan
TDS	total dissolved solids
TMDL	total maximum daily load
Trihydro	Trihydro Corporation
US 20	U.S. Highway 20
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VRM	visual resource management

WAAQS	Wyoming Ambient Air Quality Standards
WDEQ	Wyoming Department of Environmental Quality
Wenck	Wenck Associates, Inc.
WFO RMP	Worland Field Office Approved Resource Management Plan
WFO	Worland Field Office
WGFD	Wyoming Game and Fish Department
WHMA	Wildlife Habitat Management Area
WS	Wyoming Statute
WWDO	Wyoming Water Development Office
WYCRO	Wyoming Cultural Records Office
WYDOT	Wyoming Department of Transportation
WY 31	Wyoming Highway 31

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1 PURPOSE OF AND NEED FOR THE PROJECT

1.1 Introduction

The Bureau of Land Management (BLM) Worland Field Office (WFO) has prepared this environmental impact statement (EIS) to analyze the potential direct, indirect, and cumulative effects of potentially granting a right-of-way (ROW), a Clean Water Act (CWA) Section 404 permit, and highway encroachment permit for the construction and operation of the proposed Alkali Creek Reservoir and the construction of associated roads and other structures. The analysis in this final EIS has been conducted in accordance with the National Environmental Policy Act of 1969 (NEPA) (42 United States Code [USC] 4321 et seq.) and its implementing regulations (40 Code of Federal Regulations [CFR] 1500–1508). The applicant for the ROW grant, Section 404 permit, and highway encroachment permit is the State of Wyoming, Wyoming Water Development Office (WWDO).

The U.S. Army Corps of Engineers (USACE) is participating in the NEPA process as a cooperating agency (40 CFR 1501.6 and 1508.5) because the USACE has regulatory authority over the Section 404 permit application.

The Wyoming Department of Transportation (WYDOT) is also participating in the NEPA process as a cooperating agency (40 CFR 1501.6 and 1508.5) because WYDOT has regulatory authority over state roads and highways, including Wyoming Highway 31 (WY 31). An encroachment permit would be obtained from WYDOT for the construction and operation of the proposed primary and secondary access roads that would connect to WY 31.

Chapter 1 of this final EIS discusses the purpose of and need for the project (i.e., the Proposed Action), as well as applicable laws, regulations, and plans. Chapter 2 discusses the Proposed Action in detail, as well as any alternatives to the Proposed Action. Chapter 3 discusses the affected environment and analyzes the potential environmental effects that the Proposed Action and alternatives would have on the affected environment. Chapter 4 includes an analysis of the potential cumulative effects that the Proposed Action and alternatives would have on the affected environment, along with the effects of past, present, and reasonably foreseeable future actions. Seven appendices accompany this EIS, including Appendix A, which provides a list of the literature cited in this EIS, and Appendix B, which discusses the consultation and coordination that were conducted during the NEPA process.

1.2 Background

The WWDO is a State of Wyoming agency. The WWDO's primary purpose is to develop and preserve Wyoming's water and water-related land resources and to encourage development of facilities for irrigation, etc. (Wyoming Statute [WS] 41-2-112(a)).

After 8 years of conducting studies and scoping, the WWDO determined locations in Wyoming that need reservoirs. The WWDO is proposing to develop a water storage reservoir on Alkali Creek to reduce late-season irrigation shortages. Initial hydrologic modeling and investigation results for the Paint Rock Creek watershed and the lower Nowood River simulated annual irrigation shortages of 9,842 acre-feet during normal hydrologic years (these shortages assumed current idle permitted acreage was put into production) (Trihydro Corporation [Trihydro] 2016a). Subsequent refinement of the hydrologic model simulates annual irrigation shortages of 2,360 acre-feet and 6,030 acre-feet on average under current conditions and for currently idle permitted acreage, respectively (Mead 2018; Wenck Associates, Inc. [Wenck] 2019). For these shortages or need evaluations, a historic consumptive use analysis and a surface water allocation model representation of the Nowood River watershed were developed. Currently irrigated lands were determined from aerial photography, and currently idle but permitted lands were determined from Wyoming State Engineer's Office records and subsequent analysis with the hydrographer-commissioners involved in the day-to-day regulation of water in the watershed. In addition, data management tools StateDMI and TSTool were used to develop input files and analyze model results.

An irrigation shortage is the difference between irrigation demand and irrigation supply. The *irrigation demand* is the required amount of water that a crop needs beyond what it receives from precipitation. This value is calculated and is a function of a variety of parameters including climate conditions, crop types and acreages, and soil parameters. The *irrigation supply* is the amount of water delivered to the crop and is simulated based on stream flow records, ditch capacities, system efficiencies, return flows, reservoir capacities and evaporation, and water rights.

The proposed Alkali Creek Reservoir is approximately 3 miles northwest of Hyattville, in Big Horn County, Wyoming. The reservoir would require a ROW granted by the BLM WFO in Township 50 North (T50N), Range 90 West (R90W), Sixth Principal Meridian, in portions of Sections 26, 27, 33, 34, and 35; and in T49N, R90W, in portions of Section 4. The ROW area includes a portion of the Anita Ditch located in T50N, R90W, Section 35 (Figure 1.2-1). The primary access road would also require a ROW encompassing T49N, R90W in portions of Section 4, and T50N, R90W in portions of Sections 33 and 34. Alkali Creek is an intermittent creek that flows into Paint Rock Creek, which is a tributary of the Nowood River, all of which are in the Nowood River watershed.

The proposed construction would create a reservoir on Alkali Creek. The reservoir would have a capacity of 7,994 acre-feet at normal high-water level (NHWL). The reservoir area would inundate approximately 294 acres of land when it is at NHWL. Four roads would need to be built as part of the Proposed Action. The roads would comprise two temporary roads for construction and two permanent access roads. The proposed construction of a dam and reservoir on Alkali Creek (Proposed Action) would overlap both private and BLM-administered lands.

Stream flows in the Paint Rock Creek watershed and larger Nowood River watershed are used for irrigation. Figure 1.2-2 shows the irrigated lands in the *reservoir service area*, defined as the area anticipated to be served by the reservoir. The Nowood River watershed generates a significant amount of runoff, with large amounts of water occurring during spring runoff but limited amounts of water occurring in the summer. The *Nowood River Storage/Watershed Study* (Anderson Consulting Engineers, Inc. [Anderson] 2010) demonstrates that most of the available water flows in the watershed occur in April, May, and June. Shortages occur primarily during the late-season irrigation months of August and September, both in normal and dry year conditions. Annual shortages as indicated in the Nowood River StateMOD model (Trihydro 2016a, 2018b) total 2,360 acre-feet and 6,030 acre-feet on average under current conditions and for potentially irrigable permitted acreage in production), respectively. The problems presently experienced by limited flows in the summer months and occasional spring flooding may be mitigated by storage reservoirs in the watershed. Currently, there are no reservoirs located on the Nowood River and a limited number in the Nowood River watershed.

The project area is 806.8 acres and comprises all proposed project elements (e.g., dam, reservoir, spillways, ditches, bypass pipeline, access roads, recreation area, instream improvements, borrow areas, fence line) (see Figure 1.2-1). Temporary and permanent disturbance areas for the proposed project elements that occur in the project area would encompass approximately 602.9 acres, of which 203.6 acres is BLM-administered lands and 399.3 acres is privately owned lands.

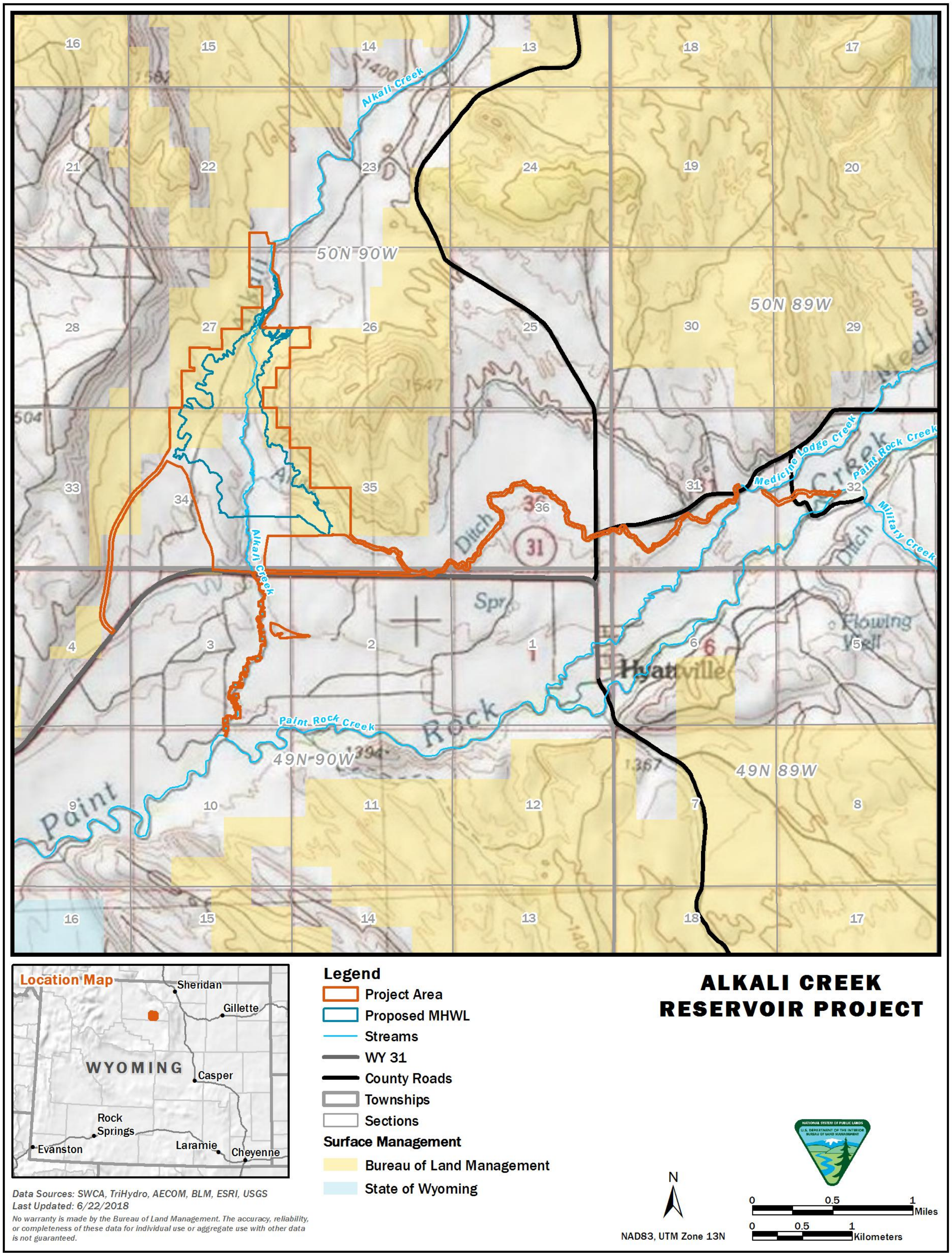

Figure 1.2-1. Location of the proposed Alkali Creek Reservoir.

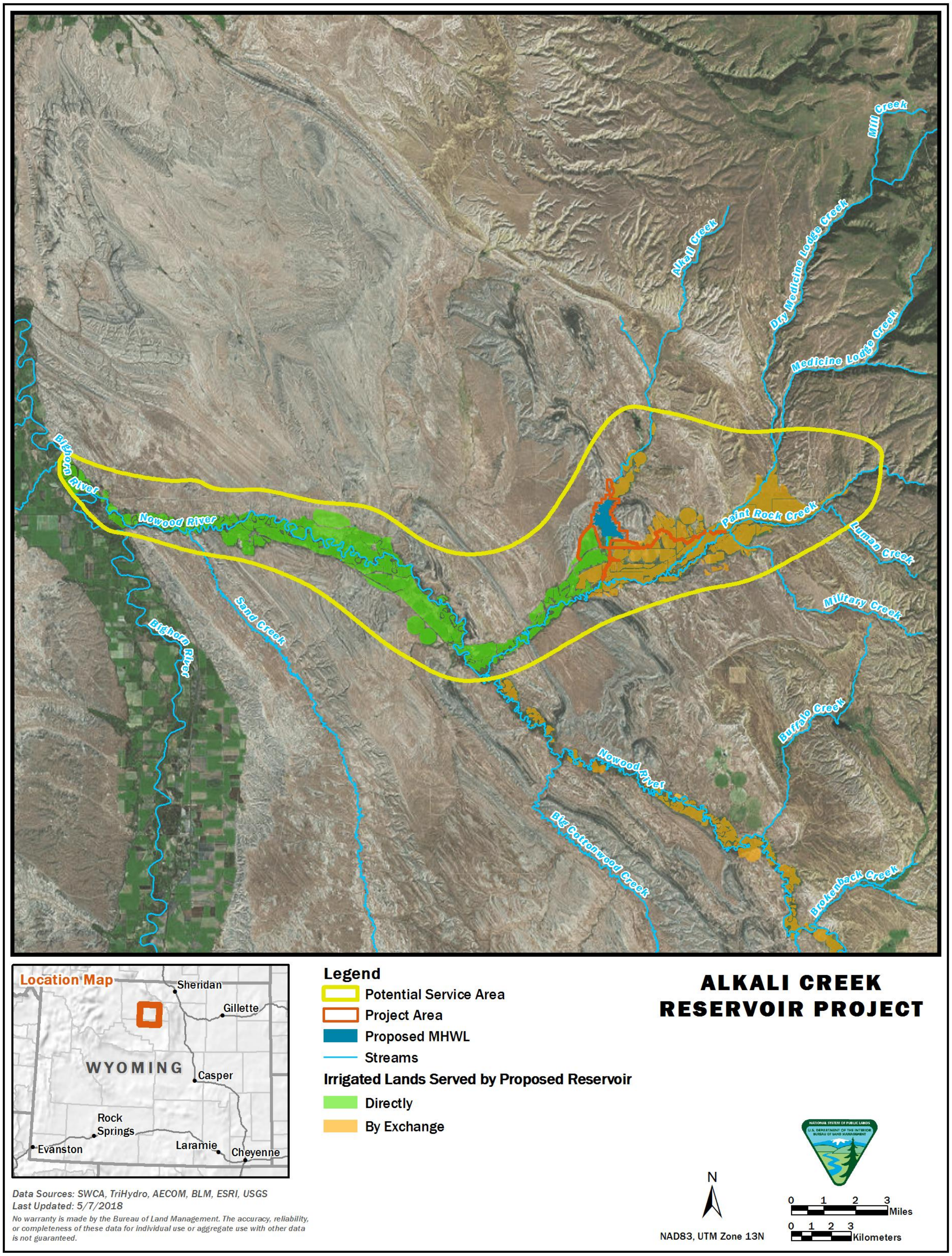

Figure 1.2-2. Irrigated lands in the reservoir service area.

The Proposed Action would include three separate approvals from three separate agencies: the BLM, the USACE, and WYDOT. A ROW for access roads and the reservoir area would need BLM approval for approximately 362.4 acres of BLM-administered lands. Because dredged or fill material would be discharged into waters of the U.S. (i.e., Alkali Creek), the USACE would need to grant approval for a CWA Section 404 permit for the construction and operation of the proposed Alkali Creek Reservoir. An encroachment permit to administer access facilities on the state highway system would be necessary from WYDOT for the construction and operation of the proposed primary and secondary access roads that would intersect WY 31. Any access to private lands would be obtained separately by the WWDO and is not considered part of this action, although the EIS analyzes impacts to all resources regardless of landowner.

1.2.1 Wyoming Water Development Office Goals and Objectives

The WWDO's primary goal is to develop a water storage reservoir to reduce late-season irrigation shortages, as described in Section 1.2, in the Paint Rock Creek watershed and the lower portions of the Nowood River watershed.

The WWDO's objectives for the Proposed Action are as follows:

- Provide for the flexibility and improvement of water reliability for local irrigators to reduce late-season water shortages and drought vulnerability.
- Store available, early-season runoff and allow local irrigators access to this water for late-season irrigation.
- Expand local and regional economic opportunities for the irrigators and the local communities through additional water management and increased crop production.
- Provide access to water-related recreational opportunities, such as fishing, boating, swimming, picnicking, and birdwatching by maintaining a conservation pool.
- Provide indirect economic recreational benefits to the local and regional community.
- Provide improved flood attenuation for the local community.

While meeting these broad objectives, the WWDO would work within the following Proposed Action–specific objectives:

- Provide a 7,994-acre-foot reservoir (at NHWL) on Alkali Creek, an intermittent stream that flows into Paint Rock Creek (a tributary of the Nowood River).
- Provide water storage in a timely manner for the Paint Rock Creek watershed and the broader lower portion of the Nowood River watershed to reduce the area's pressing irrigation needs. Hydrologic modeling and investigation results simulate average annual shortages in the reservoir service area of 2,360 acre-feet and 6,030 acre-feet under current conditions and for currently idle permitted acreage, respectively.
- Provide a 5,996-acre-foot operating pool or irrigation pool.
- Increase revenue generation in Big Horn and Washakie Counties and bolster the revenue of other agricultural-related businesses.
- Maintain a conservation pool of up to 1,998 acre-feet to provide flat-water recreation opportunities, create a reservoir fishery, enhance wildlife and riparian habitat, and provide some flood attenuation.
- Construct and maintain approximately 1,878 acre-feet of flood storage capacity.
- Maintain consistency with the WWDO's commitment to develop and preserve Wyoming's water and water-related land resources.

1.3 Purpose and Need

1.3.1 Bureau of Land Management

The WWDO has submitted a ROW application for the Proposed Action (WYW-165353) to the BLM pursuant to Title V of the Federal Land Policy and Management Act of 1976, as amended (FLPMA) and implementing regulations 43 CFR 2800. Section 501 of Title V states the following:

> (a) The Secretary, with respect to the public lands (including public lands, as defined in section 103(e) of this Act, are authorized to grant, issue, or renew rights-or-way over, upon, under, or through such lands for– (1) reservoirs, canals, ditches, flumes, laterals, pipes, pipelines, tunnels, and other facilities and systems for the impoundment, storage, transportation, or distribution of water; (6) roads, trails, highways, railroads, canals, tunnels, tramways, airways, livestock driveways, or other means of transportation except where such facilities are constructed and maintained in connection with commercial recreation facilities on lands in the National Forest System; or (7) such other necessary transportation or other systems or facilities which are in the public interest and which require ROWs over, upon, under, or through such lands.

This ROW application considers the need for late-season irrigation use and public recreational opportunities. The purpose of the BLM's federal action is to respond to the WWDO's application for a ROW to construct, operate, and maintain access roads, a reservoir, and recreation site on public lands. The need for this action is to fulfill the BLM's responsibility under FLPMA and BLM ROW regulations to manage the public lands for multiple use (43 CFR 2800). To advance these objectives, the BLM designates areas available for ROW uses on public lands through the land use planning process. To support this, the BLM is charged with analyzing applications for ROW uses on federal lands to ensure that the activity protects the natural resources of public lands and prevents unnecessary or undue degradation while coordinating, to the fullest extent possible, all BLM actions under the regulations in this part with state and local governments, interested individuals, and appropriate quasi-public entities.

1.3.2 U.S. Army Corps of Engineers

The overall purpose of the proposed project, as preliminarily determined for the USACE permitting process, is to provide a firm yield of 5,638 acre-feet of late-season irrigation water 8 out of 10 years to lands in the lower portion of the Nowood River watershed, including the Paint Rock Creek watershed. The project is needed to meet a portion of the late-season irrigation water shortages within the service area of the proposed reservoir.

The overall project purpose and need will be finalized after a Section 404 permit application is submitted to the USACE Wyoming Regulatory Office and will be subject to the 404(b)(1) guidelines (40 CFR 230).

1.3.3 Wyoming Department of Transportation

WYDOT's purpose for the Proposed Action is to provide safe, direct, and regional access from WY 31 to the proposed Alkali Creek Reservoir recreational facilities and secondary access for reservoir construction and maintenance.

WYDOT's need for the Proposed Action is established by Wyoming Administrative Rules, Chapter 13 (Access Facilities), which is approved by the Transportation Commission of Wyoming and promulgated by authority of WS 24-2-105 and WS 24-6-101 through WS 24-6-111 to administer access facilities on the state highway system. WYDOT's need for the Proposed Action is also demonstrated by the following major issues:

- Public safety during construction operations and subsequent recreational use
- Traffic control during construction operations

1.4 Decisions to be Made

This EIS does not contain final decisions regarding the Proposed Action or alternatives. The primary purpose of this EIS is to analyze and disclose potential effects on the natural and human environment and to inform decision-makers and the public of the reasonable alternatives that would avoid or minimize adverse effects or enhance the quality of the natural or human environment. In accordance with the One Federal Decision policy established in Executive Order 13807, a single record of decision (ROD) will be prepared and signed to disclose the BLM's and USACE's final decision. WYDOT's decision will also be informed by the analysis in this EIS.

1.4.1 Bureau of Land Management Right-of-Way Grant

The decision to be made by the BLM is whether or not to approve a ROW grant for the construction, operation, and maintenance of the proposed Alkali Creek Reservoir and associated roads, and if so, under what terms and conditions.

1.4.2 U.S. Army Corps of Engineers Section 404 Permit

The decision to be made by the USACE is whether or not to approve a Section 404 permit for the construction and operation of the proposed Alkali Creek Reservoir and associated roads, and if so, under what terms and conditions.

1.4.3 Wyoming Department of Transportation Encroachment Permit

The decision to be made by WYDOT is whether or not to approve an encroachment permit for the construction and operation of the proposed primary and secondary access roads that would intersect WY 31, and if so, under what terms and conditions.

1.5 Regulatory Setting

1.5.1 Federal Permits, Authorizations, and Coordination

The ROW application, as submitted by the WWDO, will be processed and evaluated under BLM statutory mandates and authority governing ROWs on BLM-administered lands and other federal authorities listed below. The CWA Section 404 permit application, as submitted by the WWDO, will be processed and evaluated under USACE statutory mandates and authority governing the discharge of dredged and fill into waters of the U.S. (a compensatory mitigation plan must be submitted to and approved by the USACE before the CWA Section 404 permit can be issued).

- NEPA (42 USC 4321 et seq.)
- FLPMA (43 USC 1761 et seq.)
- CWA (33 USC 1251 et seq.)
- National Historic Preservation Act (NHPA) (54 USC 300101 et seq.)
- ROW under FLPMA (43 CFR 2800 et seq.)

1.5.2 Conformance with the Worland Field Office Resource Management Plan

FLPMA requires that lands considered for ROWs be included in a comprehensive land use plan and that ROW decisions conform to that plan. The *Worland Field Office Approved Resource Management Plan* (WFO RMP) currently governs and addresses the ROW process in the BLM WFO (BLM 2015a). Decisions, goals, and objectives from the WFO RMP that are applicable to the Proposed Action are listed below (BLM 2015a:40, 107, 114):

- Decision LR:1.5 Effects of infrastructure projects, including siting, will be minimized using the best available science, updated as monitoring information on current infrastructure projects becomes available.
- Goal LR:3 Manage public lands to meet transportation and ROW needs consistent with goals and objectives of other resources.
- Objective LR:3.1 Provide opportunities to meet ROW demands while protecting important resources.
- Goal LR:7 Respond to distinct recreation customer demand by providing for customer realization of diverse activity, experience, and benefit opportunities.

1.5.3 State and Local Permits, Authorization, and Coordination

WYDOT requires authorization to build access to the state highway system, as described in Wyoming Administrative Rules, Chapter 13 (Access Facilities), which is approved by the Transportation Commission of Wyoming and promulgated by authority of WS 24-2-105 and WS 24-6-101 through WS 24-6-11 to administer access facilities on the state highway system. Transportation authorities at the state level are authorized to design highways and to regulate, restrict, or prohibit access to those highways. Access to state highways granted by WYDOT authorities must conform to standards set by WYDOT.

Requirements for the development and rehabilitation of water projects in Wyoming are outlined in WS 41-2-114, including who will be consulted and the requirements for reconnaissance studies, feasibility studies, and construction and operation plans.

The *2009 Big Horn County Land Use Plan* includes several land use goals that are relevant to the Proposed Action (Big Horn County 2010:13):

- Retain farming and ranching as the preferred land use in rural areas.
- Sustain scenic areas, wildlife habitat, recreational areas, and other important open spaces.
- Ensure that development protects water resource capabilities for established and future users.
- Encourage development that is well planned with respect to environmental hazards and resource limitations and is compatible with established and future land uses.
- Promote land uses that support the tourism economy including public and private recreational areas and tourist facilities.

A Big Horn County Development Permit is required for the construction of structures in the county on private lands. A Big Horn County Floodplain Development Permit is required for the construction of any structures in floodplains in the county on private lands. Big Horn County does not have any building codes for development in unincorporated areas.

1.6 Issues

In accordance with NEPA (40 CFR 1501.7), the BLM initiated the scoping process to provide for an early and open process to gather information from the public and interested agencies on the issues and alternatives to be evaluated in the EIS. Issues were identified from public comments, as well as cooperating agency comments and internal BLM scoping. Appendix B contains detailed information on the scoping process.

1.6.1 Issues Dismissed from Detailed Analysis

As part of the project's internal and external scoping process, the following issues were identified:

1.6.1.1 UTE LADIES'-TRESSES

- How would surface disturbance or changes in water flow affect Ute ladies'-tresses (*Spiranthes diluvialis*)?

The project area was found to have limited amounts of suitable Ute ladies'-tresses habitat, and no individuals or populations of Ute ladies'-tresses were found during 2 years of surveys (Trihydro 2017a, 2018e).

1.6.1.2 BAT SPECIES

- How would surface disturbance affect bat species hibernacula or maternity roosts?

The project area was found to have limited potential roosting habitat, with only a few areas identified within the project area that could provide temporary night or possible day roosts for bat species. No known hibernacula or maternity roosts occur in the area, and it is unlikely that any potential roosts sites in the project area function as maternity roosts or hibernacula (Trihydro 2017g).

1.6.1.3 NORTHERN LEOPARD FROG

- How would surface disturbance affect northern leopard frog (*Rana pipiens*) and other reptile and amphibian species?

The project area was found to have no terrestrial habitats uniquely suited to reptiles and amphibians. Additionally, SWCA Environmental Consultants (SWCA) conducted a survey for northern leopard frog and other amphibians and reptiles throughout the analysis area in 2017. No amphibians were observed (SWCA 2017b).

1.6.1.4 SELENIUM

- Would soils beneath the proposed Alkali Creek Reservoir leach selenium into reservoir water and would selenium from seleniferous geologic formations be transported and accumulated by Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek?

Surface water and sediment in Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek were sampled for selenium; selenium was not detected in any of the samples (Trihydro 2016a). Additional selenium soil sampling within the footprint of the proposed reservoir indicated that selenium was present above method detection limits at only one of the 13 tested locations. Using these results, Trihydro (2018d) estimated that the equilibrium selenium concentration in the reservoir would be at or below 0.0026 milligrams per liter (mg/L), which is well below the numeric criteria for selenium protection of aquatic life and human health. The Trihydro memorandum regarding the reservoir footprint selenium soil sampling results (Trihydro 2018d) indicates that selenium concentration in the proposed reservoir is not expected to exceed the standards in Chapter 1 (Wyoming Surface Water Quality Standards) of the Wyoming water quality rules and regulations. Because selenium concentration in the reservoir water is expected to be below surface water quality standards, this issue is not carried forward for detailed analysis in the EIS.

1.6.2 Issues Carried Forward for Detailed Analysis

Issues carried forward for detailed analysis are provided at the beginning of each resource's section in Chapter 3.

2 PROJECT ALTERNATIVES

2.1 Introduction

NEPA requires federal agencies to evaluate a reasonable range of alternatives for a proposed action when it involves unresolved conflicts concerning alternative uses of available resources. The range of alternatives must meet the purpose and need and also minimize or avoid environmental effects. *Reasonable alternatives* are defined by the Council on Environmental Quality (CEQ) as those that are technically, economically, and environmentally practical and feasible. NEPA also requires that a no action alternative be evaluated as a baseline for comparing the other analyzed alternatives.

Alternatives are developed to address issues or concerns raised during internal and public scoping. If an alternative is suggested that does not meet the purpose of and need for the project, a detailed analysis of the alternative is not required. However, a rationale for eliminating the alternative from detailed analysis must be provided. The alternatives development and evaluation process for this project are described in the following sections.

2.2 Alternatives Development and Evaluation Process Overview

In 2010, Anderson completed an evaluation of the Nowood River watershed and developed a watershed management plan for the WWDO (Anderson 2010). The evaluation included an assessment of late-season irrigation shortages in the watershed and identified 35 potential surface water storage sites. The WWDO explored the 35 sites in more detail in a Level II study completed by Trihydro, along with five additional water storage locations (Trihydro 2013). The 40 potential water storage sites were screened with a matrix analysis and compared for ownership constraints and other technical and site characteristics. Detailed investigations (including site visits, evaluations of environmental considerations, landowner discussions, and development of conceptual level designs and cost estimates) were completed for a short list of sites. As a result, two potential water storage sites were recommended for further evaluation: 1) an expansion to Meadowlark Lake, and 2) construction of a new reservoir on Alkali Creek. Trihydro further investigated these two sites, concluding that Alkali Creek was a viable reservoir site that would benefit the watershed by reducing late-season water shortages, creating diverse habitat, and providing recreation opportunities (Trihydro 2016a).

A third-party NEPA consultant, SWCA, developed a screening methodology independent of Trihydro's screening process. The screening criteria used by SWCA consisted of applying the following hierarchical screens to each alternative:

1. Purpose and need and reliability/yield: Does the alternative meet the purpose of and need for the project? Is the alternative capable of serving the water supply needs in the Paint Rock Creek watershed and the lower Nowood River? Is the reservoir storage site (singly or in combination) large enough to meet the project need? Is the water supply (yield) adequate to satisfy the purpose and need?
2. Technological feasibility: Can the alternative be constructed? Are there engineering fatal flaws such as foundation conditions, geologic or earthquake hazards, landslides, or other geotechnical considerations that cannot be mitigated?
3. Environmental impacts: Does the alternative resolve resource conflicts that other alternatives do not? For example, how do the alternatives compare when considering effects to aquatic resources? Does the alternative affect endangered species, sage-grouse habitat, big-game crucial range, designated wilderness, or important recreational facilities?

4. Project cost: Though cost alone is an insufficient justification for dismissing an alternative from detailed analysis, cost (capital and operation and maintenance costs) is an important consideration in determining the feasibility of an alternative. The WWDO is the primary funding source for irrigation water projects in Wyoming. Legislation passed by the Wyoming Legislature and signed by the governor establishes "industry norms" for funding water development projects in the state. The WWDO considers benefit/cost ratios in its project funding and generally will not fund a project if its benefit/cost analysis is less than 1.0. Does the alternative meet the WWDO's benefit/cost ratio? The screen also assumed that any alternative less than 1.5 times the cost of the WWDO preferred alternative (construction plus operation and maintenance) was feasible. The WWDO determined that any alternative that costs more than 1.5 times the Alkali Creek Reservoir project was economically infeasible.
5. Unique considerations: Are there alternatives with unique characteristics that are more desirable (e.g., recreation benefits, fishery and wildlife enhancements)? Conversely, are there unique characteristics that make certain alternatives less desirable (e.g., landownership issues, impediments to access)?

SWCA presented preliminary screening results and some additional suggested action alternatives to cooperating agencies during an alternatives development workshop held on January 9, 2018, at the BLM WFO. In addition to the 40 reservoir alternatives previously developed and screened and the no action alternative, 12 new alternatives were developed. The new action alternatives consisted of six potential modifications to the proposed Alkali Creek reservoir, three groundwater pumping options, natural storage (beaver management), water conservation, and water leasing.

Additional hydrological modeling was then conducted by Trihydro to determine the technical feasibility of the new action alternatives and whether they could reduce potential effects. Final screening of all 53 alternatives was conducted. Of the 53 alternatives, 49 alternatives were dismissed from further analysis (Section 2.3), and four alternatives are carried forward for analysis in the EIS in the form of three formal alternatives (Section 2.4). Appendix C contains a description of each of the 53 alternatives.

2.3 Alternatives Considered but Eliminated from Detailed Analysis

A description of each of the 53 alternatives, including the rationale for alternatives dismissed from detailed analysis, can be found in Appendix C.

2.4 Alternatives Carried Forward for Detailed Analysis

Of the 53 alternatives that were developed and evaluated, four alternatives are carried forward for detailed analysis in the EIS (see Appendix C). Two of the four alternatives have been grouped together as the Modified Proposed Action alternative. The rationale for carrying these alternatives forward for detailed analysis is described in Appendix C. The alternatives are described in detail in Sections 2.4.1 through 2.4.3.

2.4.1 Alternative A: No Federal Action

Alternative A (referred to hereafter as the *No Federal Action*) consists of the continued operation of the Nowood Watershed Improvement District (NWID) under current management conditions without additional storage or late-season water supplies. Currently, there are approximately 3,150 acres of unirrigated lands with associated water rights. Under this alternative, there is the potential for these idle lands to be left unirrigated, irrigated partially, or irrigated fully in the future, depending on the seniority of those water rights and available stream flows in the absence of storage.

No BLM ROW, CWA Section 404, or highway encroachment permits would be issued under the No Federal Action. Late-season irrigation water shortages would continue.

The following activities are assumed to be ongoing under the No Federal Action:

- Use of Paint Rock Creek and the larger Nowood River watershed for irrigation
- Agriculture, ranching, and livestock grazing
- Use of Medicine Lodge, Paint Rock, and Alkali Creeks and downstream reaches for recreation (e.g., fishing)

To compare the environmental effects of developing the project area versus not developing it, this EIS assumes that no ROWs or other substantial permits would be approved in the project area in the near future under the No Federal Action. However, selection of the No Federal Action would not preclude the approval of other ROWs or permits for other projects in the future. In addition, stream flow modeling for the No Federal Action was conducted with and without irrigation of the 3,150 acres of idle lands to capture the minimum and maximum potential stream flow impacts.

Although the No Federal Action does not achieve the overall project purpose of addressing late-season irrigation shortages in the lower portion of the Nowood River watershed and the Paint Rock Creek watershed, NEPA requires that this alternative be analyzed in detail as a baseline for comparison.

2.4.2 Alternative B: Proposed Action

Alternative B (referred to hereafter as the *Proposed Action*) meets the purpose of and need for the project, per the BLM WFO, the USACE, and WYDOT (see Appendix C).

The BLM has identified Alternative B, the applicant's Proposed Action, as the agency's preferred alternative in this final EIS. The identification of a preferred alternative does not constitute a commitment or decision in principle, and there is no requirement to select the preferred alternative in the ROD. If warranted, a different alternative than the preferred alternative may be selected in the ROD.

2.4.2.1 OVERVIEW

The Proposed Action would consist of the construction of a dam and reservoir on Alkali Creek, located approximately 3 miles northwest of Hyattville in Big Horn County, Wyoming. The reservoir would require a ROW granted by the BLM WFO in T50N, Range 90 West, Sixth Principal Meridian, in portions of Sections 26, 27, 33, 34, 35; and in T49N, R90W, in portions of Section 4. The ROW area includes a portion of the Anita Ditch located in T50N, R90W, Section 35. The primary access road will require a ROW encompassing T49N, R90W, in portions of Section 4, and T50N, R90W, in portions of Sections 33 and 34 (see Figure 1.2-1). The dam is proposed by the WWDO, a state agency that has planned, designed, and constructed multiple reservoir storage projects in Wyoming since 1975.

Alkali Creek is a tributary to Paint Rock Creek, which flows into the Nowood River. The Alkali Creek Reservoir would be filled with intermittent flows captured from Alkali Creek and off-channel flows diverted from Medicine Lodge Creek and Paint Rock Creek during spring runoff typically between mid-April and late June. A bypass of base flow in Alkali Creek through the reservoir would maintain current downstream conditions. Stream flow modeling for the Proposed Action was conducted with and without irrigation of the 3,150 acres of idle lands to capture the minimum and maximum potential stream flow impacts. For analysis purposes, three modelling scenarios were used: Scenario 1 reflects stream flow if all of the potentially irrigable permitted acreage goes into production, Scenario 2 shows stream flow without the inclusion of the potentially irrigable permitted acreage, and Scenario 3 tries to estimate effects to stream flow attributed solely to the proposed reservoir by comparing Scenario 1 for both the No Federal Action and the Proposed Action.

The reservoir would provide late-season irrigation water for portions of the Nowood River watershed, usually in September or occasionally in the fall. In addition, the reservoir would provide some flood attenuation and recreational opportunities such as fishing, boating, swimming, and birdwatching. A minimum pool or conservation pool would be maintained to support fisheries and recreation. The WWDO anticipates that the water right application for the conservation pool would allocate the bottom 1,998 acre-feet of the volume for fish propagation, environmental, and/or recreation and the top 5,996 acre-feet for irrigation use. This would be handled in one application with the same priority date on all designated uses. The Alkali Creek bypass would not affect the conservation pool. The irrigation pool would be available either directly or through an exchange for irrigation water.

Landownership of the project area is 36% BLM-administered lands and 64% privately owned lands at the reservoir's maximum high-water level (MHWL). The project would require a 362.4-acre ROW on public lands granted by the BLM WFO, consisting of 203.6 acres of surface disturbance and 158.8 acres of additional ROW width. The additional ROW width is the area between the proposed surface disturbance and the ROW line for the project. The ROW line follows section or lot lines and is outside the surface disturbance area. This additional ROW width is needed to match the layout of section or lot lines in determining the ROW grant.

The WWDO would assume responsibility for the project and manage overall project construction. The BLM could approve the WWDO's assigned responsibilities to another party at a later date if requested. In addition, the Wyoming Game and Fish Department (WGFD) and the BLM have expressed interest in managing the recreational uses and associated facilities at the reservoir.

In accordance with 40 CFR 1502.21, this description of the Proposed Action incorporates by reference project description elements in the *Alkali Creek Dam and Reservoir Plan of Development* (Trihydro 2017e), *Alkali Creek Dam and Reservoir Road Plan of Development* (Trihydro 2017f), *Nowood River Storage, Proposed Alkali Creek Reservoir Right-of-Way Application* (Trihydro 2016b), and the *Reclamation and Weed Management Plan* (Trihydro 2017b).

2.4.2.2 PROJECT ELEMENTS

The Proposed Action would consist of the following primary elements: a main embankment, a secondary (north) embankment, and a west embankment; the reservoir; outlet works; principal and auxiliary spillways; primary and secondary access roads; enlargement of supply ditches and a bypass pipeline; public recreation parking and boat ramp; constructed wetlands; and bed and bank stabilization and rock grade control structures on Alkali Creek. These elements are shown in Figures 2.4-1 and 2.4-2 and described in more detail following the figures.

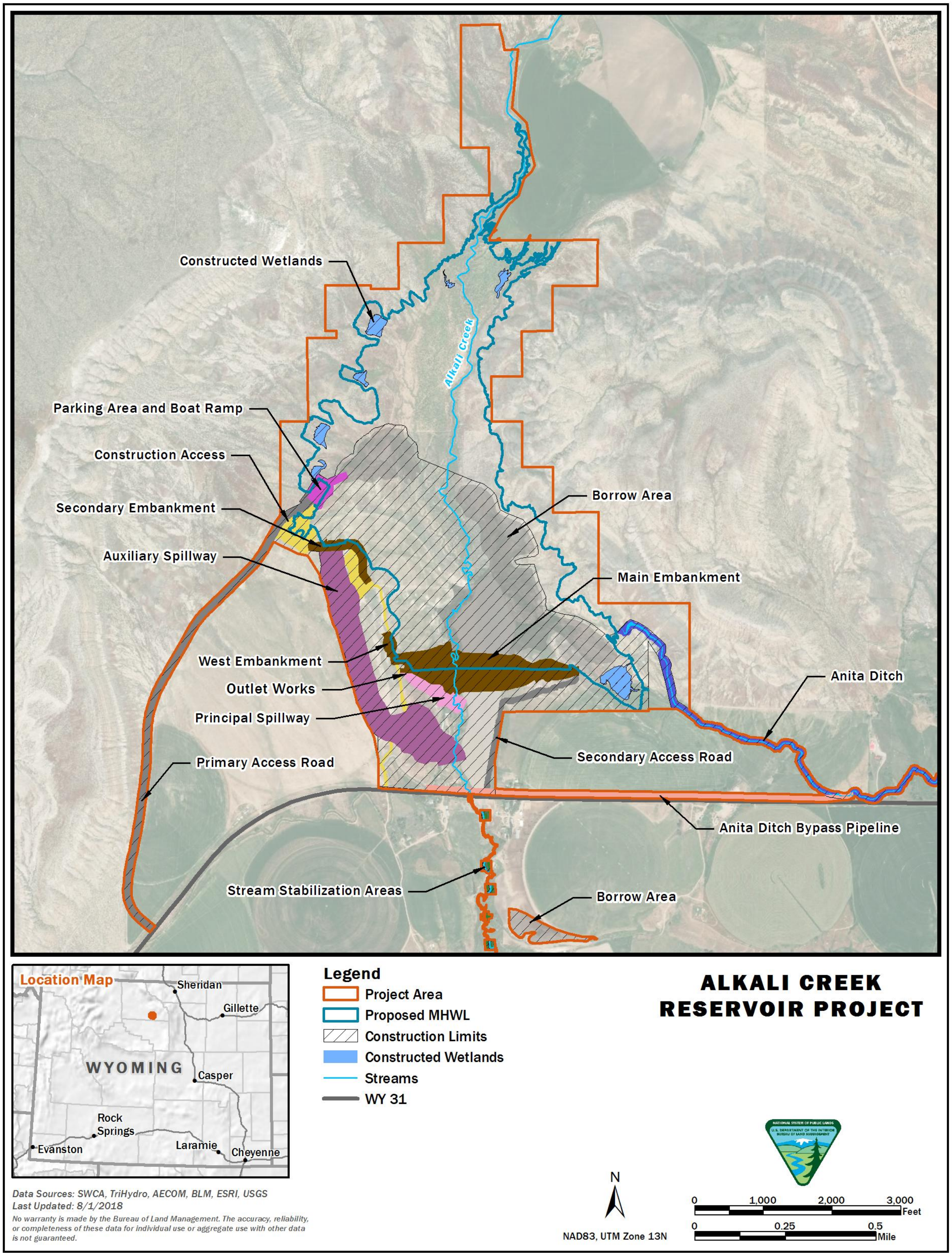

Figure 2.4-1. Proposed Action showing the project area and project elements, west side.

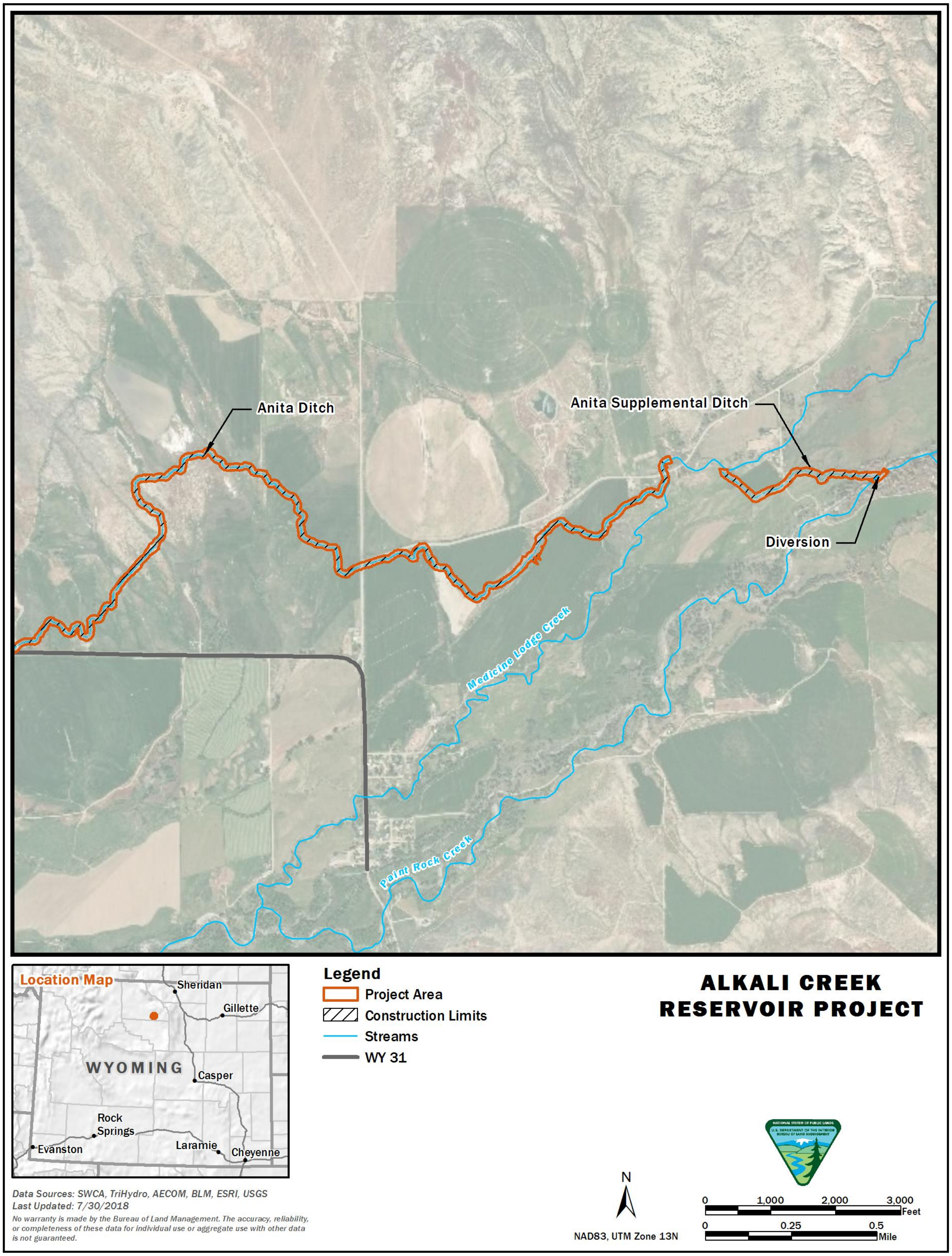

Figure 2.4-2. Proposed Action showing the project area and project elements, east side.

2.4.2.2.1 Dam and Reservoir

The dam and reservoir design consists of a homogenous earthen embankment dam and homogenous earthen dikes with a related reservoir pool, outlet works to control discharges, a principal spillway, an auxiliary spillway, and wetland mitigation areas (constructed wetlands).

The dam would consist of an east-west main embankment across the U-shaped Alkali Creek valley and two additional embankments: a secondary (north) embankment and a west embankment (see Figure 2.4-1). The main embankment would be 2,500 feet long and 98 feet high at its maximum cross section, with a crest elevation of 4,500 feet above mean sea level. The west embankment, located between the main embankment and the auxiliary spillway, would be approximately 275 feet long and 15 feet high. The secondary embankment, located approximately 850 feet north of the west embankment and extending to the auxiliary spillway, would be 1,200 feet long (including a portion of the spillway) with a maximum height of 8 feet. The embankments would maintain the appropriate freeboard when the reservoir is full or in flood stage.

The outlet works would consist of a gated intake structure, a gatehouse, a low-level outlet, concrete-encased outlet pipe(s), a control building, and an energy dissipation structure. The gated intake structure would allow for multilevel water withdrawal, which would allow for control of the temperature of released water. The low-level outlet design would be set to allow the reservoir to be emptied and would provide flexibility for unanticipated needs such as dam or outlet repairs, environmental controls, or changes in reservoir regulation. The concrete-encased outlet pipe(s) would convey reservoir discharge through the embankment to the control building. The control building would be placed at an elevation similar to the Anita Ditch to regulate water outflow to Alkali Creek and into the Anita Ditch.

The principal spillway would be a reinforced concrete structure designed to pass a 100-year, 24-hour storm event; the auxiliary spillway would be designed for the full probable maximum flood. The dam would be designed so that the auxiliary spillway would only operate during an extremely rare flood event that could be expected from the most severe combination of critical meteorological and hydrologic conditions. Because of the spillway size required to pass such large flood flows, the spillway channel would not be armored. If the auxiliary spillway is activated, repairs would be required following the flood event. Reservoir details (e.g., acreage and capacity under NHWLs and MHWLs) are provided in Table 2.4-1.

Table 2.4-1. Proposed Reservoir Footprint and Capacity

Reservoir Details	Normal High-Water Level	Maximum High-Water Level (flood conditions)
Reservoir footprint	294 acres (140 acres of BLM land)	350 acres (175 acres of BLM land)
Reservoir storage	7,994 acre-feet	9,872 acre-feet

The proposed reservoir would have 1,878 acre-feet of flood pool (flood storage capacity), 5,996 acre-feet of irrigation pool or operation pool, and 1,998 acre-feet of conservation pool. A 33,606-foot linear fence would be constructed around the reservoir to keep livestock from the reservoir. The fence would also deter trespassing on private lands north of the reservoir. Fencing would also be installed to limit public access to the spillways and operational controls. An existing fence on the north side of the reservoir would be left in place.

A 6,218-foot-long bypass pipeline would be constructed downstream of the dam to allow Anita Ditch irrigation flows to be diverted during reservoir construction. The bypass pipeline would remain following construction to provide pressurized flow to irrigators for sprinkler operation.

Irrigation releases from the reservoir would be directed into Alkali Creek for distribution to downstream irrigators along Paint Rock Creek and the lower Nowood River, and/or diverted into the Anita Ditch for distribution to its downstream irrigators. Irrigation releases would be controlled through valves in the control building located downstream of the dam. A year-round bypass of base flow in Alkali Creek (0.4 cubic feet per second [cfs]) would occur through the reservoir to maintain current downstream conditions.

2.4.2.2.2 Access Roads

Two new temporary construction roads and two new permanent access roads would be constructed as part of the project. The primary access road would be permanent and would provide public access to the reservoir. The secondary access road (also permanent) would provide access to the east abutment and dam crest for dam operations and maintenance for authorized personnel only. Both of the permanent roads would also be used as temporary access roads during construction. Two additional roads would be constructed for temporary (approximately 2 years) construction access: one road would provide temporary access to construction staging areas and the primary reservoir construction area and one road would provide temporary access for stabilizing Alkali Creek downstream of WY 31. A portion of the primary access road on private land currently exists as a two-track road. Similarly, a portion of the temporary road to the reservoir construction area also exists as an unimproved ranch road.

The primary access road would be 7,387 feet long with a running width of 28 feet. This road would run from WY 31 to the west side of the Alkali Creek Reservoir across both BLM and private lands. The secondary access road would be 2,627 feet long with a running width of 24 feet and would extend from WY 31 to the east end of the proposed dam across both BLM and private lands. The temporary construction road to the construction staging area would run north from WY 31 and would be 3,348 feet long with a width of 24 feet. The temporary construction road to Alkali Creek would run south from WY 31 along Alkali Creek and would be 8,711 feet long with a width of 20 feet.

The primary access road would require a ROW grant from the BLM WFO across public lands. The requested ROW would be 120 feet wide, 60 feet on each side of the road center line. A portion of the primary access road (486 feet of the total 7,387 feet) would fall in the larger proposed reservoir ROW boundary. The total additional requested road ROW acreage on BLM lands would be 5.6 acres (this does not include the portion of the primary access road that falls in the larger proposed reservoir ROW boundary). The portion of the secondary access road on BLM land is in the larger reservoir ROW request. The temporary construction roads are located on private lands and do not require BLM ROWs. Portions of both access roads would require easements across private land. The WWDO would work with the landowner to obtain a ROW for both access roads where they cross private property. Legal surveys and an appraisal would be conducted to assist in ROW negotiations. The landowner has indicated support for the project and intends to allow access to the project.

On the primary access road, the average daily traffic (ADT) count is projected to be less than 100. The ADT on the secondary access road is projected to be less than 10. Traffic on the primary access road would consist mostly of passenger vehicles, pickup trucks, and passenger vehicles and pickup trucks pulling small boat trailers. Traffic on the secondary access road would consist mostly of pickup trucks and utility vehicles. The expected combined ADT for all of the temporary construction roads is less than 20, with most of the traffic consisting of pickup trucks, construction equipment, and equipment and material transports. All of the roads would receive year-round use, but traffic is expected to be higher in the summer and fall.

2.4.2.2.3 Enlargement of Supply Ditches

Anita Ditch (approximately 4.3 miles long) would convey flow from Medicine Lodge Creek to the Alkali Creek Reservoir, and the Anita Supplemental Ditch (approximately 0.5 miles long) would convey flow from Paint Rock Creek to Medicine Lodge Creek. Both ditches would be enlarged to accommodate the flows required to fill the reservoir and to meet the needs of existing ditch users. The diversion structures for each ditch would also be modified. At a maximum, ditch bottom widths would be expanded to 11 feet from current bottom widths of 8 to 10 feet, the side slopes would be 2H:1V,[1] and the constructed depth would be 6 feet (existing depth varies from 2 to 8 feet). After enlargement, ditch sections would be capable of conveying up to 150 cfs at a flow depth ranging between 4 and 5 feet, depending on ditch condition and slope.

The diversion structures would be sited in the same locations as the existing structures, with slight modifications to account for structure type, size, and channel hydraulics. Diversion structure configurations and features would be based on an evaluation of channel hydraulics, sediment transport, and geomorphic conditions, as well as diversion operation criteria. Structures would be configured to divert the required flows over a range of stream flow conditions and to minimize the loss of structural integrity and stability during flood flows. Development of specific elements such as gate size, trash rack configuration, and materials would be determined during the final design process based on operational criteria and agency input and guidance. Facilitation of fish passage would be incorporated into the diversion structure designs, as appropriate, and would require determination of fish populations present and design parameters associated with each species of interest (e.g., limiting velocities). The design team would coordinate with the WGFD to determine fish passage criteria.

Rock cross vanes or similar structures would be installed in Medicine Lodge Creek and Paint Rock Creek to produce sufficient hydraulic head to divert flows through the enlarged ditches. Existing ditch infrastructure, such as turnouts, weirs, and flumes, would also be enlarged or replaced to allow for proper ditch operation and to maintain existing irrigation diversions. A section of the ditch would be lined to limit seepage losses along a cobble bench.

2.4.2.2.4 Public Access Area for Recreation

The recreation area at the reservoir would consist of a parking lot, a comfort station, and a boat ramp. It would be authorized within the requested reservoir ROW. The parking lot would be approximately 315 feet long and 170 feet wide. The boat ramp would be approximately 302 feet long and 28 feet wide, and would be designed to access the minimum pool level (top of the conservation pool) so that the reservoir would be accessible at all times of the year. The primary access road would allow the public to access these facilities and would be authorized within the requested road ROW.

2.4.2.2.5 Stream Stabilization on Alkali Creek

Alkali Creek is currently actively incising and has unstable streambanks. To prevent exacerbation of these conditions under the proposed flow changes, a stream stabilization plan would be implemented. The primary objective of stream stabilization efforts would be to create stable channel conditions following completion of the proposed project. Buried, rock grade control structures would be constructed on Alkali Creek to maintain or increase stream stability downstream of Alkali Creek Reservoir, mitigate erosion, and protect downstream structures (see stream stabilization areas on Figure 2.4-1). Natural channel design techniques would be incorporated into the final design, as well as potential habitat enhancement strategies, to the extent possible. Structures would be placed at discrete intervals down the channel along the downstream reach of Alkali Creek on private land south of WY 31.

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[1] H = horizontal measure (the distance from the middle of the ditch to the bank at the height of normal flow).
V = vertical measure (the height from the bottom of the ditch to the elevation of normal high-water flows).

Bank revetment would also be installed to control bank erosion adjacent to downstream structures. Two existing field-access culverts in Alkali Creek would be replaced with properly sized and constructed culverts. Current design plans specify 36-inch pipe arch culverts, which would be capable of passing 73 cfs and 106 cfs, respectively (flow differences are because of road embankment heights).

2.4.2.2.6 Other Elements

An embankment borrow area is proposed in the reservoir footprint and a drainage material borrow area would be located south of WY 31.

Reservoir operations would require power. The likely connection point would be south of the embankment from existing power lines. Disturbance for supplying power to the dam facilities would fall in the construction disturbance area associated with other project elements (see Table 2.4-2). Alternative power sources such as solar may also be considered. A backup generator would be installed at the dam to allow dam operation in the event of a power failure.

2.4.2.3 DESIGN FEATURES

Design features are specific means, measures, or practices that are incorporated into a Proposed Action to reduce or avoid adverse environmental effects (BLM 2008a). The following design features are included in the Proposed Action:

- Requirements would be included in the construction design plan set and specifications to stake the ROW and disturbance limits before construction. Clearing and grading would be completed within the proposed disturbance limits, which would be shown on the construction design plan set. Clearing and grading on BLM lands would only occur in the ROW.
- The construction contractor would be required to develop a stormwater pollution prevention plan (SWPPP) to detail stormwater and erosion controls, slope stabilization, and monitoring and reporting requirements. Stormwater best management practice (BMP) controls would be installed during construction to limit erosion and effects to water quality. The construction contractor would also be required to obtain a turbidity waiver from the Wyoming Department of Environmental Quality (WDEQ), if applicable, for unavoidable temporary increases in sediment releases.
- The construction contractor and the construction engineer would be required to develop site-specific health and safety plans as part of pre-construction submittals. The plans would outline project roles and responsibilities, provide project and emergency contact information, illustrate hospital routes, and identify specific site hazards and mitigation.
- The construction contractor would be required to develop a traffic management plan to limit effects to traffic.
- The construction contractor would be required to construct and maintain lined secondary containment facilities for storing petroleum products. The primary storage devices (e.g., drums, tanks) must be approved devices specifically designed for safely storing such materials.
- Soil replacement and stabilization BMPs from the draft *Reclamation and Weed Management Plan* (Trihydro 2017b) would be followed.
- The Wyoming state engineer will approve all plans and specifications for construction of the dam and diversion system. The state engineer will provide for the regulation and supervision of the dam, diversion system, and reservoir to the extent required to protect public safety and property. In addition, the state engineer or their appointed representative shall perform inspections of the dam at least once every 10 years or as often as deemed necessary.

- A bypass of base flow in Alkali Creek (0.4 cfs) would be maintained through the reservoir year-round.
- A monitoring and adaptive management plan (AMP) for the project will be developed before the ROD is published. The AMP will primarily address water quality issues and support of designated beneficial uses.

2.4.2.4 CONSTRUCTION

Construction is anticipated to take between 1 and 2 years and would not begin until all plans and specifications for construction of the dam and diversion system are approved by the Wyoming state engineer. The schedule may be affected by weather, water management approaches, the presence of sensitive species that could limit construction windows or operating hours, and other constraints imposed by the BLM or cooperating agencies. The timing and location of livestock would be considered during development of a more detailed construction schedule. The timing of construction would depend on the completion and findings of the NEPA process.

A workforce of approximately 553 employees would be required for the project, including engineering and surveying support; construction management personnel; a maintenance crew; workers for construction activities; and workers for wetlands work, revegetation, and reclamation.

During construction, available topsoil would be salvaged and stored for interim or final reclamation; portions may be used for wetland mitigation. The depth of topsoil stockpiled for extended periods would be limited to 3 feet (including the native topsoil underneath). Stockpiles would be seeded to maintain microbial activity and minimize erosion. Additional details for the salvage of topsoil and maintenance of topsoil viability are provided in the draft *Reclamation and Weed Management Plan* (Trihydro 2017b). Seeding specifications are also outlined in the draft *Reclamation and Weed Management Plan*. Access to ROWs would be limited following reclamation of temporary disturbance, except on permanent surfaced access roads.

Trees and shrubs directly disturbed by construction would be cleared and stockpiled, then burned or chipped and mulched. They may also be available for landowner use. Mulch would be applied on-site or provided to the public. Grasses, forbs, and smaller shrubs would be stripped and mixed with topsoil. Larger shrubs would be stockpiled and burned or chipped and mulched.

No hazardous wastes or toxic substance would be used, produced, transported, or stored in the project area. Industrial wastes—limited to petroleum products such as grease, oils, and fuels—may be stored in staging areas during construction.

In addition to the specific details provided below, the construction process would include obtaining construction-related permits, staking the ROW and disturbance boundaries, and implementing design features such as the installation of stormwater BMP controls. Construction activities can generally be divided into the following categories: the dam and reservoir, access roads, enlargement of supply ditches, the public access area for recreation, and stream stabilization on Alkali Creek.

2.4.2.4.1 Dam and Reservoir

Construction of the dam and reservoir (and associated elements) would consist of the following activities:

- Clearing and grubbing the disturbance areas prior to constructing and/or grading each feature
- Salvaging and stockpiling topsoil from disturbance footprints
- Constructing staging areas

- Constructing the portions of the perimeter fence located along the BLM ROW
- Salvaging hydric soils from disturbance areas to assist with wetland mitigation
- Constructing temporary structures to manage stormwater runoff and Alkali Creek flows
- Constructing the Anita Ditch bypass pipeline
- Developing embankment and drainage material borrow areas
- Excavating and constructing the embankment key trench and seepage control measures
- Constructing the auxiliary spillway and secondary and west embankments
- Constructing the earthen embankment, outlet works, and embankment drains
- Constructing the intake structure and control building
- Constructing the principal spillway
- Installing dam controls
- Installing access control fencing and signage
- Supplying power to the control building
- Placing slope protection on the upstream embankment face
- Constructing the parking lot and boat ramp
- Importing and placing surfacing material for the parking lot and boat ramp
- Spreading hydric soils and constructing wetland mitigation areas (targeted for fall for optimal plant survival)
- Installing remaining fencing on private land
- Installing cattle guards
- Performing reclamation of temporary disturbance areas

Project activities would require approximately 1.8 million cubic yards of on-site excavation materials and approximately 1.4 million cubic yards of on-site fill based on the proposed design. Riprap, parking lot surfacing aggregate, and boat ramp surfacing materials would be imported.

Two temporary construction staging or work areas (primary and secondary) would be required for equipment storage and material stockpiles during construction. Construction limits would be established that include the two construction staging areas, temporary construction access roads, the Anita Ditch bypass pipeline, the embankment borrow area in the reservoir footprint, and fringe areas that would be disturbed by construction.

As part of the dam construction, topsoil, at least the top 1 foot of sandy clays in the valley bottom, and the weathered claystone and siltstone/sandstone on the abutments would be stripped from the embankment and dike footprints before constructing the embankments. The dam design includes a key trench to be excavated into the foundation material. Measures to reduce and/or control seepage through the granular soils and bedrock below the main embankment and along the abutments would be evaluated, designed, and included as part of the embankment construction. The maximum possible dam height would be controlled by the elevation of the right abutment. The upstream (reservoir pool) embankment would be designed with a 3:1 slope, whereas the downstream slope would be designed with a 2.5:1 slope. These slopes would be reevaluated and may be flattened before construction. Riprap or other engineered slope protection would be placed on the upstream slope.

2.4.2.4.2 Access Roads

Construction of the access roads would consist of the following activities:

- Clearing and grubbing disturbance areas
- Excavating and altering terrain
- Altering ditches (i.e., installing culvert crossings)
- Clearing and grubbing access road grading limits
- Salvaging and stockpiling soil from disturbance areas
- Constructing long-term road surfaces (permanent roads)
- Constructing the primary and secondary access roads as construction access roads
- Constructing temporary access roads and staging areas
- Performing access road rough grading, including constructing ditches
- Installing culverts
- Borrowing and/or importing structural fill and crushed base material
- Constructing structural fill and placing crushed base surfacing material
- Installing cattle guards
- Performing interim reclamation on temporary disturbance areas

Typical road construction equipment would be used for the project, including over-the-road haul trucks, tracked excavators, scrapers, skid steers, road graders, dozers, and smooth-drummed or sheepsfoot roller/compactors. Road surfacing aggregate would be imported.

Access to the road construction areas would be from WY 31. Access to the ROW would be restricted during construction for public safety. Access controls would consist of temporary fencing, signs, and flaggers, depending on the work area and task.

Roads would be constructed in accordance with BLM Manual MS 9113 – Roads, which provides standards for roads and guidelines for road project planning, design, construction, and maintenance on BLM lands (BLM 2015b), and the associated BLM H-9113-1 Road Design Handbook (BLM 2011) and BLM H-9113-2 Roads Inventory and Condition Assessment Guidance & Instructions Handbook (BLM 2015c).

Culverts would be installed where necessary; each would be a minimum of 24 inches in diameter with a minimum of 12 inches cover above each culvert crossing. Structural fill and compacted crushed base would be placed on top of the subgrade during road construction. Subbase and surfacing materials would be supplied from the borrow areas or excavation areas, or the materials would be purchased and imported from a commercial supplier.

2.4.2.4.3 Enlargement of Supply Ditches

Enlarging the Anita Ditch and Anita Supplemental Ditch would consist of the following activities:

- Excavating and enlarging the Anita Ditch and Anita Supplemental Ditch
- Constructing the irrigation diversion and control structures in the enlarged ditches
- Salvaging and stockpiling hydric soils
- Constructing the Paint Rock Creek and Medicine Lodge diversion structures

Access for enlarging the existing ditches and for future operations and maintenance would be via existing ranch roads and along the ditch berms. Table 2.4-2 in Section 2.4.2.5 includes the project surface disturbance for the Anita Ditch and Anita Supplemental Ditch enlargements on both BLM and private lands.

2.4.2.4.4 Public Access Area for Recreation

Construction of the public access area would involve clearing and grubbing the area for the parking lot, comfort station, and boat ramp; excavation; and salvaging and stockpiling soil and hydric soils as needed. Construction of the primary access road is discussed in Section 2.4.2.4.2 (Access Roads). Facilities like picnic tables, shelters, and walking paths could be constructed in the future by the WGFD or the BLM if sufficient need is demonstrated. Authorization of these actions would occur upon additional NEPA analysis.

2.4.2.4.5 Stream Stabilization on Alkali Creek

Up to eight rock grade control structures would be constructed at intervals along the downstream reach of Alkali Creek on private land south of WY 31. The structures would be keyed in the banks, and the top of the structures would be set at the elevation of the upstream bed. The structures would eliminate the development of larger head cuts and would limit the ability for head cuts to migrate upstream.

Bank revetments would also be installed to control bank erosion adjacent to downstream structures. Bank stabilization would use a combination of grading (flattening certain banks), large woody debris, and rock to divert flow away from critical banks or to armor banks during high flows. Toe protection would be buried below the channel grade. Generally, voids in rocks would be filled with smaller material and soil placed over bank stabilization structures. Efforts to establish vegetation would be incorporated.

Two existing field-access culverts in Alkali Creek would be replaced with properly sized and constructed culverts.

2.4.2.5 SURFACE DISTURBANCE

Table 2.4-2 summarizes the total project surface disturbance on both BLM and private lands.

Table 2.4-2. Total Project Surface Disturbance

Project Description	Surface Disturbance by Landownership (acres)		Total Surface Disturbance (acres)
	BLM	Private	
Reservoir elements in the MHWL	174.6	173.9	348.5
Reservoir elements (construction limits) outside the MHWL	17.5	123.2	140.7
Other project elements (e.g., Anita Ditch)	4.3	76.9	81.2
Roads	7.2	25.3	32.5
Total	**203.6**	**399.3**	**602.9**

As shown in Table 2.4-2, construction of the dam, reservoir, and associated elements would result in 602.9 acres of surface disturbance, 203.6 acres of which is located on BLM lands and 399.3 acres of which is located on private lands.

2.4.2.6 OPERATION AND MAINTENANCE

2.4.2.6.1 Dam and Reservoir

Operation and maintenance of the reservoir would involve activities such as inundating land in the proposed reservoir pool, releasing water for irrigation, controlling vegetation and noxious weeds, controlling animals such as livestock, using off-highway vehicles for ongoing inspections, removing accumulated sediment from the boat ramp, repairing boat ramp surfacing as needed, diverting additional water for storage, and performing other general operation and maintenance activities. The dam would be an unmanned structure; however, dam performance instrumentation would be installed to monitor the dam.

The WWDO would assume operation, maintenance, and monitoring responsibility for the project. Operation and maintenance procedures are provided in the draft *Proposed Operation Plan* (Trihydro 2017c). Safety procedures are addressed in the draft *Proposed Emergency Action Plan* (Trihydro 2017d). The operation and maintenance procedures and the safety procedures would be refined and expanded prior to reservoir operations based on input from the WWDO, the contractor(s), the geotechnical engineer, local emergency response agencies, and equipment suppliers.

Daily monitoring operations would include a check of the supervisory control and data acquisition system and inspections of the gatehouse, control building, dam embankment, and toe drain outflow. Weekly monitoring operations would include inspections of the dam crest, spillways, inlet, stilling basin, gatehouse, intake structure, control building, wetlands, and land surrounding the reservoir inside the fenced area. Monthly inspections would include checks on various elements each month from May through November because reservoir water would primarily be operated during the irrigation season. Annual monitoring would include inspections of the gatehouse, intake structure, control building/outlet works, spillways, irrigation releases, electrical equipment, gage stations, propane fuel supply, and sluice gates.

2.4.2.6.2 Access Roads

During dam operations, use and maintenance of the primary and secondary access roads would involve controlling vegetation and noxious weeds, controlling animals such as livestock, controlling off-highway vehicle traffic for ongoing dam inspections, controlling recreational traffic, controlling dam use and maintenance traffic, as well as other general road maintenance activities.

The WWDO would assume responsibility for maintenance of the primary and secondary access roads. The temporary access roads would be removed and reclaimed following construction and would not require operation and maintenance.

Road maintenance schedules would be refined prior to construction and may be modified based on observations of road conditions and use. At a minimum, road condition assessments would be conducted monthly for the primary and secondary access roads. Condition assessments would consist of monitoring for rutting, washboarding, invasive and noxious weeds, sediment building or erosion in culvert inlets and outlets, sign damage, and sediment build-up in cattle guards. Maintenance activities such as road blading, herbicide application on weeds, litter collection, sediment removal, and erosion correction would be performed as needed based on the condition assessments. Snow removal and seasonal closures of the primary access road would be managed by the WWDO. Snow removal on the secondary access road would be managed by the WWDO. At a minimum, road repairs and maintenance would be conducted semiannually on the primary access road and monthly on the secondary access road.

The posted speed limit on the primary access road would be signed according to BLM guidance. Signs would also require motorized vehicles to remain on established roads. The secondary access road would be signed to restrict access to authorized personnel only. The use, location, and specifications of signage would be determined through coordination with the BLM, the WWDO, the WGFD, and Big Horn County.

2.4.2.6.3 Supply Ditches

The WWDO, in combination with the Anita Ditch Company, would assume operation and maintenance responsibility for the supply ditches, including maintenance of the diversion structures, flow measuring devices, ditches, turnout and control structures, and interim reclamation monitoring.

The WWDO would be responsible for inspection and maintenance schedules, which would be refined prior to reservoir filling operations based on input from the State Engineer's Office, the WGFD, the Anita Ditch Company, and irrigators. Daily monitoring operations would include checking the reservoir water level, diversion flow meters, and stream gages in Medicine Lodge Creek and Paint Rock Creek. Weekly monitoring operations would include inspections of the gage stations, diversion flow meters, and diversion structures. Monthly inspections would include checks on various elements each month from May through July because reservoir filling would primarily be operated during the spring runoff season. Annual monitoring would include inspections of the diversion structures, intake structures, electrical equipment, gage stations, and ditch alignments. Annual ditch cleaning is also expected.

Existing ranch roads would be used to access the supply ditches to perform operations and maintenance, similar to existing practice.

2.4.2.6.4 Public Access Area for Recreation

Facilities in the public access area (i.e., the parking lot, comfort station, and boat ramp) would be inspected and maintained on a regular schedule to be finalized by the permit holder. A reasonable inspection and maintenance schedule could include cleaning the comfort station and collecting trash and litter on a weekly basis; inspecting the boat ramp, comfort station, and parking lot on a monthly basis and making needed repairs, managing weeds, and removing waste; removing accumulated sediment from the boat ramp and repairing boat ramp surfacing as needed on an annual basis; and winterizing the comfort station annually.

Signage would include traffic signs (e.g., speed limit), recreation management signs (e.g., no overnight camping), and access controls (e.g., restricted area).

2.4.2.6.5 Stream Stabilization on Alkali Creek

Stream improvement structures, including the revetment protection and rock grade control structures, would be inspected and maintained on a regular schedule to be finalized by the entity assuming operation and maintenance responsibility. Reasonable monitoring would include inspecting structures annually for rock movement, erosion, and sediment accumulation. Repairs would be completed as needed based on the results and recommendations of annual inspections.

2.4.2.7 ABANDONMENT AND RECLAMATION

2.4.2.7.1 Dam and Reservoir

The estimated functional life of the dam is 75 years, but it might be extended with regular maintenance and improvements. Removal of the reservoir is not anticipated. In the event the reservoir is no longer needed in the future or is structurally unsound and must be abandoned, the WWDO would notify the BLM of its intent to reclaim the reservoir area for final abandonment.

All dam and reservoir facilities would be removed, including the reservoir embankment, intake structure, spillways, outlet pipes, parking lot, comfort station, boat ramp, and ancillary facilities such as fences and cattle guards. Debris would be hauled off-site and disposed of or recycled at a properly permitted facility. Equipment would be salvaged for resale or recycling.

Embankment materials would be excavated and re-spread over the original borrow areas. The site would be regraded to match the approximate pre-reservoir contours and blended with the surrounding terrain. Because the re-contoured site would mimic the pre-disturbance site, pre-disturbance drainage characteristics would also be matched. Existing drainage features disturbed for reservoir construction would be reconstructed to their pre-disturbance drainage pattern, profile, and dimension.

Topsoil salvaged and protected during reservoir construction, as well as accumulated sediments in the reservoir bottom, would be spread over disturbed areas. Disturbed and re-contoured areas would be fertilized (if appropriate based on soil tests), seeded with a BLM-approved seed mix, and mulched. Temporary fencing of the reclaimed reservoir area may be required after seeding to exclude livestock and wildlife and to allow for revegetation success. Once revegetation is achieved, the fence would be completely removed.

Additional reclamation detail can be found in the draft *Reclamation and Weed Management Plan* (Trihydro 2017b), which sets out reclamation performance standards for both interim and final reclamation (e.g., final reclamation success must have 90% of the vegetation consisting of species included in the approved seed mix or desirable species). Reclamation areas would be inspected regularly for general site status, soil erosion, vegetation density and diversity, and weed infestation.

2.4.2.7.2 Access Roads

If the reservoir is removed, the primary and secondary access roads would be completely removed and reclaimed unless the BLM or private landowner requests that they be left in place. The portion of the primary access road on private land is currently an existing two-track road used by the landowner for access to agricultural rangeland. It is anticipated that the landowner would want that portion of the road to remain after final reclamation. In addition, the portion of the primary access road on BLM land is used for similar purposes, and it is anticipated that the grazing lessee would want the road to remain after final reclamation. If portions of the primary access road remain for these purposes, the responsibility for road maintenance and the ROW would be transferred to the private landowner/grazing lessee with BLM approval.

The temporary access roads would be removed and reclaimed following construction, in accordance with the draft *Reclamation and Weed Management Plan* (Trihydro 2017b).

Road areas to be reclaimed would be regraded to approximate the original existing contours and blend with the surrounding terrain. A minimum of 6 inches of stockpiled topsoil would be evenly redistributed over the surface. The area would be fertilized (if appropriate based on soil tests), seeded with a BLM-approved seed mix, and mulched. Additional reclamation details can be found in the draft *Reclamation and Weed Management Plan* (Trihydro 2017b).

2.4.2.7.3 Supply Ditches

The supply ditches would be existing irrigation ditches. If the dam is removed, the ditches would remain, and operation would revert to the Anita Ditch Company. Upgraded structures would be modified to allow operation of the ditches to pre-reservoir conditions. The portions of the ditches flooded by the reservoir would be reestablished and the disturbed area would be reclaimed in accordance with the draft *Reclamation and Weed Management Plan*.

2.4.2.7.4 Public Access Area for Recreation

If the reservoir is removed, the public access area (i.e., the parking lot, comfort station, and boat ramp) would be completely removed and reclaimed. Access areas would be regraded to approximate the original existing contours and to blend with the surrounding terrain. A minimum of 6 inches of stockpiled topsoil or accumulated sediments from the reservoir would be evenly redistributed over the surface. The area would be fertilized (if appropriate based on soil tests), seeded with a BLM-approved seed mix, and mulched. Additional reclamation detail can be found in the draft *Reclamation and Weed Management Plan* (Trihydro 2017b).

2.4.2.7.5 Stream Stabilization on Alkali Creek

If the reservoir is abandoned and removed, the bank revetment would be left in place; removal may cause bank instabilities that could threaten downstream residents. Rock grade control structures in Alkali Creek would be removed or left in place, depending on WGFD evaluation and recommendation at the time of reservoir removal. Maintenance of the structures left in place would revert to the individual private landowners.

2.4.3 Alternative C: Modified Proposed Action

Alternative C (referred to hereafter as the *Modified Proposed Action*) consists of the same elements and activities as the Proposed Action with two potential modifications: 1) reducing the length of the auxiliary spillway by approximately 3,375 feet, and 2) modifying the reservoir fill time from 30 to 50 days. One or both of the modifications could be selected in the ROD.

Analysis of the Modified Proposed Action was considered with and without irrigation of the 3,150 acres of idle lands to capture the minimum and maximum potential stream flow impacts.

2.4.3.1 SPILLWAY MODIFICATION #2

This modification to the Proposed Action auxiliary spillway configuration consists of reducing the length of the auxiliary spillway by constructing an armored control section to direct probable maximum flood flows into an existing drainage flowing south across WY 31 and eventually back into Alkali Creek (Figure 2.4-3). The auxiliary spillway length would be reduced from 3,950 feet to approximately 575 feet.

This modification would reduce direct disturbance to row crops on the west side of the dam and would not introduce additional effects to irrigated fields east of Alkali Creek. It would avoid a large cut through the ridge along Alkali Creek's west bank and reduce the excavation by approximately 400,000 cubic yards. This modification would also avoid the auxiliary spillway cutting through the outlet from the reservoir to the downstream portion of the Anita Ditch.

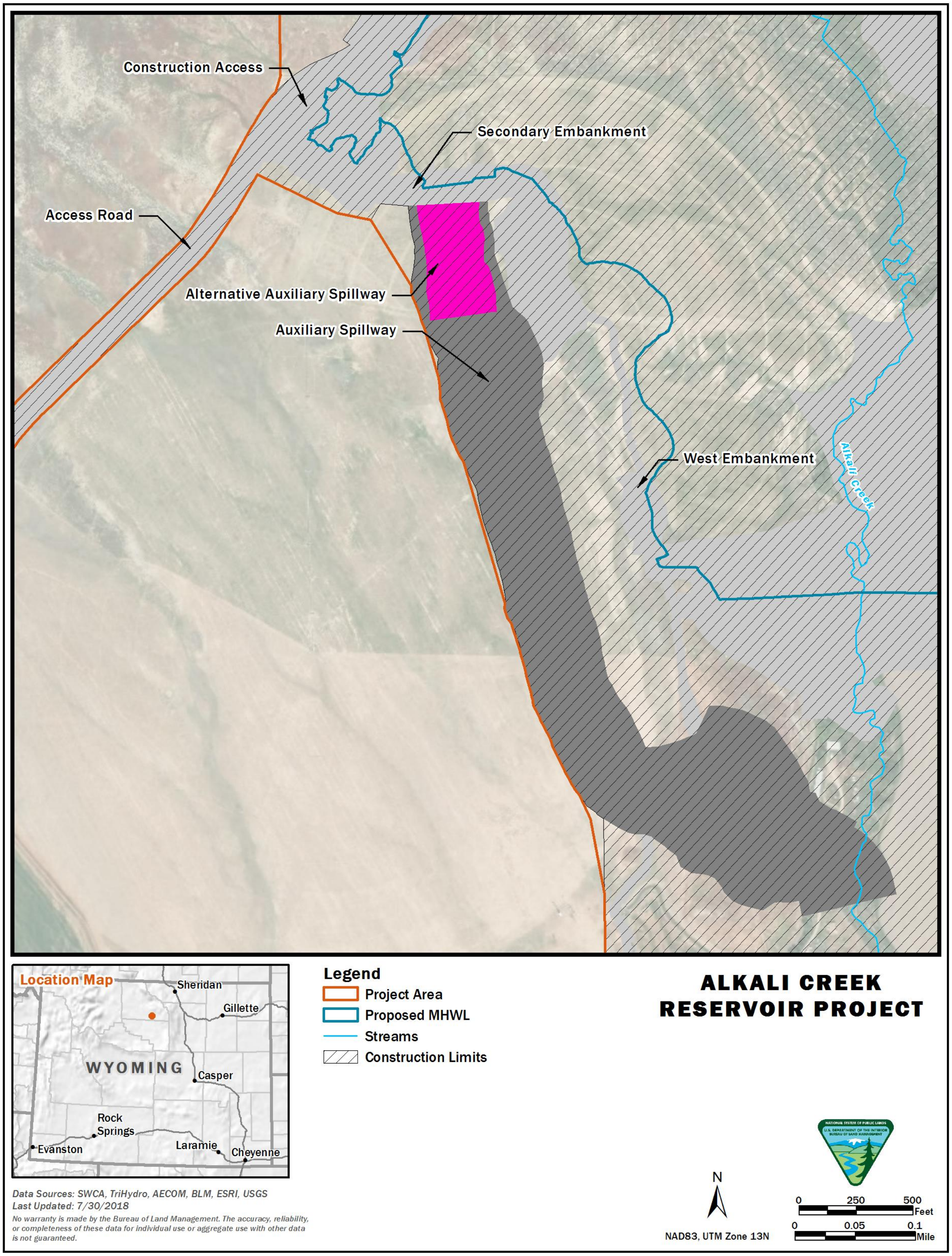

Figure 2.4-3. Modified Proposed Action, Spillway #2.

2.4.3.2 MODIFIED FILLING TIME

This modification to the Proposed Action would extend the reservoir filling window from 30 to 50 days each spring and reduce the target volume from the normal high-water volume (7,994 acre-feet), which includes the conservation pool, to the irrigation or operation pool volume (5,996 acre-feet).[2] After the initial fill, only the reservoir's operation pool should require annual filling.

This modification would involve enlarging the Anita Supplemental Ditch (to a lesser extent than the Proposed Action) to convey a total of 80 cfs (rather than 150 cfs) and enlarging the Anita Ditch to convey a total of 115 cfs (rather than 150 cfs). These flows would include the reservoir flow, conveyance losses, and the existing peak irrigation demands in May and June. By extending the filling window, the ditch flow area (during reservoir filling) would be reduced approximately 20%, decreasing the required ditch enlargements and resulting in a smaller disturbance footprint. Reducing the ditch enlargement size would lower project costs and lessen the complexities associated with replacing irrigation infrastructure. In addition, reducing the ditch enlargements and the volume of water carried in the ditches would reduce total seepage and evaporation losses.

As with the Proposed Action, rock cross vanes or similar diversion structures would still be installed in Medicine Lodge Creek and Paint Rock Creek to produce sufficient hydraulic head to divert flows through the enlarged ditches. Existing turnouts, weirs, and flumes would also be enlarged or replaced to allow for proper ditch operation and to maintain existing irrigation diversions. A section of the ditch would be lined to limit seepage losses along a cobble bench.

[2] Reservoir storage would comprise a conservation pool (1,998 acre-feet), an irrigation or operation pool (5,996 acre-feet), and a flood pool (1,878 acre-feet).

3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL EFFECTS

3.1 Introduction

This chapter describes the existing environment and trends of the area that would be affected by the No Federal Action, Proposed Action, or Modified Proposed Action alternatives and discloses the potential effects of the alternatives. The data used to describe the affected environment and to disclose environmental effects that could result from the alternatives were collected from agency geospatial datasets, field studies, and modelled scenarios based on historic data.

As noted in Section 1.6, internal agency and public scoping identified resource issues to be considered for detailed analysis. In this chapter, these issues are organized by relevant major resource areas. Each section presents the issues for analysis, impact indicators used, and existing conditions and analyses needed to address the issues. Each resource issue has a defined analysis area with which effects from the project are assessed.

3.1.1 Types of Effects

For each issue, the analysis describes the following types of effects:

- Direct effects: Effects that are caused by the action and occur at the same time and in the same general location as the action. Discussions of direct and indirect effects are often combined.
- Indirect effects: Effects that occur at a different time or in a different location than the action to which the effects are related. Discussions of direct and indirect effects are often combined.
- Short- or long-term effects: For the purposes of this EIS, short-term effects generally occur during or immediately after the construction phase (2 to 3 years). Long-term effects occur beyond that time and apply to the operation and overall life of the project through eventual decommissioning.
- Unavoidable, adverse effects: Per 40 CFR 1508.20, mitigation measures are measures that could reduce or avoid adverse effects and have not already been incorporated into the Proposed Action. Unavoidable, adverse effects are residual effects that would remain after implementation of mitigation measures.

3.1.2 Use of Indicators

Impact indicators are the “currency” used to measure changes in the human environment. Indicators may be quantitative or qualitative. For example, a quantitative indicator may be “acres of surface disturbance,” whereas a qualitative indicator may be “predicted change of stream morphological form.” Indicators are identified for each issue being analyzed.

3.1.3 General Analytical Assumptions

Although every effort has been made to ensure data accuracy, there is a level of uncertainty associated with any dataset in terms of predicting outcomes, especially when natural systems are involved. Analyses are based in part on publicly available data and assume the data provided by state and federal agencies to be accurate and sufficient for the purpose of comparing and discriminating between alternatives.

3.2 Air Quality

This section provides an overview of the current air quality and direct and indirect effects to air quality from the project.

3.2.1 Issues and Indicators

As part of the project's internal and external scoping process, the following air quality issues were identified:

- Would construction-related vehicle emissions affect air quality?
- Would fugitive dust from construction activities affect air quality?

Effects to air quality area were assessed using the National Ambient Air Quality Standards (NAAQS) and the Wyoming Ambient Air Quality Standards (WAAQS). The Clean Air Act (CAA) requires all states to control air pollution emission sources so that NAAQS are met and maintained. NAAQS and WAAQS represent the maximum allowable atmospheric concentrations that may occur to protect public health and welfare and include a reasonable margin of safety to protect the more sensitive individuals in the population. The objective of the law is for all areas to meet the NAAQS, which are promulgated by the U.S. Environmental Protection Agency (EPA) and apply nationwide. An area that does not meet the NAAQS is designated as a non-attainment area on a pollutant-by-pollutant basis.

In coordination with BLM resource specialists, the project's criteria pollutant effects are indicated by an exceedance of the NAAQS and/or WAAQS thresholds. Criteria pollutants are carbon dioxide (CO), ozone (O_3), nitrogen dioxide (NO_2), particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), and sulfur dioxide (SO_2). The WAAQS establish maximum acceptable concentrations of hydrogen sulfide (H_2S), fluoride, and suspended sulfates. Given the extremely low levels of lead, H_2S, floride, and SO_2 emissions[3] from potential project air pollutant sources, those standards are not addressed further in this analysis.

The EPA has developed different assessments to analyze exposure to potential hazardous air pollutants (HAPs) emissions. These assessments focus on short-term and long-term exposure to HAPs concentrations and long-term exposure to HAPs that are suspected carcinogens.

3.2.2 Affected Environment

The analysis area for air quality encompasses construction sites for the new reservoir and dam along Alkali Creek, plus the route for transporting construction materials. The spatial extent of the analysis area is based on the planned project activities and expected distance that the project air emissions would be transported. For example, effects from construction dust are within 100 to 200 meters of a roadway (BLM 2016a).

Regional air quality can also be affected by natural events such as windstorms and wildfires. These natural events generally are short lived, lasting from several hours to perhaps several days. The effects during these events may affect human health and the environment and generally are considered part of the natural and physical environment.

[3] Note that suspended sulfates are created by chemical reactions of SO_2 emissions in the atmosphere.

The EPA has designated the area surrounding the analysis area as in attainment for all criteria pollutants, meaning concentrations of all criteria pollutants are below the established NAAQS and WAAQS thresholds. The closest non-attainment area is for PM_{10} in Sheridan, Wyoming, which is more than 50 miles east of the project. The closest non-attainment area for O_3 is the Upper Green River Basin, Wyoming, and is approximately 140 miles south of the project. Additionally, HAPs are not measured in the region because they are only measured near large sources such as factories, refineries, or power plants, which are not located in or near the analysis area. However, there is no reason to expect elevated HAPs concentrations in the analysis area that would exceed limits set by the EPA's HAPs assessments.

The climate in the analysis area is characterized as arid, with cold winters and moderate summers. Generally, the primary wind flow in the analysis area is from the northwest and southeast. Therefore, the area that would be most affected by fugitive dust would be northwest and southeast of any project-related disturbance.

3.2.3 Methods of Analysis

The air quality effects are assessed by comparing proposed surface disturbances and construction activities from the project to the disturbance and construction activities of similar reservoir projects. A qualitative assessment of emissions and potential for exceedances of NAAQS and WAAQS is based on a relative comparison to the emissions inventories in the EISs for the similar water storage projects.

3.2.4 Environmental Effects

Short-term, direct air quality effects for the project would relate primarily to construction activities and transport of materials. For the Proposed Action and the Modified Proposed Action, air quality effects during construction would primarily include exhaust emissions from heavy-duty construction equipment, construction workers' vehicles and delivery vehicles, and fugitive dust emissions. Vehicle exhaust from construction and materials transportation activities emit criteria pollutants (e.g., CO, PM_{10}, and NO_2) and HAPs. Fugitive dust would be generated from activities associated with soil disturbance, equipment and vehicular traffic moving over disturbed areas, and windblown soil until the site could be revegetated after construction. These emissions would be greatest during the initial site preparation activities and would vary from day-to-day depending on the construction phase, level of activity, and prevailing weather conditions. After construction, long-term effects from the project would occur from recreational activities and increased passenger vehicles to and from the reservoir, as well as from increased windblown dust from exposed surfaces along the reservoir shoreline during low water levels.

3.2.4.1 ALTERNATIVE A: NO FEDERAL ACTION

There would be negligible effects to air quality under the No Federal Action because it consists of the continued operation of the NWID under current management conditions. Continued operation would consist of vehicle emissions from recreational traffic and agriculture and livestock transport vehicles. Existing fugitive dust sources are from wind erosion over exposed surfaces and vehicle traffic.

3.2.4.2 ALTERNATIVE B: PROPOSED ACTION

Construction activities and associated traffic under the Proposed Action would increase emissions in the analysis area from vehicle exhaust and fugitive dust. These minor increases would be localized and temporary during construction and limited to surrounding counties of Washakie, Sheridan, and Johnson.

For comparison purposes, the emission inventories from the Proposed Action for the *Moffat Collection System Project Final EIS* (Moffat Project) (USACE 2014) and Alternative 2 from the *Northern Integrated Supply Project Supplemental Draft EIS* (NISP) (USACE 2015) are shown in Table 3.2-1. These two projects and Alkali Creek are located in the Rocky Mountain region and have arid climates. The Moffat Project was for a 77,000-acre-foot reservoir expansion and the NISP was for a new 170,000-acre-foot reservoir. The construction of the Alkali Creek Reservoir under the Proposed Action would be less than 10,000 acre-feet and almost an order of magnitude smaller than the Moffat Project and almost two orders of magnitude smaller than the NISP. The construction of the Glade Reservoir Dam from NISP would involve on-site excavation and placement of approximately 18,710,000 cubic yards of earth materials (GEI Consultants, Inc. 2006). The excavation volume from NISP would be larger than the excavation volume for the reservoir, which is estimated to be 1,800,000 cubic yards. Because of the small size of the proposed dam, excavation volume, and construction time of the project relative to the Moffat Project and NISP, the Proposed Action would result in substantially lower emissions than either project presented in Table 3.2-1.

For both the Moffat Project and NISP, the air quality effects were found to be negligible to minor with the highest effects predicted to occur during peak construction periods. Because the project has much lower proposed soil disturbance and construction activity than both the Moffat Project and NISP, it is anticipated that the Proposed Action would have only negligible to minor effects on existing air quality during construction. Effects would be short term and transient in nature because of the relatively short period of active construction and the localized nature of construction. There would be no long-term effects from construction-related emissions after the reservoir and facilities are completed. An exceedance of the NAAQS or WAAQS is not anticipated for any of the criteria pollutants. Similarly, the effects from the increase in HAPs would be negligible.

Table 3.2-1. Emission Inventories from Similar Water Storage Projects

Project, Alternative	Reservoir New or Expansion Size (acre-feet)	Project Years	Total Type	Criteria Pollutant						Total HAPs	GHG CO_2e
				CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC		
Moffat Project, Proposed Action	77,000	4.1	Project total (tons)	494	423	315	79	12	60	1.0	26,606
			Average annual (tons/year)	127	103	77	19	3	15	0.3	6,489
NISP, Alternative	170,000	9.1	Project total (tons)	1,607	1,246	3,938	N/A	24	180	N/A	27,087
			Average annual (tons/year)	177	137	433		3	20		2,977

Sources: USACE (2014, 2015)

Notes: CO = carbon dioxide, NOx = oxides of nitrogen, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns, $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns, SO_2 = sulfur dioxide, VOC = volatile organic compounds, greenhouse gases (GHGs), carbon dioxide equivalent (CO_2e), N/A = not available

Over the long term, the Proposed Action would cause relatively small increases in fugitive dust and vehicle emissions. Fugitive dust emissions would be largely unavoidable because they depend, in part, on the extent of bare soil exposed by fluctuation of the water level in the new reservoir. Mitigation measures such as revegetating the area would not be practical because the area would need to be revegetated each season. Increases in emissions from personal vehicles and recreational equipment, although small, would be expected.

3.2.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The effects from the Modified Proposed Action would be the same as those discussed for the Proposed Action. The Modified Proposed Action is expected to be same as the Proposed Action except for a few optional modifications, such as a reduction in the length of the auxiliary spillway and modification to the fill time. This would reduce the construction activities minimally and would have no noticeable effect on air quality.

3.2.5 Summary of Effects

Table 3.2-2 presents a summary of the effects to air quality under all alternatives.

Table 3.2-2. Air Quality Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
Would construction-related vehicle emissions affect air quality?	Negligible	An exceedance of NAAQS or WAAQS is not anticipated.	Same as the Proposed Action
Would fugitive dust from construction activities affect air quality?	Negligible	Negligible to minor effects are anticipated but they would be short term and transient. An exceedance of PM NAAQS or WAAQS is not anticipated.	Same as the Proposed Action

3.2.6 Mitigation Measures

No mitigation measures are proposed for air quality because no substantial effects to air quality are predicted under any alternative.

3.2.7 Unavoidable, Adverse Effects

There would be no unavoidable, adverse effects to air quality from any alternative because reclamation and revegetation would stabilize exposed soil and help limit fugitive dust emissions. As vegetation establishes, particulate levels should return to what is typical for an arid climate. Once the construction disturbance ceases and wind-erodible surfaces are reclaimed, air quality would return to approximately its pre-construction condition.

3.3 Cultural Resources

This section describes the effects of the project on cultural resources.

Cultural resources include archaeological sites, historic buildings, structures, objects, or districts that are generally 50 years old or older. Cultural resources also include areas important to Native American tribes. Historic properties are those cultural resources determined by the BLM and State Historic Preservation Office (SHPO) to be eligible for the National Register of Historic Places (NRHP) pursuant to 36 CFR 60. Cultural resources must possess historic significance as well as integrity to be considered a historic property. A property is significant if it meets at least one of the four criteria (36 CFR 60):

(A) it is associated with events that have made a significant contribution to the broad patterns of our history;

(B) it is associated with the lives of persons significant in our past;

(C) it embodies the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction;

(D) it has yielded or may be likely to yield, information important in prehistory or history.

To convey its significance, a property must retain aspects of integrity that contribute to its eligibility. Aspects of integrity include location, setting, design, workmanship, materials, feeling, and association (36 CFR 60).

Under the WFO RMP's goals, objectives, and management decisions, the BLM will "identify, preserve, and protect cultural resources and ensure that they are available for appropriate uses by present and future generations" (BLM 2015a:95). NEPA and the NHPA provide a framework for coordinating and achieving federal compliance with historic preservation and cultural resources management laws, regulations, and policy requisites (40 CFR 1502.25, 36 CFR 800.3[b], and 36 CFR 800.8). Section 106 of the NHPA requires identification of historic properties before a federal undertaking (36 CFR 800.4) and that federal agencies consider the effects of that undertaking on historic properties (36 CFR 800.1). NEPA and NHPA outline requirements for Native American consultation in relation to federal undertakings (36 CFR 1501.2 and 36 CFR 800.2). For this project, agencies consulted with the Blackfeet Nation, Crow Tribe, Eastern Shoshone Tribe, Shoshone-Bannock Tribes, Northern Arapaho Tribe, and the Northern Cheyenne Tribe.

3.3.1 Issues and Indicators

As part of the project's internal and external scoping process, the following cultural resources issues were identified:

- How would inundation of the reservoir area affect cultural resources?
- What are the effects of clearing and excavating disturbance areas on eligible or unknown cultural resources?
- How would visual intrusions from the project affect integrity for eligible or potentially eligible historic or prehistoric cultural resources?
- How would increasing recreational opportunities and the number of people visiting the area affect cultural resources near the reservoir and access roads?
- How would the disturbance areas and associated visual effects affect cultural resources of religious, cultural, and traditional concern to tribes?

In coordination with BLM resource specialists, the following cultural resources indicators were developed:

- Number of cultural resources inundated or destroyed
- Number of NRHP-eligible resources, number and eligibility of resources identified within the proposed disturbance areas, and previously undiscovered resources identified during clearing and excavation
- Number of properties eligible for the NRHP under Criterion A, B, or C with strong visual contrasts to their settings
- Number of resources of religious, cultural, and traditional concern identified by consulting Native American tribes
- Number of cultural resources near the reservoir and access roads with unauthorized collection or disturbance as a result of increased recreational opportunities

3.3.2 Affected Environment

The analysis area for cultural resources is the project's area of potential effects (APE) as outlined in Class III investigations and by directive of the BLM. Per 36 CFR 800.16 (d), the APE is the geographic area within which an undertaking may directly or indirectly alter the character or use of a historic property. The direct APE consists of the extent of the project disturbance with a general buffer of 100 feet. The indirect APE consists of the visual horizon up to 3 miles from the reservoir, dam, and primary access road for historic properties eligible for the NRHP under Criterion A, B, or C.

Humans have lived in the Bighorn Basin since the end of the Pleistocene epoch. A Clovis-aged Paleoindian site dating to ca. 11,000 radiocarbon years before present (RCYBP) has been located near the project area. Although no evidence of Paleoindian period occupations occurs in the project area, Archaic to Late Prehistoric occupations (8,000–1,500 RCYBP), which represent most of the prehistoric occupations in Wyoming, are common adjacent to the project area, and two occupations occur in the project area.

Indigenous peoples have occupied the Bighorn Basin for thousands of years, and it is likely that different groups used the project area and adjacent areas because of its location between the mountains and basin. Linguistic evidence suggests that the Crow, a Siouan-speaking tribe, moved into the region after ca. A.D. 1500 (during the terminal Late Prehistoric era), after splitting with the Hidatsa (Hollow and Parks 1980). As interpreted by Shimkin (1947), the Eastern Shoshone moved into the area in the late seventeenth to early eighteenth centuries.

The Protohistoric period begins after ca. 275 RCYBP, as the first European trade goods become present. This period ends with the development of the Rocky Mountain fur trade. No cultural resources associated with this period are known in or adjacent to the project area.

Historic era occupations are evidenced in the project area. Hyattville was one of the earliest settlements in the basin and was originally named Paintrock after the creek that flows through the valley. The name was changed after Samuel W. Hyatt established a general store in the area in 1886 and became the town's first postmaster (Hein 2012). The following decades saw the settlement of the Mercer family, the Walter brothers, and others who initially gained their property through the 1862 Homestead Act or through purchase from the federal government (BLM 2017a). By the mid-1890s, irrigation systems were under construction to cultivate more of the acreage in the valley (Wyoming State Engineer's Office 2015). This tradition of irrigation-based farming mixed with cattle ranching continues in the area to this day.

Class III investigations were conducted for the direct APE under the supervision of field directors and principal investigators listed under current Wyoming BLM Cultural Resource Use permits. Previous investigations for the project include SWCA's 2017 and 2018 field investigations (Foster et al. 2018 [BLM Project Number 010-2014-054B]; Newton 2018). SWCA's reports provide a complete summary of the work conducted in the direct APE.

Based on a review of existing data available through the Wyoming Cultural Records Office (WYCRO) Web Database and a review of investigations by SWCA (Foster et al. 2018), known cultural resources in the direct APE are provided in Table 3.3-1. In total, 27 cultural resources are in the direct APE, and of these, four are considered eligible for the NRHP with SHPO concurrence (Table 3.3-1). Site 48BH4412 is a historic district, and 48BH4413 through 48BH4417 are considered components of this district.

Table 3.3-1. Cultural Resources Summary for the Alkali Creek Reservoir Project in the Direct Area of Potential Effects

Smithsonian/Temp Number	Type	NRHP Eligibility
48BH1915	Historic irrigation canal	Not eligible
48BH3428	Prehistoric lithic scatter	Not eligible
48BH4412	Rural historic district	Not eligible
48BH4413	Historic farmstead	Eligible under Criterion A
48BH4414	Historic farmstead	Not eligible
48BH4415	Historic farmstead	Not eligible
48BH4416	Historic farmstead	Eligible under Criterion A

Smithsonian/Temp Number	Type	NRHP Eligibility
48BH4417	Historic farmstead	Eligible under Criterion A
48BH4418	Historic sawmill	Not eligible/destroyed
48BH4419	Prehistoric open camp	Not eligible
48BH4420	Historic inscriptions, prehistoric stone tool	Not eligible
48BH4421	Historic inscriptions	Not eligible
48BH4422	Historic irrigation structure	Not eligible
48BH4423	Historic irrigation canal	Not eligible
48BH4624	Prehistoric open camp	Eligible under Criterion D
48BH4625	Prehistoric open camp	Not eligible
140305a-3	Prehistoric lithic scatter	Not eligible
140305a-20	Prehistoric lithic scatter	Not eligible
140305a-22	Prehistoric lithic	Not eligible
140305a-23	Historic farming equipment	Not eligible
140305a-25	Historic farming equipment	Not eligible
140305a-30	Prehistoric lithic scatter	Not eligible
ALK-BDN-IR1	Historic debris	Not eligible
ALK-CMF-IR1	Historic farming equipment	Not eligible
ALK-RLF-IR1	Prehistoric lithic	Not eligible
ALK-RLF-IR2	Historic debris	Not eligible
ALK-SHY-IR1	Multicomponent scatter	Not eligible

Beyond the direct APE, approximately 85 cultural resources are in the indirect APE. Most of these resources are prehistoric (n = 61), and 40 of these resources are considered not eligible for the NRHP. Eligible prehistoric cultural resources consist of 15 properties that are generally eligible under Criterion D for having the potential to yield data important to prehistory. Six properties may be of Native American concern: 48BH913, 48BH932, 48BH956, 48BH3887, 48BH4033, and 48BH4034. Cultural resources 48BH3887, 48BH4033, and 48BH4034 are considered eligible for the NRHP under Criterion A.

Regarding historic cultural resources of potential significance in the indirect APE, one historic bridge (48BH1139) is considered eligible under Criterion C. Unevaluated historic cultural resources in the indirect APE include two historic canals and the Hyattville school and a historic homestead (48BH1927).

Comments submitted during public scoping identified concerns regarding potential effects to rock art. Based on a review of existing data through the WYCRO database, no known rock art sites are in the indirect APE. Historic inscriptions are in the analysis area, but these cultural resources are not eligible for the NRHP under any criterion.

3.3.3 Methods of Analysis

Methods used to evaluate effects to cultural resources within the direct APE included the completion of a Class III investigation (field survey) and a review of previously completed Class III investigations and SHPO data. To evaluate effects to sites within the indirect APE, methods included a review of SHPO data for the visual horizon up to 3 miles from the reservoir, main access road, and dam, and the completion of visual contrast rating worksheets.

To address issues of potential effects to resources of Native American concern, the BLM WFO initiated tribal consultation. The BLM WFO has sought comments from six Native American tribes. The BLM WFO invited tribes to be a cooperating agency under NEPA via a letter on December 16, 2016. An invitation to consult under NHPA was sent on October 10, 2017. The BLM WFO provided results of Class III investigations and associated documents on February 12, 2018. Subsequent to mailing the tribal consultation invitation letters, BLM WFO cultural resource specialists followed up with the tribes through telephone calls and emails to solicit input and provide project updates to the tribes. Consultations with tribes that have an interest in the project continued throughout the NEPA process, consistent with applicable regulations and guidance, including the NHPA.

3.3.4 Environmental Effects

3.3.4.1 ALTERNATIVE A: NO FEDERAL ACTION

Under the No Federal Action, effects to historic structures may include modifications and maintenance or abandonment and removal of some structures. Modifications and maintenance to historic canals would continue. Visitation to areas with sites would continue at current levels as would the potential for unauthorized collection or disturbance of cultural resources. Ground disturbance from ranching and irrigation would continue and may further affect existing sites or disturb previously unidentified sites. Effects to cultural resources like prehistoric open camps and sites of Native American concern are considered long term and permanent. Effects to historic structures or canals may be both short term if restoration occurs and long term if they are permanently damaged or destroyed. Under the No Federal Action, these effects would continue at the existing rate.

3.3.4.2 ALTERNATIVE B: PROPOSED ACTION

Inundation of the reservoir area under the Proposed Action would result in the burial and removal of cultural resources. These effects are considered long term, resulting in permanent damage and destruction to resources. Inundation would directly affect nine known cultural resources, including portions of the Anita Ditch; however, these cultural resources are not eligible for the NRHP. No known eligible sites would be directly affected by reservoir inundation.

Proposed ground disturbance related to construction of the auxiliary spillway, construction staging area, and the dam embankment would destroy portions of four cultural resources. These sites are non-eligible resources, and these effects do not constitute adverse effects. An adverse effect can only be found for those cultural resources that are considered historic properties (36 CFR 800.5).

Ground disturbance and clearing would have the potential to damage or destroy eligible or yet-to-be discovered cultural resources. The proposed Anita Ditch bypass pipeline is near the historic residence at 48BH4417. However, the direct APE does not encroach upon the historic buildings and would result in no physical effects to the historic property.

A proposed fence line may affect an eligible prehistoric cultural resource (48BH4624) and all known surface components by fence construction and traffic. However, construction activities may expose previously undiscovered subsurface components of the site, and potential additional exposure of this site during nearby construction activities may lead to unauthorized collection or damage.

All surface-disturbing activities could affect previously undiscovered cultural resources. Construction activities such as excavation could expose and damage previously undiscovered sites. Wave action from the reservoir could also expose and damage previously undiscovered subsurface sites.

The reservoir would create a permanent alteration of the cultural landscape as it relates to sites of Native American concern and other communities with cultural or historic ties to the project area. Construction and inundation of the reservoir would affect the settings of three sites of Native American concern. Sites 48BH3887, 48BH4033, and 48BH4034 are prehistoric cultural resources eligible for the NRHP under Criterion A. These cultural resources are within the visual horizon of the proposed reservoir, which would create strong contrast to the setting as viewed from these resources. This rating follows guidelines under Visual Resource Contrast Rating in BLM Manual 8431 (BLM 1986). A strong contrast indicates that the proposed project elements cannot be overlooked and are dominant on the landscape. This rating constitutes an adverse effect. The proposed reservoir would be visible from a fourth cultural resource of Native American concern, 48BH932; however, the visual contrast would be weak (i.e., the project elements would not dominate the landscape or attract attention), and it would not constitute an adverse effect.

The reservoir and dam would be visible from two historic properties, 48BH4413 and 48BH4417, eligible for the NRHP under Criterion A, creating a strong visual contrast to the historic landscape.

Increasing recreational opportunities under the Proposed Action would increase the number of people visiting the area and has the potential to affect cultural resources near the reservoir and access roads. Increased exposure to these sites may result in increased risk of unauthorized collection from cultural resources and damage. Nine known cultural resources are within 0.25 miles of the access road and reservoir and would not be fully inundated or destroyed by construction. Increased visitation could affect these cultural resources as well as previously undiscovered sites.

3.3.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

Under the Modified Proposed Action, the length of the auxiliary spillway would be reduced by 3,375 feet and/or the reservoir fill time would be modified from 30 days to 50 days. The remaining elements would not differ from the Proposed Action.

Construction of the auxiliary spillway would not directly affect any known, eligible cultural resources. The shorter spillway would affect one non-eligible cultural resource, whereas the spillway would affect two non-eligible cultural resources. The reduced length of the auxiliary spillway would result in less potential to affect previously undiscovered sites because there would be less surface disturbance.

Indirect effects under the Modified Proposed Action would be the same as the Proposed Action for the three resources of Native American concern, 48BH3887, 48BH4033, and 48BH4034. Additionally, effects to 48BH4413 and 48BH4417 would be the same.

3.3.5 Summary of Effects

Table 3.3-2 presents a summary of the effects to cultural resources under all alternatives.

Table 3.3-2. Cultural Resource Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would inundation of the reservoir area affect cultural resources?	No effect	Permanent effects or destruction of non-eligible cultural resources would occur; no direct adverse effects to known eligible cultural resources would occur.	Same as the Proposed Action
What are the effects of clearing and excavating disturbance areas on eligible or unknown cultural resources?	No effect	Direct adverse effects to eligible cultural resources would be avoided by project design; inadvertent discovery of unknown cultural resources is possible.	Same as the Proposed Action
How would visual intrusions from the project affect integrity for eligible or potentially eligible historic or prehistoric cultural resources?	No effect	Permanent visual effects would occur to eligible resources consisting of two historic cultural resources and three cultural resources of Native American concern.	Same as the Proposed Action
How would increasing recreational opportunities and the number of people visiting the area affect cultural resources near the reservoir and access roads?	No effect	There would be a potential for increased risk of unauthorized collection.	Same as the Proposed Action
How would the disturbance areas and associated visual effects affect cultural resources of religious, cultural, and traditional concern to tribes?	No effect	No known resources of Native American concern would be affected by surface disturbance. Permanent visual effects would occur to three resources of Native American concern.	Same as the Proposed Action

3.3.6 Mitigation Measures

Under the Proposed Action and Modified Proposed Action, adverse effects to eligible cultural resources would be avoided, minimized, and/or mitigated. Mitigation measures would follow guidelines in the WFO RMP (BLM 2015a) in accordance with 36 CFR 800 and in consultation with the Wyoming SHPO and Advisory Council on Historic Preservation and Native American tribes.

The fence line would be moved to avoid an eligible prehistoric cultural resource (48BH4624).

Any adverse effects to NRHP-eligible cultural resources by the Proposed Action would need to be mitigated in a memorandum of agreement (MOA) with the Wyoming SHPO, Advisory Council on Historic Preservation if they choose to participate, tribes, landowners, the WWDO, and other consulting parties. The MOA would address the indirect, adverse effects of the project to three cultural resources of Native American concern that would have effects to setting by the proposed reservoir. Additionally, the MOA would address indirect, adverse effects of the project to the setting of two historic cultural resources.

Following standard conditions of approval for BLM ROWs, during construction, the WWDO is required to report unanticipated finds. An undertaking-specific inadvertent discovery plan would be developed in consultation with the SHPO and other appropriate parties as determined by the agency.

3.3.7 Unavoidable, Adverse Effects

Indirect, adverse effects to three cultural resources of Native American concern and two historic cultural resources would be unavoidable.

3.4 Geology and Minerals

This section describes the effects of the project on geology and minerals.

3.4.1 Issues and Indicators

As part of the project's internal and external scoping process, the following geology and minerals issues were identified:

- How would inundating the reservoir area affect mineral claims and oil and gas interests in the area, including deferred or unissued lease parcels?
- How would inundating the reservoir area affect the stability of the surrounding slopes and landslide potential?
- What would be the potential for structural failure from earthquake, ground movement, or other geologic events, and what would be the likely downstream effects?

In coordination with BLM resource specialists, the following geology and minerals indicators were developed to address these issues:

- Acres of mineral claims or oil and gas leases that would be inundated
- Slope stability and landside potential qualitatively assessed by acres of geologic formation along the reservoir high-water line and the geologic properties of these units
- Relative risks for seismic events and potential ground movement qualitatively assessed using literature review, historic event data, earthquakes visible at the surface, and potential for other geologic features (e.g., karst and swelling clays)

3.4.2 Affected Environment

The analysis area for mineral claims and oil and gas leasing is the project area and includes project disturbance up to the project fence boundary. This same area is used for the landslide, earthquake, and other geologic events analysis; as the effects of these would be local in nature.

The project area is located along the eastern edge of the Bighorn Basin in north-central Wyoming. The Bighorn Basin is structurally elongated from northwest to southeast, extending over approximately 10,000 square miles. The basin is bounded on the eastern, southern, and western edges by seven mountain ranges, including the Bighorn, Pryor, Owl Creek, Bridger, Beartooth, Absaroka, and Washakie ranges. To the north, the basin opens into the Crazy Mountain Basin. In the Bighorn Basin, the project is located on the northern end of the Hyattville Anticline, the southwestern flank of the Mercer Anticline, and the syncline that forms between these two structures (Rogers et al. 1948). These structural features make the stratigraphy in this area complicated. Based on published geologic mapping (Love and Christiansen 1985; Rogers et al. 1948), the Alkali Creek Reservoir project area is underlain by the Cretaceous Cloverly Formation, Thermopolis Shale, and Mowry Shale, and Quaternary alluvium and terrace (level 2) deposits.

Bentonite is mined from the Thermopolis and Mowry Shales throughout the Bighorn Basin. There is 230.5 acres of mining claims in the analysis area. Portions of two placer mining claims (MH 580 and MH 1145) for clay and bentonite (totaling 40 acres) are located in the reservoir area.

Mesozoic and Paleozoic units are present in the subsurface, of which the Permian Phosophoria and Tensleep Formations are frequently targeted for oil and gas development (Stilwell et al. 2010). There is 454 acres with federal oil and gas minerals in the analysis area; however, 30.7 acres of these is deferred because of visual resource management concerns and has not yet been issued by the BLM Wyoming State Office. There is an additional 354 acres with private minerals. There are no active oil and gas leases in the project area, and all wells in the townships that overlap the analysis area (49 North and 50 North, 90 West) have been abandoned. The nearest producing well is in the Manderson Field approximately 6 miles southwest of the project area (Wyoming Oil and Gas Conservation Commission 2018). According to Stilwell et al. (2010), there is high potential for oil and gas resources in the analysis area; however, most future development is predicted to occur in existing fields. The potential for additional oil or gas wells being drilled in the townships underlying the analysis area is very low; fewer than two wells were predicted for a 20-year period (Stilwell et al. 2010).

No known landslides have been mapped in the analysis area. The nearest large landslides are approximately 6 miles west in the Madison Formation associated with the limestone-bearing formations (Case 1986). The reservoir would be primarily on Quaternary alluvium and Cretaceous Cloverly Formation sands and sandy clay (Trihydro 2016a); however, the NHWL and MHWL cross finer grained sediments of the Thermopolis Shale, which is overlain by the Mowry Shale. These units, as noted above, contain bentonite mudstones, also known as expanding muds. When wet, the muds expand and then shrink as they dry out. The strength and volume of the sediment vary with the swelling and shrinking cycle. Bentonitic mudstones can be highly prone to mass movement and accelerated downslope creep, especially on steep slopes. A review of aerial imagery indicates that there has likely been some downslope creep within the exposures upslope and east of the reservoir.

Other mass movement or landslide issues in the Bighorn Basin are typically limited to fossil karst topography, which is especially known for having caves and sinkholes. In the geologic past, highly soluble rocks layers were dissolved, and voids were formed. This topography is associated primarily with the Madison Limestone, which is not exposed in the analysis area; instead, it is located more than 1,000 feet below the ground surface.

No known faults with surface expression are currently active or were active during the Quaternary in Big Horn County (Case and Green 2000). There is no record of earthquakes in the analysis area; however, four historic earthquakes with a magnitude 2.5 (minor) or greater were recorded in Big Horn County north of the project area (Case et al. 1995; Trihydro 2016a).

3.4.3 Methods of Analysis

The analysis involved intersecting oil and gas lease parcels with project disturbance to determine affected acreage.

A review of geologic maps and publications to find known faults and associated active dates, historic earthquake and landslide records, and known karst areas was conducted and resulted in a qualitative assessment of probability of events.

3.4.4 Environmental Effects

3.4.4.1 ALTERNATIVE A: NO FEDERAL ACTION

Geologic conditions including lease acres available for development, landslide or ground movement potential, and seismic hazards would remain the same as present under this alternative.

3.4.4.2 ALTERNATIVE B: PROPOSED ACTION

Reservoir construction, inundation, and associated infrastructure development would have some effect on mineral resources. If two placer mining claims are not withdrawn by the claim holder and a plan of operations received and authorized by the BLM, the claims would be partially inundated by the reservoir.

Surface disturbance from the proposed reservoir and other associated infrastructure would affect 454 acres with oil and gas federal minerals, 30.7 acres of which is deferred and not currently available to leasing. No oil and gas leases would be directly affected. However, per the WFO RMP (BLM 2015a), mitigation would be required for the oil and gas lease areas underlying the reservoir and within 0.25 miles of the proposed recreation area because these would need to be given a no surface occupancy stipulation on the lease (at a minimum), though they could be reclassified as no leasing or no development. This would remain in effect for the life of the reservoir and recreation area or following a modified RMP. Therefore, at a minimum, oil and gas leases with this stipulation would require directional drilling to access the mineral resource, but because of the additional costs associated with directional drilling, this may also result in these resources being inaccessible for the life of the reservoir and recreation area.

Inundation and long-term wave erosion on the slopes of the reservoir would result in the potential for an increase in sediment creep or landslides. This would be primarily limited to the bentonitic-rich, unvegetated, gradual to sharply sloping Thermopolis Shale exposures along the eastern edge of the reservoir, which are just crossed by the NHWL and MHWL. As the bases of the exposures are eroded, properties within the exposure may change and tension may be released, which could cause downslope movement of some material.

No seismic activity would be expected to occur from, or be induced by, the reservoir. No faults occur in or near the project area, and only a few minor historic earthquakes have been recorded near the analysis area. The risk of dam failure is considered low because of the low risk of seismic activity and the design of the dam to accommodate both the design seismic event and the probable maximum flood (see Section 3.8.4.2). In the unlikely event there was a structural failure due to a geologic hazard, downstream effects to geologic resources would be limited to the Inundation Area from Sunny Day Breach (Trihydro 2017d:Figure 2) and concentrated between the reservoir and Paint Rock Creek. Effects would primarily be erosion of Quaternary alluvial sediments in an area where there is no active mineral extraction or important surface geological resources.

3.4.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The effects from the Modified Proposed Action would be similar to those discussed for the Proposed Action.

3.4.5 Summary of Effects

Table 3.4-1 presents a summary of the effects to geology and minerals under all alternatives.

Table 3.4-1. Geology and Minerals Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would inundating the reservoir area affect mineral claims and oil and gas interests in the area, including deferred or unissued lease parcels?	No effect	There would be a low effect to mineral claims. If the current placer mining claims are not pulled, the water level can be dropped to allow access to these mineral claims. There would be a low effect to oil and gas interests. The project area is more than 6 miles from an existing oil field and has minimal acreage that would have, at a minimum, no surface occupancy during the life of the project.	Same as the Proposed Action
How would inundating the reservoir area affect the stability of the surrounding slopes and landslide potential?	No effect	There would be a minor increase in the potential for landslides from inundating the reservoir. The natural slope along the MHWL on the east side of the reservoir has slopes of unvegetated bentonitic-rich Thermopolis and Mowry Shales, which may slide or creep because of changes in slope from erosion.	Same as the Proposed Action
What would be the potential for structural failure from earthquake, ground movement, or other geologic events, and what would be the likely downstream effects?	No effect	The potential for structural failure from an earthquake is negligible because of the low probability of an earthquake and stringent requirements of the structural design. For this reason, there would be no downstream effects. The potential for other types of ground movement, specifically from karst topography and swelling clays, which would cause structural failure, is low. Effects from other geologic events are not anticipated.	Same as the Proposed Action

3.4.6 Mitigation Measures

The reservoir water level would be dropped to sufficiently allow mining activities if the two placer mining claims are not withdrawn and a plan of operations is not received and authorized by the BLM. In addition, a no surface occupancy stipulation would be applied to future federal mineral leases within 0.25 miles of the proposed reservoir/recreation area.

3.4.7 Unavoidable, Adverse Effects

Unavoidable, adverse effects would include the loss of existing and potential future mineral leasing opportunities in the analysis area. But these are minor due to the limited acreage and low potential for the use of these resources during the life of the project.

3.5 Land Use

This section examines potential project effects as they relate to landownership, valid and existing rights, ROWs and easements, and private property.

3.5.1 Issues and Indicators

As part of the project's internal and external scoping process, the following land use issues were identified:

- How would the project affect other ROWs or land use authorizations?
- How would the project affect adjacent or nearby private property?

In coordination with BLM resource specialists, the following land use indicators were developed to address these issues:

- Acres of BLM-administered land, state land, and private land affected
- Acres of mineral leases affected
- Acres of ROWs and utility corridors affected
- Changes in visitation

3.5.2 Affected Environment

The analysis area for potential land use effects is the 806.8-acre project area. This analysis area is used because it comprises the land that would be directly affected by the proposed reservoir and infrastructure, and land where any existing and potential future mineral leasing and ROWs would be affected. The 806.8-acre analysis area represents approximately 0.04% of Big Horn County, Wyoming.

The primary existing land use in the analysis area and surrounding region is agriculture, including irrigated crops and livestock grazing. Recreation, consisting of hunting, fishing, hiking, off-road vehicle (ORV) use, and camping, is also prevalent in and near the analysis area. The analysis area comprises 362.4 acres of BLM-administered land and 444.4 acres of private land (Figures 3.5-1 and 3.5-2). There is 454 acres of federal oil and gas minerals in the analysis area (but no active oil and gas leases) and 230.5 acres of mining claims. There are no energy corridors, BLM pipeline ROWs, BLM power and transmission ROWs, or any other BLM ROWs in the analysis area. ROWs are present on private lands. WYDOT holds an easement along WY 31 that would be avoided by the proposed temporary bypass pipeline. Big Horn County currently does not have county-wide zoning regulations, but does require permits for construction and development (Big Horn County 2018). Figures 3.5-1 and 3.5-2 depict the existing mineral leasing categories in the analysis area.

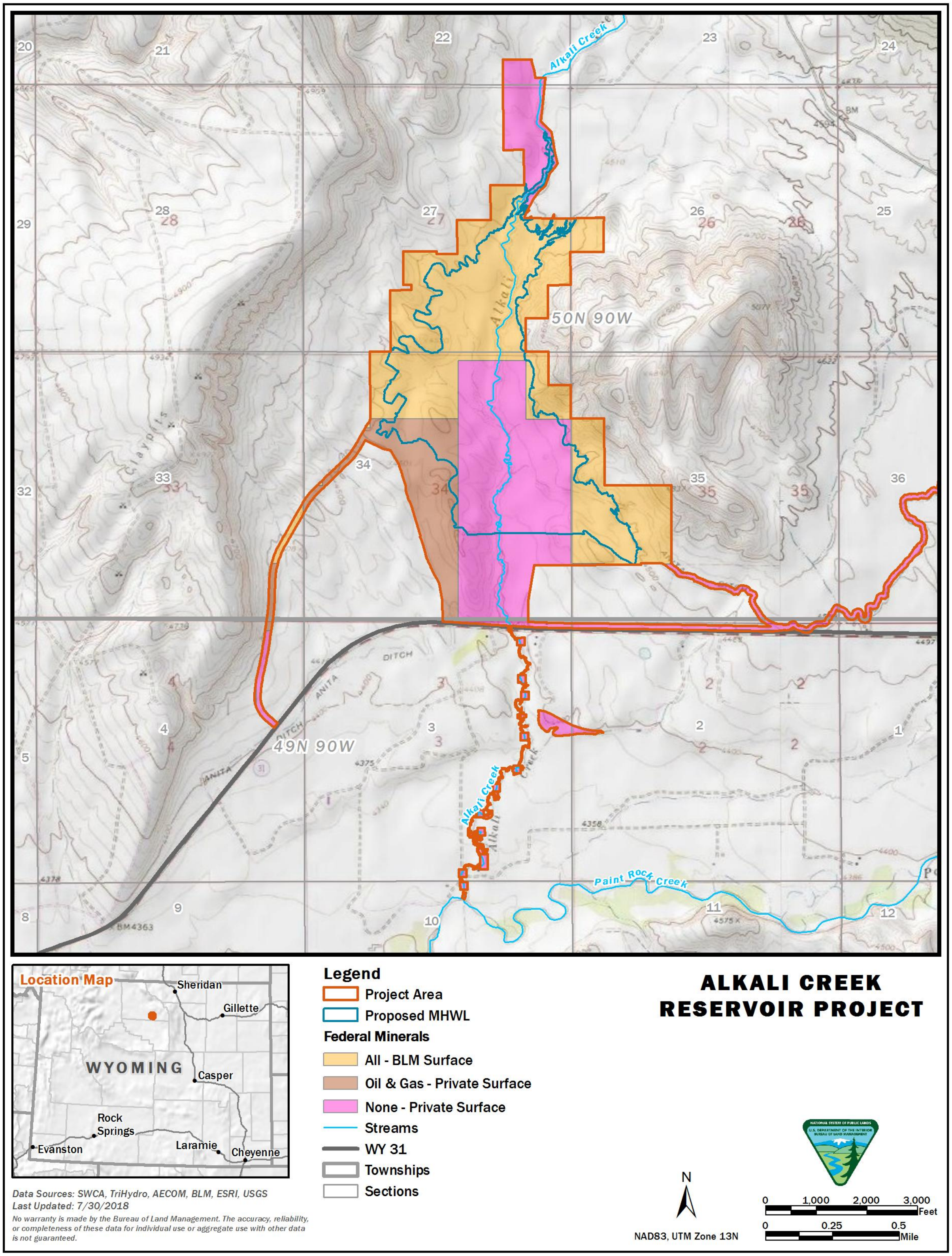

Figure 3.5-1. Mineral leasing categories in the project area (land use analysis area), west side.

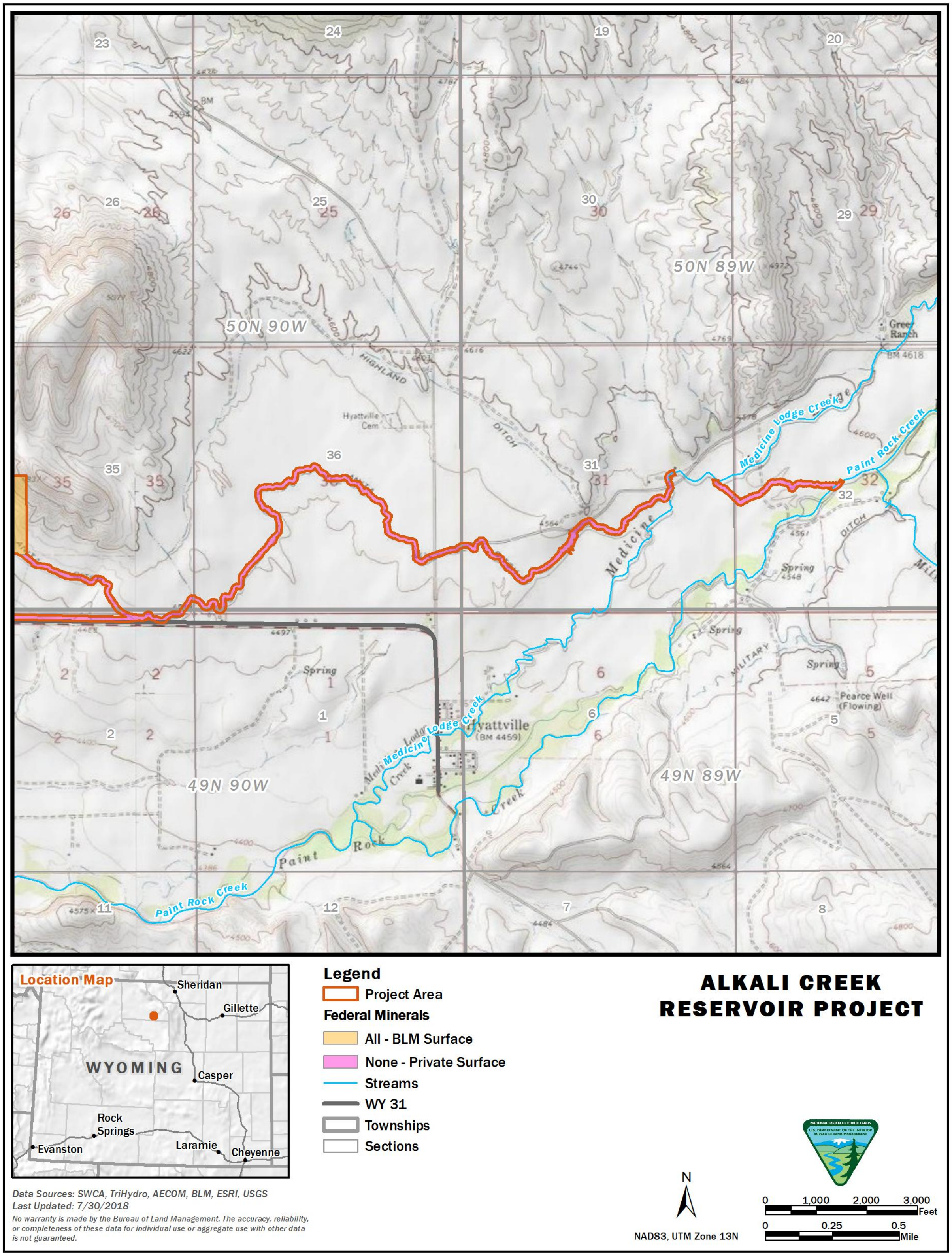

Figure 3.5-2. Mineral leasing categories in the project area (land use analysis area), east side.

3.5.3 Methods of Analysis

Potential effects to land use were analyzed by overlaying the analysis area with any existing mineral leases, ROWs, and utility corridors. Acres of any mineral leasing categories, ROWs, and utility corridors affected were also calculated. A qualitative analysis of the potential for increased dispersed use of the analysis area resulting from the project is also included.

3.5.4 Environmental Effects

3.5.4.1 ALTERNATIVE A: NO FEDERAL ACTION

Under the No Federal Action, there would be no effects to land use as a result of the project. The existing land uses in the analysis area, such as agriculture, hunting, fishing, hiking, ORV use, camping, and mineral extraction, would continue.

3.5.4.2 ALTERNATIVE B: PROPOSED ACTION

Under the Proposed Action, surface disturbance from the project would affect or prevent certain land uses in the analysis area. Approximately 91.9 acres of existing oil and gas leases and 230.5 acres of existing mining claims would be affected by the proposed surface disturbance. Surface disturbance from the project would prevent potential future mineral leases or ROWs on the 362.4 acres of BLM-administered land in the analysis area. Surface disturbance from the project would prevent potential future mining and other land uses on the 444.4 acres of private land in the analysis area. Other potential land uses that would be affected in the 806.8-acre analysis area include agriculture, hunting, camping, ORV use, mining, oil and gas exploration and development, power and transmission lines, and other ROWs. This would represent land use limitations on approximately 0.04% of the land in Big Horn County, Wyoming. However, there would likely be an increase in visitation to the analysis area for recreational opportunities created by the project, such as boating, swimming, and fishing. The Proposed Action would not affect any existing energy corridors, power and transmission lines, or ROWs on public lands because there are none in the reservoir. However, there are power lines, fiber optic lines, pipelines, stock drive, and access located on the private lands in the analysis area. Because most of the nearby and adjacent private property is used for agriculture or mining, the increased access and visitation to the analysis area may affect private property through a potential decrease in privacy, a potential increase in trespassing incidents, and a potential increase in safety issues and livestock mortality resulting from a potential increase in vehicle traffic on nearby roads.

3.5.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The effects from the Modified Proposed Action would be the same as those discussed for the Proposed Action.

3.5.5 Summary of Effects

Table 3.5-1 presents a summary of the effects to land use under all alternatives.

Table 3.5-1. Land Use Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would the project affect other ROWs or land use authorizations?	No effect	No active oil and gas leases would be affected. Approximately 231 acres of existing mining claims would be affected. Approximately 362 acres of BLM-administered land in the analysis area would be unavailable for future ROWs or other land use authorizations. Approximately 445 acres of private land in the analysis area would be unavailable for potential future mining and other land uses.	Same as the Proposed Action
How would the project affect adjacent or nearby private property?	No effect	Increased visitation to the analysis area may affect adjacent or nearby private property through a potential decrease in privacy, a potential increase in trespassing incidents, and a potential increase in safety issues and livestock mortality resulting from a potential increase in vehicle traffic on nearby roads.	Same as the Proposed Action

3.5.6 Mitigation Measures

No mitigation measures are proposed for land use in addition to standard terms and conditions.

3.5.7 Unavoidable, Adverse Effects

Unavoidable, adverse effects would include the loss of existing and potential future mineral leasing opportunities in the analysis area, the loss of potential future ROWs and land use authorizations in the analysis area, and the potential adverse effects on nearby and adjacent private property resulting from increased visitation in the analysis area.

3.6 Noise

This section provides a background on noise, an overview of applicable regulations, and existing noise conditions in the analysis areas. Temporary and permanent noise from construction, recreation, operation, and maintenance activities from the project on nearby receptors are analyzed in this section. Noise effects to livestock would be the same as effects to wildlife, which are discussed in Section 3.18 Terrestrial and Aquatic Wildlife.

3.6.1 Issues and Indicators

As part of the project's internal and external scoping process, the following noise issues were identified:

- How would noise from construction, operation, recreation, and maintenance activities affect nearby residents, livestock, and wildlife?

In coordination with BLM resource specialists, the following noise indicators were developed to address these issues:

- Noise level that exceeds 5 A-weighted decibels (dBA) above ambient for construction, and a noise level that exceeds 3 dBA above ambient for recreation, operation, and maintenance activities

3.6.2 Affected Environment

Two analysis areas for noise are used to assess project-related effects from noise. Because elevated noise can be audible within 2 miles of a noise source, the analysis area for noise effects from construction activities encompasses the 806.8-acre project area and a 2-mile buffer. Noise-producing project activities would be limited to the areas with construction activities. A 0.5-mile buffer for operations and maintenance is proposed around the project area. Effects from operations and maintenance activities are expected to be minimal; therefore, a smaller analysis area is required.

The state of Wyoming and Big Horn County do not have any applicable regulations setting limits on noise. Additionally, there are no applicable federal regulations for reservoir construction projects like this one.

Within the 2-mile construction analysis area, fewer than 50 single-family residences are scattered in the rural area south and east of the project area. Within the 0.5-mile operations and maintenance analysis area, only four homes—two homes south of WY 31 and two near the project area—are found. Most of the land use in the analysis areas is agricultural and undeveloped, with only a few roads that have intermittent traffic, which would not affect continuous noise levels. Traffic is discussed further in Section 3.12 Transportation.

Existing noise levels throughout the analysis areas at given receptors vary widely depending on topographic shielding, ground cover, wind conditions, traffic, and nearby human activity. The American National Standards Institute (ANSI) provides estimates of general ambient noise levels based on land use descriptions (ANSI 2013). Based on the isolated setting and land use described for the analysis areas and the proximity of these areas to WY 31, the estimated ambient noise level in the analysis areas is approximately 48 dBA (ANSI 2013).

3.6.3 Methods of Analysis

In the absence of regulatory standards, perceptibility thresholds are provided to give context to predicted project effects. An increase in noise of 3 dBA over the background ambient level is barely discernable or perceptible. An increase of 5 dBA over the background ambient level, although still small, generally has a noticed community response.

A perceptible change to the existing ambient noise level would be considered an effect. A predicted noise level of 3 dBA above the ambient level during operation and maintenance activities in the operation and maintenance analysis area is considered an effect. A predicted noise level exceeding 5 dBA above the ambient noise level during construction activities in the construction analysis area is considered an effect. A higher threshold is considered acceptable for construction because it would produce a temporary effect.

To predict project noise levels, the greatest noise-generating activities for construction and operation and maintenance are identified. Then, a simple distance attenuation model is used to predict expected noise levels from the loudest sources in the analysis areas (Lamancusa 2009). The simple attenuation model is based on noise attenuating by 6 dBA for every doubling of distance of the receiver to the source.

3.6.4 Environmental Effects

3.6.4.1 ALTERNATIVE A: NO FEDERAL ACTION

The No Federal Action would have no change to ambient noise conditions. The No Federal Action would not generate additional noise sources. Noise levels may increase incrementally over time from local growth or from changes in land use in the area.

3.6.4.2 ALTERNATIVE B: PROPOSED ACTION

To predict noise levels from construction, it is conservatively assumed that the two loudest noise sources would be running continuously at the same location in the project area. Of the construction equipment potentially used at the site, a scraper and a haul truck would be the loudest. A scraper has a noise level of 89 dBA at a distance of 50 feet from the source, and a haul truck has an 88-dBA noise level at 50 feet (Federal Highway Administration [FHWA] 2006). Together, these two pieces of equipment operating at the same place and time would produce an aggregate noise level of 92 dBA at 50 feet. Noise from this equipment attenuates to 5 dBA above the ambient noise or 53 dBA at approximately 0.75 miles from the sources. Based on this conservative approach, if this equipment is operating at the boundary of the project area, receptors within 0.75 miles of the project area may be affected by noise from construction activities.

Multiple sources of noise associated with operation and maintenance activities would occur in the project area. Activities that occur during operations would be the result of recreational activities. Noise from recreation would largely occur on the weekends and holidays and would be dominated by traffic on the main entry road as well as watercraft. Both sources of recreational noise are intermittent and would occur during daylight hours. Traffic along the entry road would have a noise level of 55 dBA (FHWA 2006), and noise from a motorboat would have a noise level of 85 dBA at 50 feet (Lanpheer 2000). Maintenance activities would include driving along access roads, performing inspections, and general housekeeping at the restrooms and common areas. The highest source of noise from these activities would be a pickup truck with a noise level of 55 dBA at 50 feet (FHWA 2006). During times of high water, the spillway would receive flow and have temporary noise associated with water fall. Noise from water over the spillway would depend on many factors, including velocity of water, width of spillway, and total height of water fall. A previous study with a water fall of 8 feet and estimated velocity of 120 liters per minute produced a noise level of approximately 20 dBA at 50 feet (Galbrum and Ali 2012). It can be assumed that noise generated by the spillway would have a flow rate of more than 120 liters per minute periodically. A conservative assumption for spillway noise would be triple the flow rate from the project and a noise level of 60 dBA at a distance of 50 feet. No other activity at the reservoir is expected to cause more noise than the activities described here.

All major noise-producing activities described above for operation and maintenance would occur concurrently in the project area, and a total noise level of 85 dBA would be emitted from the project area. Noise from operation and maintenance sources attenuates to 3 dBA above the ambient noise of 51 dBA at approximately 0.5 miles of the project area. Based on this conservative approach, receptors within 0.5 miles of the project area may be affected by noise from operation and maintenance activities.

Predicted noise levels are determined with the most conservative model, which places the noise-producing sources in the project area and does not consider the attenuation provided by topography, vegetation, and atmospheric absorption. Furthermore, reservoirs create a natural land barrier system because the surface is below the ground level. These factors would dampen project noise and would greatly decrease the distance from the project area at which effects would be observed and decrease the number of potentially affected receptors.

3.6.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The effects from the Modified Proposed Action would be the same as those discussed for the Proposed Action.

3.6.5 Summary of Effects

Heavy construction equipment, operation and maintenance vehicles, and recreational noise from traffic and motorboat sources would cause increased noise levels in and near the project area.

Table 3.6-1 presents a summary of the effects to air quality under all alternatives.

Table 3.6-1. Noise Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would noise from construction, operation, recreation, and maintenance activities affect nearby residents, livestock, and wildlife?	No effect	Residents within 0.75 miles of the project area would be affected by increased noise levels exceeding 5 dBA above current ambient conditions. Livestock and wildlife would not likely be adversely affected by noise levels exceeding 5 dBA above current ambient conditions.	Same as the Proposed Action
		Residents within 0.5 miles of the project area would be affected by increased noise levels exceeding 3 dBA above ambient. Livestock and wildlife would not likely be adversely affected by noise levels exceeding 3 dBA above ambient.	Same as the Proposed Action

3.6.6 Mitigation Measures

Mitigation measures proposed for noise would be limited to operational restrictions and are as follows:

- Limiting reservoir use to non-motorized boats and recreation would limit noise levels for the life of the project.
- Motorboat use would be restricted to portions of the reservoir farther away from receptors.

3.6.7 Unavoidable, Adverse Effects

Although none of the noise effects discussed in this section are considered adverse, unavoidable effects from noise include increased levels within 0.75 miles of the project area from construction and unmitigated increased noise levels within 0.5 miles of the project area from operation and maintenance.

3.7 Paleontological Resources

This section describes the effects of the project on paleontological resources.

Paleontological resources are any fossilized remains, traces, or imprints of organisms, preserved in or on the Earth's crust, that are of paleontological interest and that provide information about the history of life on earth. Paleontological resources are considered non-renewable resources because the organisms they represent no longer exist, and such resources, if destroyed, cannot be replaced.

Paleontological resources on federal lands are managed under provisions of FLPMA; 43 USC 1737(b); Public Law 94-579; and the Omnibus Public Land Management Act of 2009, Subsection D, Section 6302, Public Law 111-011. The BLM's Manual and Handbook H-8270-1 (BLM 1998), Instructional Memorandum (IM) 2009-011 (BLM 2008b), IM 2012-141 (BLM 2012a), and IM 2016-124 (BLM 2016b) contain general procedural guidelines for paleontological resource management. General BLM management objectives include locating, evaluating, managing, and protecting paleontological resources and ensuring that proposed land-use projects avoid damaging or destroying important paleontological resources. In addition, the WFO RMP (2015a) establishes practices and guidelines for the long-term management of paleontological resources on BLM land. Paleontological resources on private land are the property of the landowner.

3.7.1 Issues and Indicators

As part of the project's internal and external scoping process, the following paleontological resource issues were identified:

- How would inundation of the reservoir area affect paleontological resources?
- What would be the effects of clearing and excavating disturbance areas on known or unknown paleontological resources?
- How would an increase in human activity during construction, recreational activities, and operations affect paleontological resources?

In coordination with BLM resource specialists, the following paleontological resource indicators were developed to address these issues:

- Number of known paleontological localities
- Acres of geologic units with the potential to contain scientifically important fossils within the area of direct disturbance or inundation. Acres of geologic units provide a quantitative value for unknown paleontological resources that are buried but could be physically disturbed or inundated by the project.

In addition, a qualitative assessment of changes in human activity is used as a surrogate for potential effects to known and unknown paleontological resources.

3.7.2 Affected Environment

The analysis area for paleontological resources is the 806.8-acre project area, a 100-foot buffer around the project area, and a 0.25-mile buffer around access roads. The access road buffer is used because of the tendency for people to explore areas along access roads, and is not used for other public areas because the fence line would deter most visitors from further exploration.

The Potential Fossil Yield Classification (PFYC) is a ranking of geologic units according to their potential to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils. These rankings are used in land use planning, as well as for identifying areas that may warrant special management and/or special designations. The BLM has assigned a PFYC ranking (1–5) to each geologic unit (formation, member, or other distinguishable unit) based on the taxonomic diversity and abundance of previously recorded scientifically significant paleontological resources associated with the unit and the potential for future discoveries, with a higher-class number indicating higher potential (BLM 2016a).

BLM data (2002, 2015a) and published geologic mapping (Love and Christiansen 1985; Rogers et al. 1948) indicate that the analysis area overlies two PFYC 2 geologic units (Quaternary alluvium and terrace deposits), two PFYC 3 geologic units (Mowry Shale and the Thermopolis Shale, including the Muddy Sandstone), and one PFYC 5 geologic unit (Cloverly Formation, including the Sykes Mountain Formation and "rusty beds"). Table 3.7-1 summarizes the geologic units in the analysis area that have a moderate (PFYC 3) and high (PFYC 5) potential to contain important paleontological resources. Paleontological resource summaries for these geologic units follow the table. For a more detailed discussion of the geologic setting, refer to Section 3.4 Geology and Minerals.

Table 3.7-1. Geologic Units in the Analysis Area with Moderate to High Potential to Contain Important Paleontological Resources

Geologic Unit	Age	Typical Fossils	PFYC
Mowry Shale	Late Cretaceous	Invertebrate and vertebrate fossils, including fragmentary ray finned fish (e.g., isolated scales), marine reptiles, fish ammonites, and other mollusks	3
Thermopolis Shale, including the Muddy Sandstone	Early Cretaceous	Vertebrates (fish, reptiles), invertebrates (mollusks), plants, foraminifera, and ichnofossils	3
Cloverly Formation, including Sykes Mountain Formation and "rusty beds"	Early Cretaceous	Vertebrates (mammals, reptiles dominated by dinosaurs) and plants	5

The Mowry Shale contains other fish remains; trace fossils; fossil wood and plant debris; foraminifera; barnacles; bivalves; brachiopods; gastropods; radiolarians; pterosaurs; and marine reptiles, including plesiosaurs and ichthyosaurs (Knechtel and Patterson 1962; Massare and Dain 1989; Romer 1968; Stewart and Hakel 2006). The age of the Mowry Shale has been determined primarily on fossil assemblages defined by ammonites (Reeside and Cobban 1960).

Fossil taxa represented in the Thermopolis Shale include forams; freshwater Pelecypods, *Inoceramus*, and gastropods (upper shale, just below Muddy Sandstone); plant leaves; trace fossils (e.g., trails and casts); fish teeth and bone fragments (throughout); crocodilia (lower Thermopolis); the type specimen of the short-necked plesiosaur, (Muddy Sandstone); and the turtle *Glyptops* (Druckenmiller 2002; Eicher 1960). The Mowry Shale is known for its ammonites and abundant fossil fish scales (Cobban and Kennedy 1989; Cockerell 1919).

The Cloverly Formation is known for its dinosaurian taxa, as well as a few taxa of fish, turtles, crocodiles, and mammals (Ostrom 1970). More recently, an updated taxonomic list was compiled that nearly doubles the number of known taxa from the Cloverly Formation (Oreska et al. 2013). Oreska et al. (2013) conclude from an extensive multi-year survey effort that natural erosion of Cloverly Formation exposures is very slow because some of the 1962 quarries were readily visible in the early 2000s and contained freshly broken rock.

BLM-approved paleontologists from SWCA performed paleontological fieldwork in 2013 and 2017 on approximately 990 acres in the analysis area (Knauss and Johnson 2014, 2017). A search of existing data prior to the field survey concluded that no previously recorded fossil localities were known in the analysis area (Knauss and Johnson 2017).

Following BLM guidelines, the pedestrian field surveys concentrated on bedrock exposures of geologic units with moderate to high potential to contain paleontological resources (PFYC 3 and PFYC 5). The field surveys concentrated primarily on exposures of the Cloverly Formation and Thermopolis and Mowery Shales. Much of the area mapped as the Cloverly Formation is flat or gently sloping and covered by vegetation, whereas the Mowery and Thermopolis Shales are well exposed along the eastern edge of the analysis area on the slopes of a large butte. The objective of the field surveys was to examine the analysis area for the presence of surface fossils and potentially fossiliferous outcrops of bedrock.

During the field surveys, five new localities were documented, and fossils from these localities comprise remains of fish scales and vertebrae, belemnite rostrums (invertebrates), and plesiosaur vertebrae. Three localities are in the Thermopolis Shale and two are in the Mowery Shale (Knauss and Johnson 2017). All localities were recorded on BLM-administered land in the analysis area. No scientifically important or unique paleontological resources were identified or collected during the field surveys. The results of literature review, previously recorded locality search, and the field survey indicate that buried paleontological resources may be present but not exposed at the surface.

3.7.3 Methods of Analysis

The analysis approach included a geographic information system (GIS) analysis of acres of geologic units and PFYC classes that would be disturbed or inundated, a review of relevant paleontological pedestrian surveys, a review of known paleontological localities, and a qualitative assessment of potential effects on paleontological resources.

3.7.4 Environmental Effects

3.7.4.1 ALTERNATIVE A: NO FEDERAL ACTION

Under the No Federal Action, effects to paleontological resources would remain at existing levels. Existing effects to paleontological resources in the analysis area are associated with access to the area by existing roads and ranching and farming activities. Within the proposed project area, there is previous disturbance from existing roads and from ranching and farming activities. In most cases, these areas are underlain by geologic units with a low potential to contain paleontological resources (PFYC Class 2) or with some soil cover; therefore, these existing actions have little to no direct effect to paleontological resources. Human activity along the existing roads may cause indirect effects through unpermitted collection of surface fossils.

3.7.4.2 ALTERNATIVE B: PROPOSED ACTION

Under the Proposed Action, up to 207 acres of the Cloverly Formation (PFYC Class 5) and 33 acres of the Thermopolis Shale (PFYC Class 3) would be directly disturbed by construction of the dam embankment, spillway, south wetland, access roads, pipelines, borrow areas, and recreational facilities. Although there are no known paleontological resources in these areas, there is the potential for important paleontological resources to be present in the subsurface. Ground disturbance and increased human activity in remote areas during construction of the perimeter fence may affect known and unknown paleontological resources.

Following construction of the Proposed Action, 239 acres of the Cloverly Formation (PFYC Class 5) and 33 acres of the Thermopolis Formation (PFYC Class 3) would be within the MHWL. No known paleontological localities are within the MHWL of the Proposed Action. There is the potential for an unknown number of undiscovered localities to be within the MHWL, and these would be inaccessible for the long term. In addition to submergence, direct long-term effects to paleontological resources would include annual fluctuations of the reservoir water levels, which could erode sediment and expose previously unknown paleontological resources. Paleontological resources that are exposed from increased wave action may be completely eroded away prior to authorized collection. Although the Cloverly Formation has been shown to erode slowly, which would limit the effect from increased erosion activities to that formation, much of the MHWL edge lies on the much more erodible Thermopolis Shale.

Post-construction, indirect effects to paleontological resources could occur from increased, unsupervised human activity through unauthorized collection or damage of paleontological resources. Increased human activity could indirectly affect paleontological resources for the long term through increasing unauthorized surface collection of paleontological resources or ground disturbance. This could occur at the five known paleontological localities in the analysis area or at newly exposed localities.

3.7.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The auxiliary spillway, underlain by a PFYC Class 5 geologic unit, would be reduced by 3,375 feet under the Modified Proposed Action. This would reduce the potential for effects to previously undiscovered subsurface paleontological resources. All other effects would be as described for the Proposed Action.

3.7.5 Summary of Effects

Table 3.7-2 presents a summary of the effects to paleontological resources under all alternatives.

Table 3.7-2. Paleontological Resources Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would inundation of the reservoir area affect paleontological resources?	No effect	Reservoir inundation would affect 37 acres of PFYC 3 and 239 acres of PFYC 5. Soft PFYC 3 shale units would receive most of the erosion along the shores of the reservoir. Inundated acres would be inaccessible to research for the life of the project.	Same as the Proposed Action
What would be the effects of clearing and excavating disturbance areas on known or unknown paleontological resources?	No effect	Clearing and excavating disturbance areas would affect 33 acres of PFYC 3 and 206 acres of PFYC 5. Disturbance would occur to geologic units with the potential to contain important paleontological resources.	Clearing and excavating disturbance areas would affect 33 acres of PFYC 3 and 173 acres of PFYC 5. Less ground disturbance would occur than under the Proposed Action, which may reduce the likelihood of affecting previously undiscovered paleontological resources.
How would an increase in human activity during construction, recreational activities, and operations affect paleontological resources?	No effect	Effects are likely.	Same as the Proposed Action

3.7.6 Mitigation Measures

Under the Proposed Action and Modified Proposed Action, effects to paleontological resources would be avoided, minimized, and/or mitigated under existing stipulations in the WFO RMP (BLM 2015a) and other applicable guidance (e.g., Handbook H-8270-1 [BLM 1998], IM 2009-011 [BLM 2008b]).

The following additional mitigation measures could be implemented to minimize effects to paleontological resources:

- Before construction, personnel would be instructed that it is unlawful to damage, alter, excavate, or remove vertebrate fossils or other scientifically significant paleontological resources from the area.
- Monitoring for paleontological resources during construction would be conducted by a BLM-permitted paleontologist for disturbance of PFYC Class 3 and 5 geologic units.
- A paleontological discovery plan would be developed and submitted to the BLM for review and approval before any ground disturbance. Paleontological discoveries would be reported per the paleontological discovery plan.
- Following these measures would minimize or alleviate any direct effects to paleontological resources.

3.7.7 Unavoidable, Adverse Effects

Although implementation of mitigation measures would reduce effects to paleontological resources and potentially provide scientific value through preservation and curation, removal of the resources or destruction of previously unknown resources would be an unavoidable, adverse effect.

3.8 Public Health and Safety

This section describes the effects of the project on public health and safety. Threats to public health and safety include hazardous materials, solid waste, and potential dam failure of the proposed Alkali Creek Reservoir. Hazardous materials that would be present during construction include petroleum products and chemicals. Solid waste would be generated during construction and require subsequent disposal. Potential failure modes may exist and could cause uncontrolled release of water that could affect life and property during the life of the reservoir.

3.8.1 Issues and Indicators

As part of the project's internal and external scoping process, the following issues that relate to public health and safety were identified:

- What would be the effects to soils, surface waters, or groundwater if spills or releases of chemicals or petroleum products occur?
- What would be the potential for structural failure of the dam due to earthquake, ground movement, or other geologic events, and what would be the likely downstream effects?

Releases of hazardous materials downstream of the dam would specifically relate to effects on soil, surface water, and groundwater if spills or releases of chemicals or petroleum products occur during construction. Structural failure considers the potential effect to hazardous materials at downstream homes and businesses in the event of an uncontrolled release of water.

In coordination with BLM resource specialists, the following public health and safety indicators were developed to address these issues:

- Change in risk of a small- or large-scale hazardous material release and effects of releases on air, surface water, soil, or groundwater quality

3.8.2 Affected Environment

The analysis area for effects to public health and safety comprises the Alkali Creek watershed above and below the Alkali Creek Reservoir through Paint Rock Creek. This area was selected because the reservoir area would be most susceptible to contamination during the construction of the reservoir; because areas upstream of the reservoir could be affected by equipment storage or construction activities; and because areas downstream of the potential reservoir, including both Alkali and Paint Rock Creeks, would be affected if the dam should fail (Trihydro 2017d).

The proposed reservoir is on Alkali Creek, an intermittent stream that flows into Paint Rock Creek approximately 8 miles upstream of its confluence with the Nowood River. The proposed reservoir area lies at an elevation of approximately 4,400 feet above mean sea level, 1.6 miles upstream of Alkali Creek's confluence with Paint Rock Creek. Landownership in the project area comprises BLM-administered lands (43%) and private land (57%). Lands in and around the analysis area are used primarily for agriculture, including irrigated crops and livestock grazing (Trihydro 2016a). Downstream lands along Alkali and Paint Rock Creeks are similarly used by approximately 10 additional property owners.

Trihydro (2016a) and the Wyoming State Geological Survey (Case et al. 2002) have previously reviewed the seismicity of the area. No active exposed faults have been identified in Big Horn County. Four magnitude 2.5 and greater seismic events have been documented in Big Horn County (Case et al. 2002). There are no known exposed active faults with a surficial expression near the project area (Section 3.4.2). The reservoir area is in Seismic Zone 1, as defined by the Uniform Building Code, a document prepared by the International Conference of Building Officials to provide minimum standards to safeguard life or limb, health, property, and the public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within its jurisdiction. Seismic Zone 1 is considered low risk.

3.8.3 Methods of Analysis

The analysis of these potential changes included a review of baseline conditions using aerial imagery, the *Nowood River Storage Level II Study Phase II Report* (Trihydro 2016a), and the seismological characterization report for Big Horn County. These data were used to predict the current risk of hazardous material releases resulting from agricultural practices or geologic events. The potential for storage of hazardous materials downstream of the site was also assessed to evaluate the risk of a release in the case of a structural failure of the dam. The proposed engineering design was used to make a qualitative risk assessment, based on probability of events, that a failure could occur and to identify the regions and communities that would be affected by inundation if a breach occurred.

3.8.4 Environmental Effects

If the Alkali Creek Reservoir is constructed, hazardous materials could be spilled or released into the environment. The magnitude of any effects would depend on the volume of materials released, the material into which they are introduced, and the timing of the release. The dam is designed not to fail; however, potential failure modes may exist, and dam failure would have adverse consequences if it occurred. These potential effects are considered with respect to each alternative.

3.8.4.1 ALTERNATIVE A: NO FEDERAL ACTION

If the Alkali Creek Reservoir is not constructed, there would be no hazardous materials brought on-site. There would be no increase in the potential for hazardous material contamination in the project area with this alternative. The potential for small and scattered releases of pesticide, herbicide, or petroleum product on agricultural lands in the area would persist so long as existing land use practices continue. The risk of seismic activity is low, and given the lack of facilities that manufacture or store large volumes of chemicals, the likelihood of a hazardous materials release from a seismic event would also remain low.

3.8.4.2 ALTERNATIVE B: PROPOSED ACTION

Under the Proposed Action, hazardous materials would be brought on-site during construction and implementation. These materials would include fuels, lubricants, coolants, and solvents necessary for the heavy machinery and transportation vehicle operation. Fuels used would include gasoline and diesel fuel for powering vehicles, combustion engines, and heavy machinery, and propane for generating heat. Lubricants would include motor oil, transmission fluids, brake fluids, and miscellaneous lubricants and grease required by machinery and vehicles used in construction. Coolants (antifreeze) would be used in combustion engines used for construction, drilling, and transportation. Solvents would include various cleaning solutions and paint thinner and would be used for general maintenance of construction equipment and operations facilities. Fuels, lubricants, coolants, and solvents all contain constituents deemed hazardous.

Additional hazardous materials that may be brought on-site for project construction and operation include herbicides, paints, and explosives. Herbicides and paints would be used for maintaining the dam and reservoir operations facilities. Explosives may be used in the construction of the dam and delivery canal. Effects from hazardous materials brought on-site are expected to be minimal provided proper use and handling guidelines are followed, personnel are trained in the correct use of the hazardous material, and state and federal guidelines regarding hazardous material are followed.

If any hazardous materials are spilled or released into the environment, effects to the environment would be noticeable. Releases to the environment could adversely affect vegetation, wildlife, aquatic life, livestock, and human life. The extent and magnitude of the effects would depend on the type of hazardous material released, the amount released to the environment, the location and substance into which it is released, and the timing of the release. Releases of petroleum-based products to soil or water can present lethal and or acute toxicity poisoning of vegetation and aquatic organisms. Releases to surface water can also have deleterious effects on taste and odor, which affect the water use class and suitability for recreation. Petroleum-based products can also volatilize and cause air quality issues for workers. Depending on the size of the release and location relative to local water-bearing rock formations, groundwater quality could also be adversely affected. If any release occurs during construction, the contractor would be required to clean up the spill and notify the State of Wyoming in accordance with Chapter 4 (Releases of Oil & Hazardous Substances into Waters) of the Wyoming water quality rules and regulations.

The potential for dam failure caused by seismic events or other geohazards would be very low. The seismotectonic evaluation prepared by Trihydro (2016a) indicates that a peak horizontal ground acceleration of 0.1678 g would have a 2% probability of exceedance in 50 years (2,500-year return period) and should be used in dam design. This seismic coefficient is relatively low and would be used in the final design process to ensure stability during a seismic event.

If the dam fails, the uncontrolled release of the reservoir water could have immediate and adverse effects on downstream life and property. Effects associated with dam breach flooding include property damage and potential loss of life within the inundation area identified in the emergency action plan (Trihydro 2017d). This release of water to downstream creeks could also result in the release of hazardous materials stored at the homes and businesses affected by the flooding. These hazardous materials would likely include petroleum products such as gasoline, diesel fuel, and heating oil; herbicides and pesticides; and other household hazardous materials. Given the lack of facilities that manufacture or store large volumes of chemicals, construction and operation of the proposed reservoir should not increase the risk of a high-volume hazardous materials spill.

3.8.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The effects from the Modified Proposed Action would be the same as those discussed for the Proposed Action.

3.8.5 Summary of Effects

Table 3.8-1 presents a summary of the effects to public health and safety under all alternatives.

Table 3.8-1. Public Health and Safety Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
What would be the effects to soils, surface waters, or groundwater if spills or releases of chemicals or petroleum products occur?	Negligible	Releases of hazardous materials during construction could occur.	Same as the Proposed Action
What would be the potential for structural failure of the dam due to earthquake, ground movement, or other geologic events, and what would be the likely downstream effects?	Negligible	In the unlikely event of dam failure, the resulting flood could cause small hazardous materials releases.	Same as the Proposed Action

3.8.6 Mitigation Measures

Effects from hazardous materials in the analysis area would arise if a spill or misuse of the material occurs. Mitigation for use of hazardous materials for project construction and implementation center on education and proper use of materials and would be the same for either alternative.

Mitigation measures proposed for public health and safety include the following:

- Including in the on-site project manual the types and quantities of hazardous materials used, stored, transported, produced, or disposed of in conjunction with the project and contingency plans for releases, spills, fires, or explosions
- Maintaining Safety Data Sheets on file at project operations headquarters
- Properly storing hazardous materials
- Fueling and lubricating construction and transportation equipment only in a designated area with secondary containment if required by regulation (e.g., spill prevention, control, and countermeasure plan)
- Adhering to proper management and handling procedures for hazardous materials and waste

- Following manufacturers' suggested guidelines for use and disposal of hazardous materials
- Properly training and educating employees who would be using hazardous materials during project construction and implementation
- Conducting frequent visual inspections of the dam by the dam operator and formal dam safety inspections by the Wyoming State Engineer's Office Safety of Dams Division
- Complying with the Wyoming Pollutant Discharge Elimination System permit

3.8.7 Unavoidable, Adverse Effects

There would be no unavoidable, adverse effects to public health and safety.

3.9 Recreation

This section describes the effects of the project on recreation. Recreation as a resource refers to an area of BLM-administered land that combines the natural qualities of land and water areas and the ability and desire of humanity to use this combination for personal satisfaction and enjoyment. Recreation as leisure refers to activities such as walking, hiking, hunting, fishing, or nature viewing and may be undertaken individually or with others.

3.9.1 Issues and Indicators

As part of the project's internal and external scoping process, the following recreation issues were identified:

- How would water impoundment, downstream channel improvements, and changing water flows in Paint Rock Creek and Medicine Lodge Creek affect recreation use in the area, including fishing opportunities?
- How would providing recreational facilities (boat ramp, comfort station) affect local recreational opportunities and public access?

In coordination with BLM resource specialists, the following recreation indicators were developed to address these issues:

- Changes in (loss and creation of) dispersed recreational activities in the area
- Changes in the recreation setting (e.g., undeveloped or rural settings) of the project area with the introduction of the reservoir
- Changes in land available for dispersed recreation

3.9.2 Affected Environment

The spatial analysis area for analyzing the direct and indirect effects to recreation is the project area with a 5-mile buffer. This area captures the variety of recreation settings and opportunities that would likely be affected by the proposed project.

The temporal boundaries for analyzing the direct and indirect effects to recreation are 1 to 2 years for short-term effects (the anticipated duration for construction) and 2 to 75 years for long-term effects. The proposed project is expected to be in operation for approximately 75 years.

3.9.2.1 RECREATION SETTING

Recreational opportunities and activities in the project area are managed by the BLM in accordance with prescribed settings. The BLM WFO has established prescribed recreation settings using a tool called the recreation opportunity spectrum (ROS). The ROS is a system used to inventory and classify public lands according to physical, social, and managerial settings, which combine to offer specific types of recreational opportunities. As the name implies, such settings range across a spectrum of opportunities.

Critical to producing recreational opportunities is the condition of recreation settings on which those opportunities depend. The ROS uses settings that correspond to allowable uses. The ROS stratifies and defines classes of outdoor recreation environments. The spectrum may be applied to all lands, regardless of ownership or jurisdiction.

The ROS divides recreation settings into six broad classes: Urban, Rural, Roaded-Natural, Semi-Primitive Motorized, Semi-Primitive Non-Motorized, and Primitive (U.S. Forest Service 1986). The project area's ROS acreages in the analysis area are in Table 3.9-1 and shown on Figure 3.9-1.

Table 3.9-1. Recreation Opportunity Spectrum Classes in the Analysis Area

Recreation Opportunity Spectrum Class	Analysis Area (acres)
Rural	13,978.9
Roaded-Natural	30,623.3
Semi-Primitive Motorized	46,796.4
Semi-Primitive Non-Motorized	949.1

Note: Total ROS acreage does not correspond to total analysis area acreage because some areas of the analysis area have not been assigned a ROS classification.

The WFO RMP (BLM 2015a) provides a description of the applicable ROS classes that are present in the project area.

Rural ROS classification areas in the analysis area generally correspond to developed areas, largely confined to developed agriculture along WY 31. Roaded-Natural classification areas in the project area typically correspond to the route network, which also generally corresponds to and follows surface water drainages. Semi-Primitive Motorized classification areas cover most of the analysis area and are characterized by a predominantly natural setting and dispersed recreation use. Semi-Primitive Non-Motorized areas are on the east edge of the analysis area with limited user access.

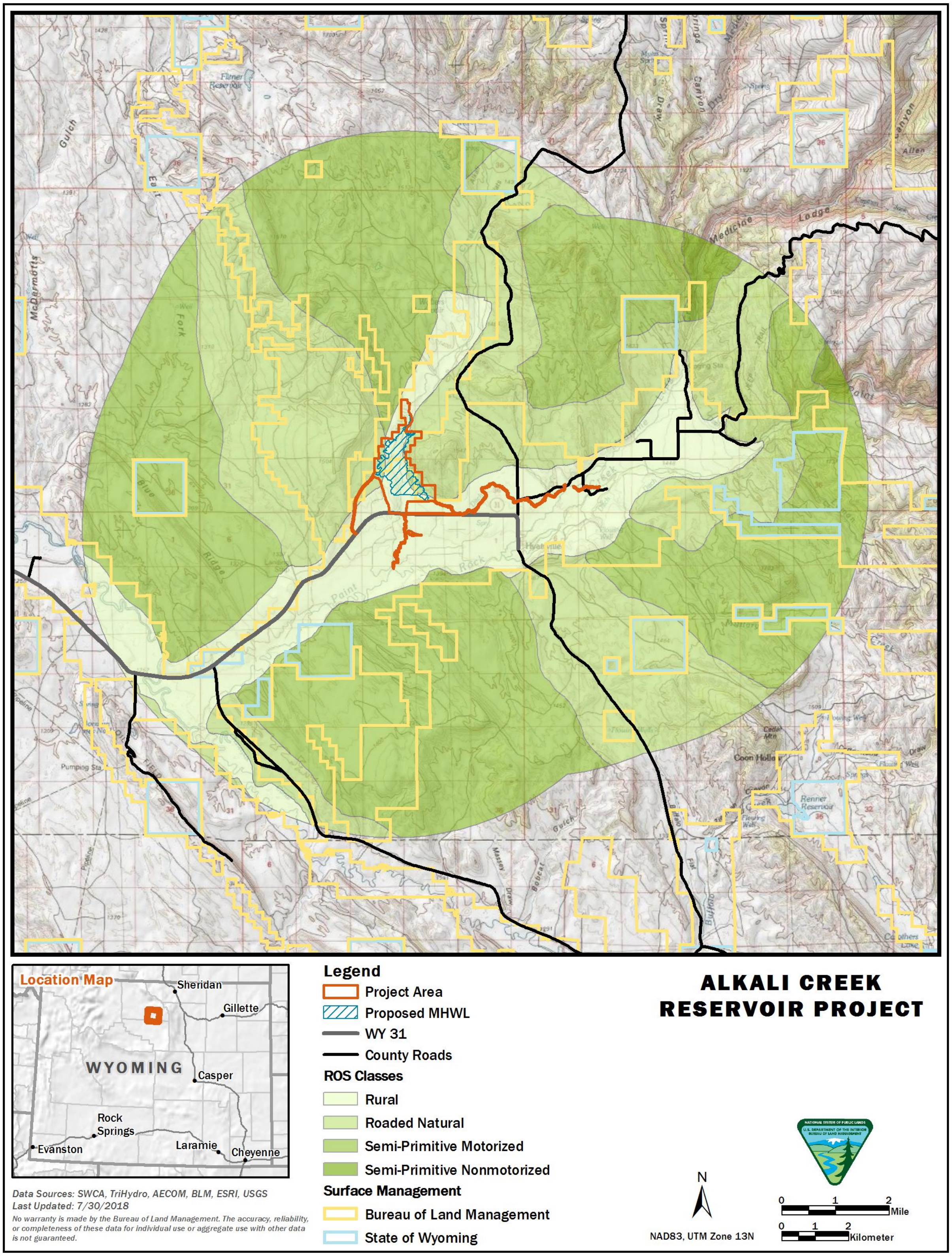

Figure 3.9-1. Recreation opportunity spectrum classes in the analysis area.

3.9.2.2 DEVELOPED RECREATION SITES

3.9.2.2.1 Paint Rock Canyon Trail

The Paint Rock Canyon Trail extends 5 miles up the Paint Rock Canyon alongside Paint Rock Creek, a superb fishery for rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), and cutthroat trout (*Oncorhynchus clarki*) (BLM 2018a) (also see Section 3.9.2.3 Dispersed Recreation). The steep canyon walls and massive rocks make this trail highly scenic, and it is the only canyon along the west slope of the Bighorn Mountains with a maintained trail. The Paint Rock Canyon Trail is located approximately 5 miles east of the proposed reservoir.

3.9.2.2.2 Medicine Lodge Archaeological Site State Park

Located along Medicine Lodge Creek, the State of Wyoming operates the Medicine Lodge Archaeology Site State Park, featuring hundreds of prehistoric petroglyphs and pictographs, developed campgrounds, seasonally open visitor's center, fishing, and hiking (Wyoming State Parks 2018). The park is approximately 5 miles northeast of the proposed reservoir.

3.9.2.2.3 Red Gulch/Alkali National Backcountry Byway

The Red Gulch/Alkali National Backcountry Byway is a 32-mile scenic drive on improved gravel and dirt roads through the foothills of the Bighorn Mountains. The south end of the byway begins 2 miles northeast of the proposed reservoir; here, a National Backcountry Byway kiosk provides historical information about the byway as well as road conditions. The steep, rugged canyons cut into the mountains along the byway and offer many challenging and interesting hiking opportunities. The byway is used for driving for pleasure and access to hunting, hiking, and fishing opportunities (BLM 2018b).

3.9.2.3 DISPERSED RECREATION

The BLM WFO planning area is known for its large-scale, undeveloped areas and remoteness, which provide a variety of recreational opportunities for users who wish to experience undeveloped recreation, as well as those seeking more organized or packaged recreation experiences. The availability of public roads as well as private-permission roads make it fairly easy to access the public lands to hike, camp, observe wildlife, birdwatch, drive for pleasure, drive off-highway vehicles (OHVs), and ride horses. Generally, because of the topography and private lands confining access at the proposed reservoir site, there is low dispersed recreation use in the project area.

3.9.2.3.1 Medicine Lodge Creek

Medicine Lodge Creek is a foothill stream that flows off the west side of the Bighorn Mountains. After spring runoff subsides, this stream offers great fishing for brown trout and occasional rainbow trout and mountain whitefish (*Prosopium williamsoni*). The Medicine Lodge Creek watershed is fairly stable and well-vegetated, and it yields relatively clean gravels and good water quality that benefit trout spawning and insect production (WGFD 1997).

The instream flowing channel, which is the most popular recreation fishing area of Medicine Lodge Creek, is approximately 5 miles northeast of the proposed reservoir site (WGFD 2018a).

3.9.2.3.2 Paint Rock Creek

Paint Rock Creek is also a foothill stream that flows off the west side of the Bighorn Mountains. It offers excellent brown trout fishing. Private ranches line the creek near the edge of Hyattville, Wyoming; public access is gained by following the Paint Rock Canyon Trail.

3.9.2.4 HUNTING

Unless otherwise specified, land in the project area is open to hunting if the user possesses an active individual permit (e.g., a valid Wyoming hunting license and tag). The WGFD manages wildlife hunting areas (game management unit [GMU]) according to species. Big-game hunting and trophy-game hunting are popular in and surrounding the project area, as is small-game and upland bird hunting for species such as grouse, partridge, pheasant, rabbit, hare, and squirrels (WGFD 2017a).

Big-game hunting and trophy hunting are very popular on public lands adjacent to the project area. GMUs are numbered according to species. The project area is located within six GMUs: GMU 79 is the antelope (pronghorn) hunt area, GMU 47 is the deer hunt area, GMU 41 is the elk hunt area, GMU 42 is the moose hunt area, GMU 3 is the black bear hunt area, and GMU 21 is the mountain lion hunt area (WGFD 2017b–f, 2018b).

Hunting is permitted year-round, during specified seasons for specific species; most hunting occurs in the late summer and fall. Hunting is pursued by local Big Horn County residents, Wyoming residents, out-of-state residents, and hunters visiting from different countries (WGFD 2018c).

3.9.3 Methods of Analysis

The analysis to determine potential effects to recreation is based on existing management and data from the BLM WFO and state resource management. Spatial and GIS data were also used in this analysis and include recreation settings, developed recreation sites, existing BLM routes, and GMUs. Potential changes to the recreation setting (based on the Proposed Action) and to the resource condition indicators provide the basis for assessing effects. The analysis approach included a GIS analysis using the Proposed Action and Modified Proposed Action overlaid on acres of recreation setting or opportunities to indicate where lost or converted recreation settings may occur, and it was supported by a quantitative (e.g., acres) and qualitative discussion on resource issue effects.

3.9.4 Environmental Effects

3.9.4.1 ALTERNATIVE A: NO FEDERAL ACTION

Under the No Federal Action, the BLM would not issue permission to the WWDO for the construction of the reservoir and associated facilities; therefore, there would be no adverse effects to recreation opportunities or use in the area. Recreation activities, including fishing, would continue as they exist today, and would continue to be controlled by private landowner access and managed by the BLM in accordance with the WFO RMP.

3.9.4.2 ALTERNATIVE B: PROPOSED ACTION

The Proposed Action would be consistent with the existing ROS settings prescribed in the WFO RMP (BLM 2015a). The project area under the Proposed Action would be located within Roaded-Natural RSO classification areas. The new recreation settings would include open water, shorelines, access roads, a parking lot, a comfort station, and a boat ramp. Each of these settings and the recreation activities and opportunities that they would support would be within the thresholds established in the WFO RMP for the Roaded-Natural and Rural characterizations of remoteness, naturalness, facilities, group size, contacts with other users, evidence of use, visitor services, management controls, and mechanized use.

The Proposed Action would not affect Paint Rock Canyon Trail, Paint Rock Creek, Medicine Lodge Creek, Medicine Lodge Archaeological Site, or the byway because there would be no changes to the settings, opportunities, or values of these areas if the reservoir is built. These areas would continue to be operated and used as they are today. The highest value fishing reaches of Paint Rock and Medicine Lodge Creeks would not be affected by the proposed ditch diversions and improvements; the head gates would be located downstream of these reaches.

Under the Proposed Action, up to approximately 350 acres would be graded to accommodate the project elements and fenced for safety and security purposes. This would reduce the size of BLM administered-lands available for terrestrial recreation by less than 1%. This would result in a direct loss of recreational opportunities in the project area, including hiking, hunting, and horseback riding. These activities would be replaced by the proposed reservoir, shifting the recreation setting from terrestrial to water-based. The 350 acres would be converted from open rangeland and low-lying creek beds, where hiking, hunting, and horseback riding may be pursued, to standing water and shorelines with developed facilities (i.e., parking lot, comfort station, boat ramp), where fishing, boating, and car-based activities (e.g., picnicking) may be pursued.

Opportunities for dispersed recreation in the areas adjacent to the project area would be negligibly interrupted during construction of the reservoir; no changes in patterns of access would be caused by construction traffic. Increases in vehicular traffic on WY 31 would negligibly deter or delay some recreationists from the area due to safety concerns, noise, and traffic congestion. Conversely, the new road from WY 31 to the reservoir site would provide additional access to adjacent public lands (subject to existing laws and regulations) for hiking, hunting, horseback riding, and nonmotorized recreation opportunities, as well as new access to developed recreation opportunities like the comfort station and boating. This new recreation setting would attract those recreationists that seek opportunities for boating, lake-based fishing, swimming, and birdwatching that previously would not have been attracted to the project area.

Effects to hunting opportunities (both big-game and small-game) that could be displaced by the construction and operation of the proposed reservoir would be minor because the areas within GMUs that are outside of the project area would remain available for hunting, subject to applicable laws and regulations. The WGFD would post signs in accordance with the laws and regulations for hunting to indicate the reservoir site would be closed to hunting during construction and operation activities. For hunting seasons that occur year-round or for construction activities that cannot be sequenced to avoid hunting seasons, hunting with a firearm for those species would be precluded in the project area because the laws and regulations for manner and method of taking wildlife would make it illegal to discharge firearms near the construction activities; in this case, construction of the proposed project.

In addition, human presence and construction activities would likely cause some wildlife species to temporarily avoid these areas; therefore, even if hunting were not precluded, many of the wildlife species being hunted would likely not be present during construction because of the increased noise and human activity. Following construction activities, the area would transition from open rangelands to open water, and terrestrial wildlife would likely be deterred by fencing. Therefore, potential effects to hunting opportunities during construction and operation activities would be long term and minor. The number of hunting permits that are issued in individual GMUs would not change as a result of construction of the project. The availability to hunt in GMUs that are included in the project area and the number of hunting permits per GMU would not be affected by the project because the ROW for BLM lands, if granted, would represent less than 1% of the total GMUs available. Further, hunter days would not change because hunting could persist elsewhere in the GMUs.

No existing access roads would be lost under the Proposed Action because no public access roads would be inundated by the creation of the reservoir.

Long-term, beneficial effects to recreation would result from the operation of the proposed reservoir, both from new recreation facilities and new recreation opportunities. The new recreation facilities at the reservoir would consist of access roads, a parking lot, a comfort station, and a boat ramp. The new recreation opportunities would be boating, fishing, and swimming; these activities are not currently available in the project area. Boating and swimming are not currently available in the project area, and fishing is limited to stream environments. The proposed reservoir would meet the WGFD minimum pool recommendation of 1,998 acre-feet to provide aquatic benefits, including fishing. This reservoir level would maintain a guaranteed minimum (conservation) pool that would be beneficial to fish species, which would also create new recreation opportunities. These new recreation opportunities would be pursued by locals and visitors. There would be an increase in visitors to the proposed reservoir site (primarily in the spring, summer, and fall) because new recreation opportunities would be available. Visitation to the general Hyattville area (as well as surrounding recreation sites), although expected to increase, is not anticipated to increase in a manner that would affect traffic patterns on WY 31, require additional parking, or increase law enforcement presence.

3.9.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

Effects to recreation resources under the Modified Proposed Action would be the same as the Proposed Action because modifications to the spillways and/or filling of the reservoir would not change the potential effects to recreation resources as described under the Proposed Action. The proposed reservoir, access roads, and recreation facilities would be constructed in similar manners as described under the Proposed Action. Further, there would be no change in the number of vehicles used for construction and operation or any differences in access between the Proposed Action and Modified Proposed Action.

3.9.5 Summary of Effects

Table 3.9-2 presents a summary of the effects to recreation resources under all alternatives.

Table 3.9-2. Recreation Resource Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would water impoundment, downstream channel improvements, and changing water flows in Paint Rock Creek and Medicine Lodge Creek affect recreation use in the area, including fishing opportunities?	No effect	There would be negligible effects from loss of the dispersed recreation setting; no effect would occur to fishing opportunities in creeks in the analysis area.	Same as the Proposed Action
How would providing recreational facilities (boat ramp, comfort station) affect local recreational opportunities and public access?	No effect	There would be beneficial, long-term effects from increasing the developed recreation setting; negligible effects would occur from loss or dispersed recreation setting.	Same as the Proposed Action

3.9.6 Mitigation Measures

No mitigation measures are proposed for recreation resources.

3.9.7 Unavoidable, Adverse Effects

Unavoidable effects, such as the noise, sight, and presence of construction equipment and workers, could temporarily disturb the dispersed recreation setting, and depending on the activity, it could also temporarily disturb the recreation opportunity (e.g., hunting and/or recreationists seeking solitude, quiet, and undeveloped rangeland areas). These adverse and unavoidable effects would be temporary, short term, and localized (i.e., site specific), occurring only when construction activities are being implemented on the ground.

3.10 Socioeconomics

This section describes the socioeconomic affected environment and socioeconomic effects of the project and evaluates the potential for environmental justice concerns under the action alternatives.

3.10.1 Issues and Indicators

As part of the project's internal and external scoping process, the following socioeconomic issues were identified:

- How would the construction workforce affect the local economy in terms of housing availability, services, transportation, and revenue generation?
- How would the project affect agricultural productivity and expenses for adjacent landowners?
- How would the project affect property values?
- What would be the economic effects from increased recreation on the local community?
- Would there be a disproportionate effect on disadvantaged communities?

In coordination with BLM resource specialists, the following socioeconomic indicators were developed to address these issues:

- Changes in annual employment, labor income, state and local tax revenues, economic output, and housing availability
- Qualitative assessment of changes to property values
- Qualitative assessment of changes to recreation-related consumer surplus
- Apparent disproportionate effects on identified disadvantaged communities

3.10.2 Affected Environment

The analysis area for socioeconomics is referred to as the socioeconomics study area (SESA). The SESA comprises Big Horn and Washakie Counties. This area was chosen because of the project's proximity to cities and towns in both counties. The SESA includes 11 incorporated communities as well as surrounding rural areas. In 2016, the combined population of both counties was estimated to be 20,240 with approximately one-third of the population living in rural areas. Populations in the incorporated communities in the SESA ranged from a low of 118 (Manderson, Big Horn County) to a high of 5,316 (Worland, Washakie County) (U.S. Census Bureau 2018).

3.10.2.1 INCOME AND POVERTY

Between 2012 and 2016, the median household income was $50,820 in Big Horn County and $46,212 in Washakie County. Between 2007 and 2011, the median household incomes in Big Horn and Washakie Counties were $52,597 and $50,177, respectively. The data show that median household incomes in both counties continue to be affected by the nationwide recession that occurred in 2009 (U.S. Census Bureau 2018).

The poverty rate in the state of Wyoming averaged 11.6% between 2012 and 2016. During the same time, the poverty rates in Big Horn and Washakie Counties averaged 11.9% and 14.7%, respectively. Across the communities in the SESA, the average poverty rate between 2012 and 2016 ranged from a low of 4.8% in Manderson (Big Horn County) to a high of 27.5% in Frannie (Big Horn County) (U.S. Census Bureau 2018).

3.10.2.2 HOUSING

An average of 9,187 housing units were in the SESA between 2012 and 2016. In the incorporated communities within the SESA, the average housing stock ranged from a low of 58 units in Frannie (Big Horn County) to a high of 2,428 units in Worland (Washakie County) between 2012 and 2016. During this time, Hyattville contained an average of 76 housing units. Between the periods from 2007 to 2011 and from 2012 to 2016, the average housing stock in the SESA grew by only nine units from 9,178 to 9,187. During this time, median home values increased by approximately 17% to $148,200 in Big Horn County and by approximately 8% to $156,900 in Washakie County (U.S. Census Bureau 2018).

There was an average of 338 units for rent, 65 units for sale, and 1,483 units classified in another form of vacancy in the SESA from 2012 through 2016. Overall vacancy rates in the SESA, which include units that are rented; unoccupied; meant for seasonal, recreational, or occasional use; or for migrant workers, averaged 17.1% in Big Horn County and 8.3% in Washakie County. Rental vacancy rates in the SESA were 7.0% in Big Horn County and 9.4% in Washakie County, respectively (U.S. Census Bureau 2018). Vacancy rates over 5% typically reflect housing markets with capacity to absorb additional housing demand without undue effects on availability or cost (Kasulis 2016).

3.10.2.3 ECONOMIC ENVIRONMENT

In 2015, the SESA's top four non-government employment sectors were farming, retail trade, construction, and manufacturing. The farm sector was the single largest non-government employer during this time, accounting for 8.7% of the SESA's employment. Employees in the SESA received salaries and benefits totaling approximately $476.8 million in 2015, of which $12.5 million was paid to farm workers. Since 2001, farm compensation in the SESA has increased by 64.6% to an average of $12,955 per worker. The construction sector employed approximately 836 people in the SESA in 2016, which constituted approximately 7% of the SESA's total workforce. During this time, construction workers in the SESA earned a total of $32.24 million or approximately $38,566 per worker, on average. The average annual salary and benefits in the SESA across all employees was approximately $38,560 in 2016 (U.S. Bureau of Economic Analysis 2016).

Between 2012 and 2016, the labor force in the SESA averaged 9,608 individuals. This represents a decrease of 4% compared to the average labor force size of 10,014 individuals between 2007 and 2011. The state of Wyoming's average labor force grew by approximately 2% during the same time periods. From 2012 to 2016, the average unemployment rate in the two-county SESA was 3.3% in Big Horn County and 7.4% in Washakie County, compared to 4.9% for the state of Wyoming (U.S. Census Bureau 2018).

3.10.2.4 AGRICULTURE

There were 836 farms in the SESA in 2012, of which 255 were engaged in crop production and 581 focused on ranching. The SESA contained 643,902 acres of farmland in 2012, of which 147,133 acres was irrigated. The irrigated acreage was split between 112,313 acres of irrigated cropland and 34,820 acres of irrigated pasture or other irrigated land. The irrigated land in the SESA is used to grow a mix of crops, including alfalfa, grass hay, corn, various grains, and sugar beets. However, alfalfa is the predominant irrigated crop grown in the SESA and accounted for approximately 90% of the area's hay production in 2015 (U.S. Department of Agriculture [USDA] 2016a). In 2014 and 2015, farms growing alfalfa in Big Horn County saw yields of 3.85 tons per acre, whereas farms in Washakie County saw yields of 3.80 tons per acre in 2014 and 4.05 tons per acre in 2015 (USDA 2016b). The value of agricultural land in the two-county SESA, including buildings, was estimated to be approximately $765 million in 2012, corresponding to an average farm value of $915,107 (USDA 2012). The locally assessed value of irrigated agricultural land in the study area was $25 million in 2016 (USDA 2016c). In 2012, the average agricultural production costs in the SESA were $178 per acre and average net farm income was $39,258 per year (USDA 2012).

3.10.2.5 NON-MARKET ECONOMIC VALUES

Many residents in the SESA place a high value on rural landscapes and rural lifestyles. Residents value the open space and rural viewscapes as well as the lifestyles associated with farm and ranch operations, livestock grazing, and abundant recreational opportunities, and prefer land uses that conserve or enhance these values (DOI 2015). Agricultural land in Wyoming is part of a broader cultural landscape that encompasses many of the non-market values that farmers hold in high regard, such as sense of place and purpose (Cross et al. 2011). As a result, farmers in Wyoming develop a sense of attachment to the landscapes that visitors, recreationists, and others may not. These values are not reflected in market prices. Instead, they are reflected in farmers' commitments to the land and the farming lifestyle.

3.10.2.6 OUTDOOR RECREATION

Residents and visitors to the SESA participate in a number of recreational activities, including camping, hunting, hiking, use of OHVs, fishing, boating, flat-water recreation, horseback riding, and birdwatching (BLM 2015d). Recreational fishing is the most important water-based recreational activity in the Bighorn Basin, which constitutes a large portion of the SESA. In 2015, there were 784 jobs pertaining to accommodation, food services, recreation, entertainment, and the arts in the SESA (U.S. Department of Commerce 2017).

3.10.2.7 ENVIRONMENTAL JUSTICE COMMUNITIES

Consideration of environmental justice issues is mandated by Executive Order 12898, which was published on February 11, 1994. This executive order requires that all federal agencies incorporate environmental justice into their mission by "identifying and addressing … disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations, low-income populations, and Indian tribes and allowing all portions of the population a meaningful opportunity to participate in the development of, compliance with, and enforcement of federal laws, regulations and policies affecting human health or the environment regardless of race, color, national origin, or income" (CEQ 1997).

The CEQ defines a community with potential environmental justice populations as one that has a greater percentage of minority or low-income populations than does an identified reference community. Minority populations are those populations having 1) 50% minority population in the affected area, or 2) a meaningfully greater minority population than the reference area (CEQ 1997). The CEQ has not specified what percentage of the population can be characterized as "meaningfully greater" in order to define environmental justice populations. Therefore, for the purposes of this analysis, a conservative approach was used to identify potential environmental justice populations; it is assumed that if the affected area minority and/or poverty status populations are more than 5 percentage points greater than those of the reference area (e.g., the state in which the counties are located), there may be an environmental justice population of concern. Low-income populations were defined as those individuals and families who are considered to be living below poverty levels. For determining the presence of minority and/or low-income communities as environmental justice populations, communities in the analysis area were evaluated against a reference population defined as the state of Wyoming.

Based on the approach just described, the following communities are considered environmental justice communities for this evaluation:

- Greybull, Big Horn County (proportion of minority residents)
- Frannie, Big Horn County (proportion of minority residents and proportion of residents living below the poverty line)
- Lovell, Big Horn County (proportion of minority residents)
- Worland, Washakie County (proportion of minority residents and proportion of residents living below the poverty line)
- Byron, Big Horn County (proportion of residents living below the poverty line)

3.10.3 Methods of Analysis

Socioeconomic effects are discussed in terms of combined effects on the economies of Big Horn and Washakie Counties. The economic effects of the project were estimated using the impact analysis for planning (IMPLAN) regional economic model. The IMPLAN model is an input-output model originally developed by the U.S. Forest Service that uses a mathematical representation of a region's economy to represent the interdependencies between each economic sector in terms of sales, expenditures, and employment over a specific period of time, generally a calendar year (IMPLAN 2016). This structure allows the model to trace a change in demand for goods and services or income in one sector to changes in demand for goods and services and income across every other economic sector. The model does not monetize the costs and benefits of the Proposed Action and action alternatives because the 2016 CEQ guidance states that this is not required under NEPA (CEQ 2016).

3.10.4 Environmental Effects

3.10.4.1 ALTERNATIVE A: NO FEDERAL ACTION

Under the No Federal Action, the proposed reservoir would not be built. There would be no change in irrigation supplies or recreational opportunities from existing conditions. Consequently, the No Federal Action would have no effect on current socioeconomic conditions.

3.10.4.2 ALTERNATIVE B: PROPOSED ACTION

The Proposed Action would create a number of direct, indirect, and induced socioeconomic effects over the short and long term. In the short term, construction activities would create direct effects through the hiring of local and non-local labor and the construction of the proposed reservoir. Construction firms would purchase some goods and services from local businesses, creating indirect effects. As the workers of these firms spend their additional income, they would create induced effects in other segments of the economy.

In the long term, the Proposed Action would create direct effects by making more irrigation water available, leading to enhanced crop yields and greater farm incomes. It would also require annual operations oversight and maintenance. This would increase household income for the employee(s) tasked with fulfilling these duties. As farm households and operations staff spend their additional income, it would create induced effects throughout the economy. The demand for agricultural inputs may also increase for the duration of the proposed reservoir's life, creating additional indirect effects as farms purchase inputs from local businesses that also spend part of their additional revenues in the local economy.

The Proposed Action would also include recreation infrastructure, which would enhance opportunities for flat-water recreation. Increased recreational use of this area could stimulate additional economic activity in the local economy if recreational opportunities supported by the project were to induce new visitation within the SESA.

The effect estimates derived in the following sections are based on reasonable and substantiated assumptions about construction costs, including salaries and benefits paid to workers, interdependencies between economic sectors in the SESA, crop responses to increased water application, crop revenues generated by additional crop yields, and the distribution of agricultural land devoted to different types of crops. Assumptions were validated with local data from the SESA wherever possible to help ensure the effects analysis reflects the best estimates of the potential effects from the Proposed Action.

3.10.4.2.1 Short-Term Effects

Engineering studies have developed three design options for construction (Trihydro 2016a). Direct, indirect, and induced effects for these three construction options are shown in Appendix D. Construction of the proposed project is projected to support between 55 and 60 short-term jobs in the SESA, on average. This comprises the projected 23 direct jobs associated with construction as well as 32 to 37 indirect and induced jobs that would be supported by the local purchases of supplies and materials for construction, household expenditures by the locally hired workers, and local expenditures of non-local workers during the construction period. In addition to the $4.0 to $4.3 million in total compensation anticipated to be paid to local and non-local construction workers and proprietors, construction of the proposed project is estimated to indirectly produce an additional $1.8 to $2.4 million in total labor earnings during the 23-month construction period. Overall, construction of the proposed project is estimated to increase the SESA's economic output by $34.0 to $40.3 million during the 23-month construction period, including direct construction expenditures. The economic effects created by short-term construction activities would also generate additional tax revenues for state and local governments between $1.8 and $2.2 million over the 23-month construction phase of the proposed project.

The construction activities of the Proposed Action are projected to increase the short-term demand for housing by approximately 17 units. This represents approximately 7% of vacant units for rent or sale in the SESA at any given time between 2012 and 2016 (U.S. Census Bureau 2018). Based on the current size of the SESA's housing market and the rental vacancy rate, housing availability and rents in the SESA as a whole would be largely unaffected by the Proposed Action. Rents in some parts of the SESA could increase modestly if workers compete for housing in a single community or small geographic area, but the total effect on the SESA's housing market would be negligible.

The construction activities of the Proposed Action would increase the number of trips made on roads in the SESA. However, given the relatively small size of the construction workforce and the rural location of the proposed reservoir site, effects on roads and road maintenance costs throughout the SESA are likely to be small.

3.10.4.2.2 Long-Term Effects from Operations

Once construction is completed, the proposed project would require operations and maintenance. In total, annual operations and maintenance costs are anticipated to be approximately $76,000 per year during the first 5 years and $45,000 each year thereafter (Trihydro 2016a). These expenditures are expected to support approximately one full-time equivalent local job. The recirculation of the wages paid to the operations and maintenance staff would produce modest ongoing economic activity in the SESA.

3.10.4.2.3 Long-Term Irrigation-Related Effects

The crop output generated by the additional irrigation water is likely to support approximately seven direct, indirect, and induced jobs per year during the operational life of the proposed project. These comprise five direct jobs on local farms and two indirect and induced jobs supported by local purchases of supplies and materials and household expenditures by farm owners and workers. In addition to the $470,000 in additional annual agricultural output expected to be produced in the SESA from the additional water supply, the direct, indirect, and induced economic activity associated with growth in agricultural output is expected to produce about $158,000 in additional annual labor income (see Appendix D).

Overall, the additional irrigation water stored by the proposed project would be expected to increase the SESA's economic output by about $600,000 per year. This total includes the projected $470,000 increase in direct output from higher crop yields as well as additional economic output from recirculation of wages and expenditures. Following the construction of the proposed reservoir, the agricultural sector would contribute approximately $27,000 more to state and local tax revenues each year. The enhanced water supply and greater productivity of farms receiving irrigation supplies under the Proposed Action would lead to a minor increase in property values for those farms.

The agricultural activities related to the Proposed Action are projected to increase the long-term demand for housing in the SESA by approximately five units. Although conditions in the local housing market could have changed since 2016, the last year for which data are available, it seems likely that the SESA could accommodate the increase in long-term housing demand under the Proposed Action without much difficulty.

3.10.4.2.4 Long-Term Recreation-Related Effects

The proposed reservoir would cover approximately 280 acres when full. The proposed reservoir would also have a conservation pool of approximately 1,900 acre-feet. The boat ramp would be designed to access the conservation pool so that the reservoir would be accessible year-round. If irrigators used their full allotment each year, the minimum footprint of the proposed reservoir would be approximately 100 acres and the average footprint throughout the year would be approximately 190 acres. Additionally, construction of the proposed reservoir would include the addition of a boat ramp, picnic facilities, restrooms, trash facilities, parking areas, and access roads. The additional surface area and recreation facilities would provide opportunities for flat-water recreation, including boating and fishing.

The Alkali Creek Reservoir would be small in comparison to other reservoirs in the region, including Bighorn Lake (17,300 acres), Buffalo Bill Reservoir (8,315 acres), Boysen Reservoir (20,000 acres), and Lake De Smet (3,000 acres). Consequently, the proposed reservoir would likely be visited primarily by SESA residents, limiting any economic effects.

It is unclear how the proposed reservoir would affect consumer surplus in the SESA or change the visitation patterns of local recreationists. Recreationists may experience small increases in consumer surplus if recreation opportunities at the reservoir caused local residents to increase the total number of days they spend participating in activities like fishing or boating, or if the new location reduced travel times and out of pocket costs associated with the current number of reservoir-related recreation days. If the reservoir expansion caused the total number of recreation days to remain constant and only resulted in a change in the location where people recreate, there would be no change to consumer surplus.

3.10.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The effects from the Modified Proposed Action would be the same as those discussed for the Proposed Action.

3.10.4.4 ENVIRONMENTAL JUSTICE

As described above, five communities in the SESA could be considered environmental justice communities based on their proportions of minority residents or residents living below the poverty level: Greybull, Frannie, Lovell, Worland, and Byron.

Given the distant geographic location of the communities relative to the proposed reservoir, any adverse, short- or long-term environmental effects from the Proposed Action and Modified Proposed Action would not fall disproportionately on disadvantaged communities in the SESA.

3.10.5 Summary of Effects

Table 3.10-1 presents a summary of the effects to socioeconomics under all alternatives.

Table 3.10-1. Socioeconomic Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would the construction workforce affect the local economy in terms of housing availability, services, transportation, and revenue generation?	Negligible	There would be short-term positive effects on employment, income, and economic output. Negligible or minor short-term negative effects would occur to housing availability, services, and transportation.	Same as the Proposed Action
How would the project affect agricultural productivity and expenses for adjacent landowners?	Negligible	There would be long-term positive effects on employment, income, and economic output. Negligible negative effects would occur to adjacent landowners.	Same as the Proposed Action
How would the project affect property values?	Negligible	There would be a minor positive effect on property values for farms receiving irrigation supply.	Same as the Proposed Action
What would be the economic effects from increased recreation on the local community?	Negligible	There would be a positive effect on resident welfare from improved access to recreation opportunities.	Same as the Proposed Action
Would there be a disproportionate effect on disadvantaged communities?	No effect	No effect	Same as the Proposed Action

3.10.6 Mitigation Measures

No mitigation measures are proposed for socioeconomics.

3.10.7 Unavoidable, Adverse Effects

There would be no unavoidable, adverse effects to socioeconomics.

3.11 Soils

This section describes the effects of the project on soils.

3.11.1 Issues and Indicators

As part of the project's internal and external scoping process, the following soils issues were identified:

- What would be the effects to topsoil from clearing and excavating disturbance areas, and how would that affect mitigation, restoration, and reclamation efforts?
- What would be the effects of building impervious surfaces on soils with erosion and pollution runoff potential near those areas?

In coordination with BLM resource specialists and using the SSURGO Wyoming 603 Soil Survey and the STATSGO U.S. Soil Survey from the Natural Resources Conservation Service (NRCS) (NRCS 2017a, 2017b), the following land use indicators were developed to address these issues:

- Acres of disturbance of highly erodible soils and soils with high runoff potential
- Soil degradation susceptibility, resistance to compaction, and restoration potential

3.11.2 Affected Environment

The analysis area to quantify and describe the soils is the project area with a 0.25-mile buffer. The proposed project area is located within the Northern Intermountain Desertic Basins Major Land Resource Area, which covers approximately 8,910 square miles of north-central Wyoming (NRCS 2006). This area is primarily located within a syncline positioned between anticlinal mountain ranges. The surface is covered with old deposits of sand and gravel washed into the basin by the streams and rivers draining the surrounding mountains. This area supports a variety of shrub-grass vegetation. The soils in this major land resource area are primarily shallow to deep, well-drained loams with a mesic soil temperature regime, an aridic soil moisture regime, and mixed mineralogy.

3.11.3 Methods of Analysis

Seven soil properties are critical to quantifying and evaluating potential effects to soils: hydric soils, prime and unique farmlands, wind erosion, surface runoff, degradation potential, compaction potential, and reclamation potential. Geospatial analysis was conducted to determine temporary and permanent surface disturbance of soils with these properties for each project element.

3.11.4 Environmental Effects

3.11.4.1 ALTERNATIVE A: NO FEDERAL ACTION

Under the No Federal Action, the WWDO would not construct the reservoir and associated facilities; therefore, there would be no adverse effects to soils.

3.11.4.2 ALTERNATIVE B: PROPOSED ACTION

Under the Proposed Action, there would be approximately 603 acres of direct effects to soils. Of these direct effects, approximately 434 acres would be permanent and 169 would be temporary. Temporary and permanent effects could occur in soil types that have limiting factors, such as soil strength or chemistry, and/or sensitive soils that may considerably affect the soil resource.

Effects to soils would be expected from the removal and/or loss of topsoil and vegetation, compaction of the soil surface, wind and water erosion, and general construction activities. Temporary effects to soils would be reclaimed in accordance with the mitigation measures outlined in Section 3.11.6. Table 3.11-1 details the total acres affected by project element as well as how many soil property indicator acres are affected for each project element. There are no prime and unique farmlands in the project area.

Table 3.11-1. Soil Acres under the Proposed Action

Project Element	Total Area Affected (acres)	Soil Properties Affected (acres)					
		High Site Degradation Susceptibility	Low Compaction Resistance	Low Restoration Potential	Hydric	Hydrologic Group D	Wind Erosion Group 3
Permanent							
Access roads	15.4	1.6	1.6	12.1	2.1	6.0	11.8
Dam and reservoir	333.3	1.6	2.1	6.3	1.6	12.9	12.8
Enlargement of supply ditches	7.6	12.0	26.2	235.2	84.4	190.1	205.7
Borrow areas	74.3	0.3	1.1	1.7	1.9	6.1	5.2
Public access area for recreation	3.5	4.3	3.8	26.7	42.4	66.8	12.3
Subtotal	*434.0*	*18.1*	*33.3*	*273.3*	*132.5*	*278.3*	*237.2*
Temporary							
Access roads	16.1	0.03	3.4	5.0	0.7	13.2	11.2
Dam and reservoir	90.9	9.9	14.1	43.0	24.4	77.8	53.1
Enlargement of supply ditches	48.3	2.2	6.7	11.8	9.9	35.5	31.5
Borrow areas	5.9	4.2		4.2	4.2	5.9	5.9
Stream revetment and rock grade control structures	7.8	0.01	5.2	0.01	0.01	7.2	0.3
Subtotal	*168.9*	*16.4*	*29.3*	*64.1*	*39.2*	*139.7*	*102.1*

In general, indirect effects to soils would come from increased erosion from topsoil and vegetation being removed, soils compaction, and other general project construction activities, and would also come from increased vehicular and foot traffic around the reservoir and recreation areas.

3.11.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The Modified Proposed Action consists of the same elements and activities as the Proposed Action with two potential modifications. Changes to permanent and temporary effects to soils for each modification are outline below.

Reducing the length of the auxiliary spillway by approximately 3,375 feet would permanently disturb 34.9 acres less than under the Proposed Action. Acres of temporary disturbance would be the same as the Proposed Action. Table 3.11-2 summarizes the effects. Indirect effects would be the same as under the Proposed Action.

Modifying the reservoir fill time would have the same effects to soils as under the Proposed Action.

Table 3.11-2. Soil Acres Affected under the Modified Proposed Action, Spillway Modification #2

Project Element	Total Area Affected (acres)	Soil Properties Affected (acres)					
		High Site Degradation Susceptibility	Low Compaction Resistance	Low Restoration Potential	Hydric	Hydrologic Group D	Wind Erosion Group 3
Permanent							
Access roads	15.4	1.6	2.1	6.3	1.6	12.9	12.8
Dam and reservoir	298.3	12.0	8.7	206.3	83.0	174.8	174.7
Enlargement of supply ditches	7.6	0.3	1.1	1.7	1.9	6.1	5.2
Borrow areas	74.3	4.3	3.8	26.7	42.4	66.8	12.3
Public access area for recreation	3.5	–	–	3.5	2.3	2.3	1.1
Subtotal	*399.1*	*18.1*	*15.8*	*244.4*	*131.1*	*263.0*	*206.1*
Temporary							
Access roads	16.1	0.03	3.4	5.0	0.7	13.2	11.2
Dam and reservoir	90.9	9.9	14.1	43.0	24.4	77.8	53.1
Enlargement of supply ditches	48.3	2.2	6.7	11.8	9.9	35.5	31.5
Borrow areas	5.9	4.2	–	4.2	4.2	5.9	5.9
Stream revetment and rock grade control structures	7.8	0.01	5.2	0.01	0.01	7.2	0.3
Subtotal	*168.9*	*16.4*	*29.3*	*64.1*	*39.2*	*139.7*	*102.1*

3.11.5 Summary of Effects

Table 3.11-3 presents a summary of the effects to soils under all alternatives.

Table 3.11-3. Soils Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
What would be the effects to topsoil from clearing and excavating disturbance areas, and how would that affect mitigation, restoration, and reclamation efforts?	No effect	The following permanent effects to soil properties may affect mitigation, restoration, or reclamation: High degradation susceptibility: 18.1 acres Low resistance to compaction: 33.3 acres Low restoration potential: 273.3 acres	Reducing the length of the auxiliary spillway would reduce permanent effects to soils with low resistance to compaction by 1.4 acres and effects to soils with low restoration potential by 15.3 acres. Other permanent effects to soils would be the same as the Proposed Action.
What would be the effects of building impervious surfaces on soils with erosion and pollution runoff potential near those areas?	No effect	Impervious surfaces would increase both wind and water runoff. Under the Proposed Action, 278.3 acres of soils with high surface runoff potential (hydrologic Group D) would be permanently affected. In addition, 237.2 acres of soils with low-moderate wind erosion potential (WEG 3) would be permanently affected.	Reducing the length of the auxiliary spillway would reduce permanent effects to soils with high surface runoff potential (hydrologic Group D) by 28.9 acres and effects to soils with low-moderate wind erosion potential (WEG 3) by 31.1 acres less than the Proposed Action.

3.11.6 Mitigation Measures

The following mitigation measures and other best management practices are proposed for soils:

- Topsoil salvaged and protected during reservoir construction plus accumulated sediments in the reservoir bottom would be spread over disturbed areas.
- Disturbed and re-contoured areas would be fertilized (if appropriate based on soil tests), seeded with a BLM-approved seed mix, and mulched in accordance with the draft *Reclamation and Weed Management Plan* (Trihydro 2017a).
- Temporary fencing of the reclaimed reservoir area may be required after seeding to exclude livestock and wildlife and to allow for revegetation success. Once revegetation is achieved, the fence would be completely removed.
- Additional reclamation details can be found in the draft *Reclamation and Weed Management Plan* (Trihydro 2017a), which sets out reclamation performance standards for both interim and final reclamation (e.g., final reclamation success must have 90% of the vegetation consisting of species included in the approved seed mix or desirable species). Reclamation areas would be inspected regularly for general site status, soil erosion, vegetation density and diversity, and weed infestation.

3.11.7 Unavoidable, Adverse Effects

All direct effects to soils would be unavoidable and adverse.

3.12 Transportation

This section discusses temporary and permanent motor vehicle trip generation and corresponding traffic effects during the construction and operation phases of the project on the local roadway network, access, congestion, safety, and road maintenance.

3.12.1 Issues and Indicators

As part of the project's internal and external scoping process, the following transportation issues were identified:

- How would temporary traffic during construction affect local traffic safety and conditions?
- How would increasing recreation opportunities at the reservoir affect traffic safety, access, mobility, and congestion?

In coordination with BLM resource specialists, the following transportation indicators were developed to address these issues:

- The nature and extent of local roadway network and access changes
- Total number of trips generated on a peak day
- Congestion expressed as delay, caused by inadequate capacity or slow-moving vehicles, along primary roads and at key intersections
- Safety and road maintenance conditions presented by new traffic volumes, especially involving heavy and slow-moving vehicles moving through key intersections

3.12.2 Affected Environment

The analysis area for transportation is the local roadway network comprising U.S. Highway 20 (US 20) from Greybull to Worland, WY 31 from Hyattville to Manderson, existing local roads in Manderson (South Sherman Avenue and Railway Street), and unimproved roads south of the reservoir site and north of WY 31. These roadways were selected for their proximity and connectivity to the project area and for their anticipated project-related traffic. Vehicle volumes on US 20, WY 31, and local roads in the analysis area result from typical residential, commercial, industrial, agricultural, and recreational activity in the area. WYDOT reports annual average daily traffic (AADT) volumes on US 20 to be between 2,000 and 6,000 vehicles and fewer than 2,000 vehicles on WY 31. These volumes are lower than roadway design capacity. Intersection controls and features along US 20 are sufficient to handle WY 31 movements. There are no overall safety issues or crash history records of concern. There is, however, a localized safety issue associated with wildlife crossing crashes on US 20 between the two intersections that lead to WY 31 (WYDOT 2017, 2016).

3.12.3 Methods of Analysis

Trip generation and operational factors were based on standard engineering practices and worst-case assumptions. Maintenance implications were estimated based on roadway surface conditions and anticipated traffic volumes and heavy vehicle trips. Initial assumptions were validated through consultation with WYDOT and Big Horn County staff.

3.12.4 Environmental Effects

3.12.4.1 ALTERNATIVE A: NO FEDERAL ACTION

The No Federal Action would not include any roadway network changes or facility improvements, so there would be no changes to travel patterns, mobility, or accessibility. The No Federal Action would not generate additional traffic, so traffic volumes would not change. Incremental, annual increases in traffic and associated congestion caused by new development and other factors would occur over time at rates associated with anticipated local, regional, and statewide growth trends. Traffic safety conditions and rates by accident type would be unaffected because there would be no additional traffic caused by the No Federal Action. No new safety issues would be expected. Pavement on local roads would not be modified or subject to new traffic or loads from heavy vehicles. Road maintenance conditions, trends, and requirements would be similar to existing conditions, and no new influences on repair requirements or schedules would be introduced.

3.12.4.2 ALTERNATIVE B: PROPOSED ACTION

The proposed roadway construction would improve existing roadway network conditions by creating new and improved road segments and by improving public accessibility to the new reservoir and associated recreation facilities. Roadway construction would temporarily disrupt travel on routes currently in use. Traffic volumes on disrupted roadways are low and primarily involve vehicles traveling to and from origins and destinations on private property. Anticipated traffic-control measures during construction would follow applicable engineering design requirements and standards to help ensure private property access and mobility and to provide adequate safety and traffic operations on the roadway network.

The ADT for all temporary construction roads would be fewer than 20 vehicles per day, with most of the traffic consisting of pickup trucks, construction vehicles, and equipment and material transport vehicles. The project's construction-related traffic was added to existing and future estimated AADT to evaluate the project's direct effects on traffic volumes. Also, construction-related trips to and from the project area were distributed over the regional and local roadway network during the construction period, which is anticipated to take approximately 2 years.

No substantive congestion effects would be expected along US 20 or WY 31 or at the existing intersections in Manderson. The number of anticipated construction phase trips would be well below the design capacity of each road and intersection. Left turns at WY 31 construction access intersections, especially by slow-moving construction vehicles, could present minor delays for motorists traveling along WY 31 and corresponding safety issues (Bridges 2018; Merritt 2018).

If construction activities affect ditches along Cold Springs Road or other Big Horn County roads by requiring improvements at bridges and/or crossing and changing the traffic flow or road conditions, then coordination and construction plans would require review and approval by the county (Merritt 2018).

On the primary access road, the ADT after construction is estimated to be fewer than 100 vehicles per day. The ADT on the secondary access road is estimated to be fewer than 10 vehicles per day. Traffic on the primary access road would consist mostly of passenger vehicles, pickup trucks, and passenger vehicles and recreation vehicles with some pulling trailers. Traffic on the secondary access road would consist mostly of pickup trucks and utility vehicles. All the roads would receive year-round use, but traffic is expected to be higher in the summer and fall because these seasons are traditionally considered the peak periods for recreational activity. The combination of maintenance vehicles and recreation vehicles would not create traffic congestion or other issues requiring mitigation measures along the access roads, at WY 31 intersections, along WY 31, or in Manderson even during the peak seasons. The need for and design of temporary and/or permanent intersection controls at the WY 31 intersections should be determined during the final design process and through the WYDOT encroachment permit process.

Construction and operational phase vehicles would incrementally increase the potential for accidents in and near the project area. This effect would be minor and would be addressed by existing roadway design and standard design elements and could be mitigated.

Construction phase traffic would incrementally affect existing pavement and road maintenance. These effects would be minor and temporary (Bridges 2018).

3.12.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The effects from the Modified Proposed Action would be the same as those discussed for the Proposed Action.

3.12.5 Summary of Effects

Table 3.12-1 presents a summary of the effects to transportation under all alternatives.

Table 3.12-1. Transportation Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would temporary traffic during construction affect local traffic safety and conditions?	No effect	There would be a potential increase in safety risks, which could be addressed with temporary and/or permanent intersection controls and safety program. There would be a potential for increased roadway surface maintenance on roads that are not designed for heavy truck travel (minor).	Same as the Proposed Action
How would increasing recreation opportunities at the reservoir affect traffic safety, access, mobility, and congestion?	No effect	There would be potential increased delays for vehicles traveling along WY 31 and if ditches at bridges or crossings are affected; these effects could be addressed with standard practices.	Same as the Proposed Action

3.12.6 Mitigation Measures

The following mitigation measures are proposed for transportation:

- The construction contractor would be required to develop a traffic management plan to limit effects.
- A safety program would be developed that includes driver safety reminders involving on-site and off-site travel, designated travel routes, and recommendations for drivers of large trucks making turns to and from WY 31. Most safety effects would be addressed by roadway improvements and could be addressed with standard and customized construction driver awareness efforts and site-specific construction period intersection control measures, where appropriate. Intersection safety measures could include temporary signing, and traffic control devices at key locations, as well as flaggers in some instances. Risks of collisions with wildlife and livestock would be highlighted in the safety program along with speed limits on individual roadway segments.
- Move primary access road to address WYDOT concerns with sight distance.
- Move proposed pipeline from WY 31 ROW to adjacent land.

3.12.7 Unavoidable, Adverse Effects

There would be no unavoidable, adverse effects to transportation.

3.13 Vegetation

This section describes the effects of the project on vegetation. Woody riparian vegetation is addressed in Section 3.17.

3.13.1 Issues and Indicators

As part of the project's internal and external scoping process, the following noxious weed issue was identified:

- How would construction affect the potential for the introduction or spread of noxious weeds?

In coordination with BLM resource specialists, the following noxious weed indicators were developed to address this issue:

- Acres of soil disturbance (project footprint) and the recorded presence and general abundance of noxious weeds in the project area (noxious weeds are the plant species most likely to be a problem for the project)

Some other issues identified for vegetation are addressed in Section 3.17 Wetlands, including effects from changes in the volume and timing of stream flows to riparian and wetland plant communities along Alkali, Paint Rock, and Medicine Lodge Creeks.

No issues were identified for effects to general vegetation or to threatened, endangered, or sensitive plant species.

3.13.2 Affected Environment

Vegetation cover data for the project area were obtained from the U.S. Geological Survey (USGS) LANDFIRE Data Distribution Site (LANDFIRE 2014). In all, 35 LANDFIRE-Gap Analysis Program land cover types were identified in the analysis area (USGS 2016). Cover types were combined based on similarity of composition, structure, and successional status to form 12 cover types to help characterize the analysis area (Table 3.13-1). Native upland vegetation types, including sagebrush and saltbush, occupy approximately 60% of the analysis area. Wetland and riparian cover types occupy approximately 10%, and are mostly dominated by nonnative species. A more detailed discussion of wetlands and riparian vegetation is provided in Section 3.17. Four cover types resulting from human activity occupy approximately 30% of the analysis area and are agriculture, developed and roads, nonnative grassland, and open water; these types are likely to have the greatest abundance of noxious weeds under existing conditions.

Table 3.13-1. Vegetation Cover Types in the Project Area

Cover Type	Area (acres)	Analysis Area (%)
Big sagebrush shrubland and steppe	389.6	48.3%
Saltbush and greasewood	64.7	8.0%
Native grassland	12.7	1.6%
Aspen forest and woodland	8.0	1.0%
Conifer woodland	7.8	1.0%
Montane/foothill shrub	1.8	0.2%
Barren/sparsely vegetated	3.8	0.5%
Wetland/riparian	78.5	9.7%
Nonnative grassland and steppe	26.0	3.2%
Agriculture	112.5	14.0%

Cover Type	Area (acres)	Analysis Area (%)
Developed and roads	99.9	12.4%
Open water	0.7	0.1%
Total	**806.0**	**100.0%**

The analysis area for noxious and invasive plant species is the project area with a 1-mile buffer, because the species populations in this area are most likely to present a potential problem during and following construction. Information on the occurrence of noxious and invasive plant species in the analysis area was obtained from Big Horn County Weed and Pest Control District (Big Horn County Weed and Pest Control District 2018). The district is the agency lead for management of weeds in Big Horn County and has conducted numerous weed surveys and treatment activities in the analysis area. The data provided for the project include nearly 2,500 records, including location and size of weed occurrences by species. A list of weeds and invasive species in the analysis area is provided in Table 3.13-2. Thirteen noxious weed species observed in the analysis area are listed by the State of Wyoming (designated), and two are listed by Big Horn County (declared). Data points from the Big Horn County Weed and Pest Control District are mostly along roads or near Paint Rock Creek east of Hyattville and do not cover much of the analysis area, including the proposed reservoir and embankment, Alkali Creek, Anita Ditch, and Anita Supplemental Ditch. Additional noxious weeds are likely present in the analysis area on private lands not covered by county weed management activities. Some observations of noxious weeds were recorded for Alkali Creek and the ditches during the Trihydro aquatic resources inventory (Trihydro 2018a) and are also included in Table 3.13-2.

Table 3.13-2. Noxious Weeds and Invasive Plants in the Analysis Area

Common Name	Scientific Name	Wyoming Weed Status	Relative Abundance and Distribution in the Analysis Area	Reported Area (acres)
Canada thistle	*Cirsium arvense*	Designated	Common along roads and along some parts of Alkali Creek and Anita Ditch	13.0
Common burdock	*Arctium minus*	Designated	Common	3.1
Field bindweed	*Convolvulus arvensis*	Designated	Common along roadsides	5.7
Houndstongue	*Cynoglossum officinale*	Designated	Very common near Paint Rock Creek	22.8
Japanese knotweed	*Fallopia japonica*	Declared	Rare, two records	0.1
Leafy spurge	*Euphorbia esula*	Designated	Uncommon	0.3
Musk thistle	*Carduus nutans*	Designated	Uncommon along roads	0.3
Perennial sowthistle	*Sonchus arvensis*	Designated	Rare, two records	> 0.1
Puncturevine	*Tribulus terrestris*	Declared	Somewhat rare, seven records	0.2
Purple loosestrife	*Lythrum salicaria*	Designated	Rare, three records	0.2
Russian knapweed	*Centaurea repens*	Designated	Uncommon	1.6
Russian olive	*Elaeagnus angustifolia*	Designated	Uncommon, present along Alkali Creek	0.5
Saltcedar	*Tamarix* spp.	Designated	Rare, three records Also present along portions of Alkali Creek and Anita Ditch	0.4
Spotted knapweed	*Centaurea maculosa*	Designated	Uncommon	0.1
Hoary cress (whitetop)	*Cardaria draba* and *Cardaria pubescens*	Designated	Very common, especially near Paint Rock Creek	51.1

Sources: Big Horn County Weed and Pest Control District (2018), Trihydro (2018a), Wyoming Weed and Pest Council (2017a, 2017b)

No known threatened, endangered, or sensitive plant species are in the project area. A survey for the federally threatened Ute ladies'-tresses was conducted in 2017 in the project area (Trihydro 2017a) and again in 2018 (Trihydro 2018e). No individuals or populations of this species were found during these two surveys. Most of the project area has very low potential for Ute ladies'-tresses habitat based on the presence of clayey soils, disturbed areas along the ditches, steep banks in most areas, and dense stands of reed canary grass and cattails. Ute ladies'-tresses is not known to occur along the creeks and rivers downstream of the project area.

3.13.3 Methods of Analysis

Potential effects from noxious weeds were assessed qualitatively using GIS overlay of noxious weed data points within project disturbance area and buffer, and project weed management plan (Trihydro 2017b). The weed management plan was reviewed to assess adequacy.

3.13.4 Environmental Effects

3.13.4.1 ALTERNATIVE A: NO FEDERAL ACTION

The No Federal Action does not involve any construction, and existing noxious weed control activities would continue.

3.13.4.2 ALTERNATIVE B: PROPOSED ACTION

Potential effects under the Proposed Action would include the introduction or spread of noxious or invasive plant species as a result of construction activities or operational procedures. Construction may contribute to the spread of noxious weeds in several ways, including removal of existing vegetation cover, movement of seeds and propagules during grading and earth moving, potential import of noxious weed seeds or other propagules by vehicles and construction equipment travelling from areas that contain invasive species, seeding of disturbed areas by airborne seeds from nearby established populations, or the import of construction materials that may contain weed seeds. Operation of the reservoir may also provide favorable conditions for establishment of some species, including saltcedar and Russian olive. A number of noxious weed species are already established in the analysis area (see Table 3.13.2), and these are the species most likely to spread under the Proposed Action.

The WWDO has provided a draft *Reclamation and Weed Management Plan* (Trihydro 2017b). An integrated weed management approach would be used, including planning, prevention and education, treatment, monitoring, and reporting. Proposed management activities would be consistent with BLM invasive and noxious weed management policies and procedures and with the Big Horn County Weed and Pest Control District, the lead agency for weed management in Big Horn County. Before using pesticides, an approved pesticide use proposal would be completed and submitted to the state by a Wyoming licensed applicator. Weed management planning would be conducted on an annual basis. With implementation of the weed management plan, effects from noxious weeds and invasive species are expected to be minor.

3.13.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

Effects to vegetation would generally be the same as those under the Proposed Action, although the amount of ground disturbance would be decreased under Spillway Modification #2. Potential effects from noxious weeds would be controlled under the weed management plan, and effects would be minor.

3.13.5 Summary of Effects

Table 3.13-3 presents a summary of the effects to vegetation under all alternatives.

Table 3.13-3. Vegetation Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would construction affect the potential for the introduction or spread of noxious weeds?	No new construction disturbance would occur, and existing weed management activities would continue. No additional effects would occur.	New construction disturbance would result in greatly increased chances for spread of noxious weeds. Weed management would be done under a project-specific weed management plan. Increased weed management activities would occur. Effects would be minor.	Same as the Proposed Action

3.13.6 Mitigation Measures

The following mitigation measures are proposed for vegetation resources:

- The WWDO has committed to implementing noxious weed management and has provided a draft weed management plan.
- BLM requires provisions for invasive species management for all BLM-authorized actions. BLM Wyoming Reclamation Policy (IM WY-2012-032) requires the following for all surface-disturbing activities: assessment of the area for invasive plants before initiating the activity, development of an invasive plant management plan, control of invasive plants using an integrated weed management approach, and monitoring of treatments (BLM 2012b). BLM requirements for weed management would not apply to private lands; here, weed management would need to comply with landowners' desires and Wyoming Weed and Pest Control Act requirements.

3.13.7 Unavoidable, Adverse Effects

The project would unavoidably create favorable conditions for the introduction and spread of noxious weeds, which would require an increased level of noxious weed management activities in order to avoid or minimize adverse effects.

3.14 Visual Resources

This section describes the effects of the project on visual resources. This section also includes a visual characterization of the existing aesthetic conditions of the landscape. The BLM's visual resource management (VRM) guidance (BLM H-8410-1 [BLM 1986]) is used as a basis for analysis for all landscapes, regardless of jurisdiction.

3.14.1 Issues and Indicators

As part of the project's internal and external scoping process, the following visual resources issues were identified:

- How would surface-disturbing activities and the construction of the embankments and associated facilities affect the viewshed, including the viewshed of the Red Gulch/Alkali National Backcountry Byway?
- Would the project exceed the management objectives for VRM classes?

In coordination with BLM resource specialists, the following visual resources indicators were developed to address these issues:

- Visual contrasts that may exceed existing VRM class management objectives (Table 3.14-1) for areas of the project area that occur on BLM land
- Qualitative discussion of visual contrasts on private land

3.14.2 Affected Environment

The analysis area for visual resources is the project area with an approximately 5-mile buffer, determined through the application of visibility mapping and field reconnaissance. These views were identified based on the potential visibility of the project and to inform the assessment of effects on the viewing public as a result of the project. The temporal analysis period includes the anticipated 75-year life of the project.

BLM developed the VRM class system to establish the desired future conditions of visual resources (see Table 3.14-1). Within the visual resources analysis area, 45,127 acres is classified as Class II, 5,855 acres is classified as Class III, and 40,468 acres is classified as Class IV (Figure 3.14.1).

Table 3.14-1. Visual Resource Management Classes and Objectives in the Analysis Area

VRM Class	Management Objectives
Class II	To retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III	To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV	To provide for management activities which require major modification of the existing character of the landscape: The level of change to the characteristic landscape can be high. Management activities may dominate the view and may be the major focus of viewer attention. However, the effect of these activities should be minimized through careful siting, minimal disturbance, and repeating the basic elements of form, line, color, and texture within the existing setting.

Source: BLM (1986)

The Alkali Creek drainage and its irrigated farmland offer a distinct change in visual appearance from the surrounding badlands. The developed landscape in this area is generally rural, low-density residential and agricultural lands, surrounded by large swaths of undeveloped, open shortgrass uplands. The lower drainage area is primarily flat farm fields bisected by lush riparian vegetation along Alkali Creek, surrounded by shortgrass foothills with unvegetated rocky areas. The middle Alkali Creek drainage is rolling shortgrass foothills transitioning to more rugged uplands, bisected by incised, meandering drainage channels of Alkali Creek. The upper drainage of Alkali Creek transitions back to irrigated farmland surrounded by rolling shortgrass foothills, though the Alkali Creek channel is more incised and riparian vegetation less lush than the lower drainage.

The BLM visited the project area on March 30, 2018, to identify existing visual and aesthetic conditions, as well as to identify sensitive viewing locations from which the project may be visible. Eight key observation points (KOPs) were initially identified. During this site visit, the project area was viewed from these eight KOPs on various public roads to develop an overall assessment of the existing landscape character and viewing conditions of the project area (Figure 3.14-2). After the site visit and follow-up analysis, it was determined that portions of the project would be visible from three of the eight KOPs. KOPs 1, 5, and 7 capture the views of the primary affected viewers in the project area, that is, drivers along the Red Gulch/Alkali National Backcountry Byway and WY 31. These three KOPs are described below.

KOP 1 WY 31: This KOP is located on WY 31 near the southwestern-most “corner” of the project area. Its view is to the northeast where the reservoir would be constructed and where the proposed access road would intersect the north side of WY 31. The topography includes the highway, powerline, sloped rangelands, agricultural fields, and grassy hillsides/mesas. Sparse vegetation is mottled along fencerows and ditches paralleling the highway. The background view is of the distant Bighorn Mountains and the Hyattville Valley to the east. Some structures are visible, including ranch barns, outbuildings, and homes. Dominant colors for the landscape are tans and browns, with darker greens shading the agricultural fields and distant mountains. Viewers include local residents, tourists, and travelers, and viewer concern is generally low due to the high rate of speed of those travelling on the highway.

KOP 5 WY 31 Below Proposed Dam: This KOP is located along WY 31, approximately 0.3 miles south of the proposed dam, and the view is to the north toward the proposed dam. The topography, background, viewers, and level of viewer concern are similar to that described for KOP 1. Dominant colors are greens and browns with varying textures of fine, medium, and coarse. Numerous structures are visible, including ranch barns, outbuildings, and homes.

KOP 7 Red Gulch/Alkali National Backcountry Byway: This KOP is located along the Red Gulch/Alkali National Backcountry Byway near a turnoff onto a private drive leading to a residence. The view is to the southwest where the north end of the reservoir would be located. The topography includes the dirt road, agricultural fields, and sloped and flat rangelands. The background is of hillsides/mesas west and east of the proposed reservoir. Dominant colors for the landscape are greens and browns, with white shading on the mesas. Numerous structures are visible. Viewers include local residents, tourists, and travelers, and viewer concern is generally moderate because of the location of this KOP along a backcountry byway, moderate rate of speed of travel, and the moderate duration the project area would be in view.

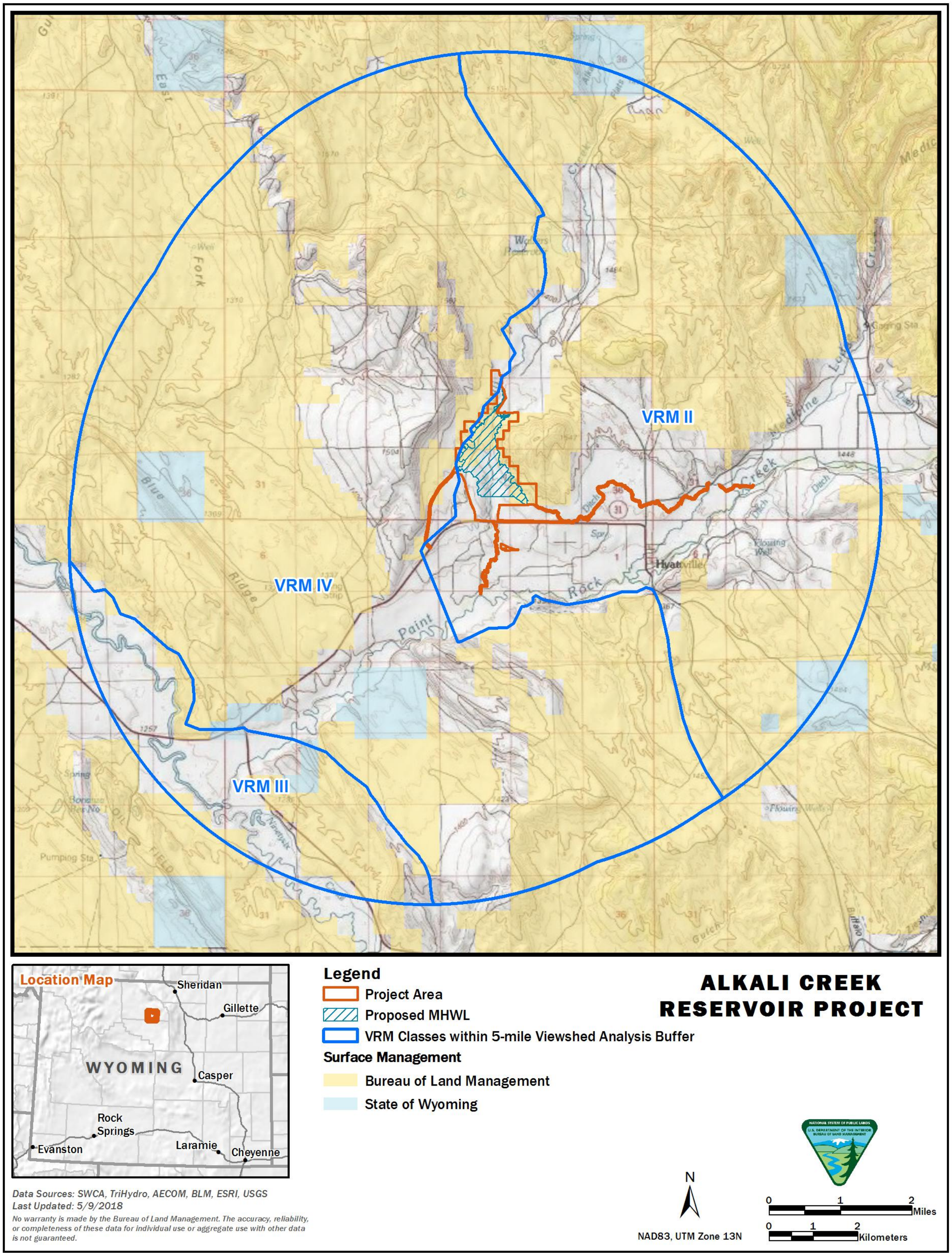

Figure 3.14-1. Visual resources management classes in the visual resources analysis area.

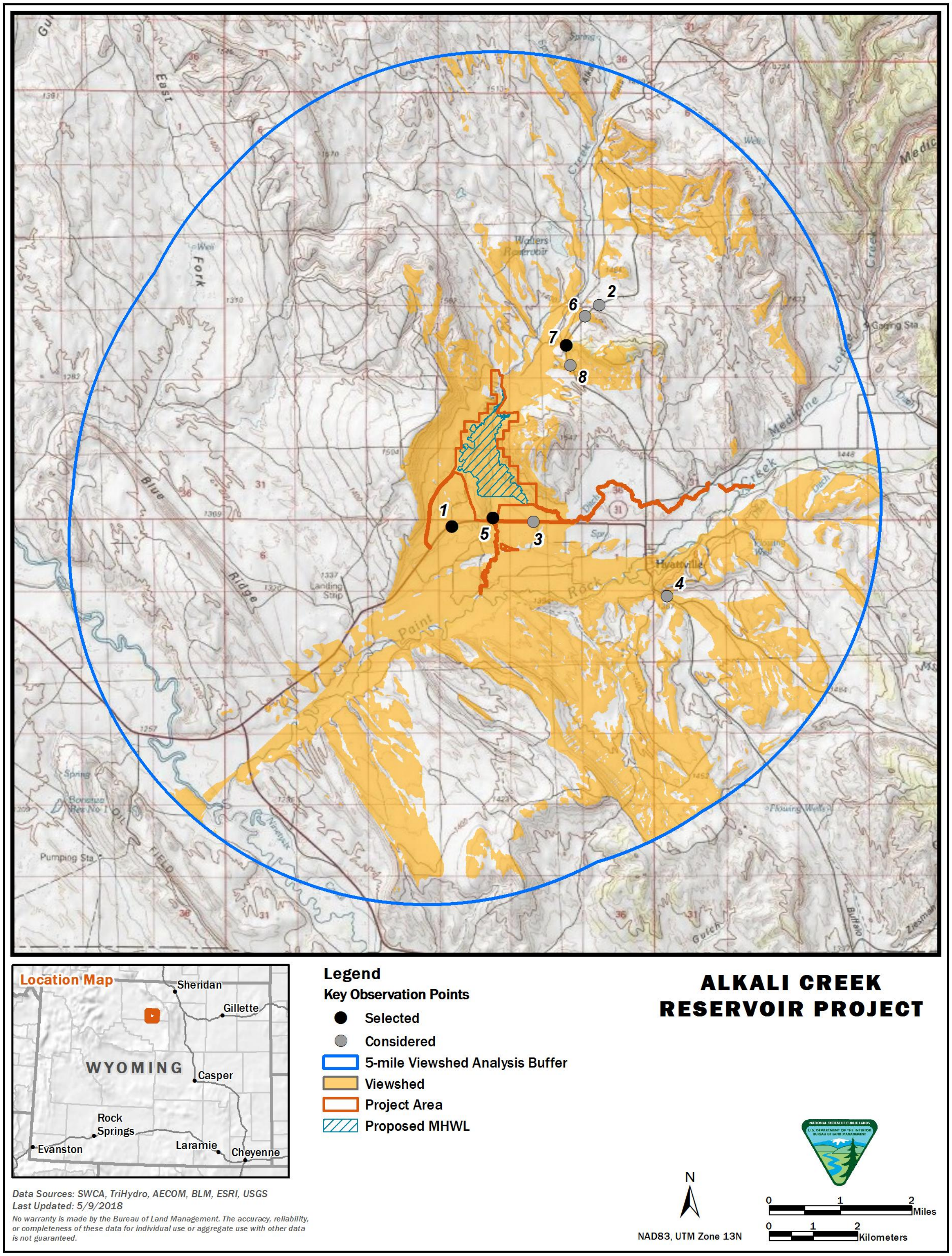

Figure 3.14-2. Key observation points and viewshed analysis within the visual resources analysis area.

3.14.3 Methods of Analysis

The analysis is based on observations made during the site visit and the potential changes to the existing visual resources that may result from construction and operation of the project. At each KOP, the existing landscape was further characterized for aesthetic-contributing factors. In addition, the analysis included a review of available technical data, maps, aerial imagery, and ground-level photographs. The analysis is focused on the evaluation of KOPs (depicted on Figure 3.14-2), from which project elements may be visible. VRM analysis involves determining if the visual effects of the project elements would meet the management objectives established for the project area in the WFO RMP (BLM 2015a). The BLM has established a visual contrast rating process to complete this analysis. Visual resource specialists evaluated the degree of visual contrasts from each KOP, based on the form, line, color, and texture changes between the existing landscapes and how the landscapes would look after implementation of the proposed project.

In addition to the KOP evaluations, the visual impact analysis is based on an evaluation of the anticipated changes to existing visual resources that would result from short-term construction and long-term operation of the project. These changes were assessed, in part, by comparing the existing views from the three KOPs to visual simulations illustrating views of the project from each KOP. This “before” and “after” approach illustrates the potential visual changes or level of contrast that would occur with implementation of the project. Baseline (before-project) photographs were taken with a digital single-lens reflex camera and a “normal” 50-millimeter-equivalent lens that represents a horizontal view angle of approximately 50 degrees and approximates the relative magnification that the human eye would see. The simulation methods employ systematic computer modeling and rendering techniques. Digital aerial photographs and information about the project design provided the basis for developing a three-dimensional (3D) computer wireframe model of the dam, channel, access roads, facilities, and reservoir. For each simulation, viewer location was input from GPS data collected on-site. The 3D model was then superimposed on the digital photograph to verify scale and viewpoint location. Digital visual simulation images were then produced based on computer renderings of the 3D model combined with digital versions of the selected site photographs.

Visual effects were also assessed using a viewshed analysis. A viewshed analysis displays whether or not the project might be visible from surrounding terrain using a line-of-sight analysis. It should be noted that *visible* in this context means that under clear-sky conditions and conditions during daylight hours, a casual viewer may be able to see the project if the viewer chooses to focus on the project. *Visible* does not discern the degree of contrast the project would impose upon the view, nor does it imply that a casual viewer would automatically notice the project. Accordingly, the farther a viewer is located from the project, the more difficult it would be for them to discern the project from the existing landscape. The ability of the viewer to discern the project from the existing landscape is indicative of the degree of contrast or change that would result from implementation. The degree of visual change allowed on BLM land is determined by VRM classifications; change that would exceed that allowed under management objectives for each class would require a change in VRM classification for the affected area.

3.14.4 Environmental Effects

3.14.4.1 ALTERNATIVE A: NO FEDERAL ACTION

Under the No Federal Action, the BLM would not issue permission to the WWDO for the construction of the reservoir and associated facilities; therefore, there would be no short- or long-term effects to visual resources as a result of the project. No project-related effects to visual resources would occur, and visual resource conditions would remain unaffected by the proposed project. Visual resources would continue to be affected by current actions and activities in the analysis area.

3.14.4.2 ALTERNATIVE B: PROPOSED ACTION

The portion of the project area that occurs on BLM land falls in a mixture of VRM Classes II and IV. The Class II areas consist primarily of irrigated farmlands, the Alkali Creek corridor, and rugged uplands to the south and east. The Class IV areas are west of Alkali Creek. The potential areas of disturbance and visual change located on BLM lands occur largely within the VRM Class II areas (197.17 acres); only a portion of an access road falls within Class IV areas (6.45 acres). Under Class IV, changes to the characteristic landscape are permitted and may be major. Under Class II, changes are also permitted and must be low; however, the WFO RMP 5048 HR:7 states the following: "allow surface-disturbing activities in areas managed as VRM Class II only if the level of change to the landscape from the activities are low, and will not attract the attention of the casual observer, or the project can be mitigated to meet these objectives" (BLM 2015a:101). Overall, the visual changes on BLM land associated with the project are not anticipated to exceed the management objectives for VRM Classes II or IV because best management practices for visual resources, as specified in the WFO RMP, would be followed. The WFO RMP specifies that actions within Class II areas that may cause visual change but do not attract the attention of the casual user are allowable changes to the characteristic landscape. As described in detail below, the changes to Class II areas are not anticipated to dominate or attract the attention of a casual observer.

Short-term construction-related visual effects to KOPs 1 and 5 could occur with the presence of equipment, materials, and work crews in the project area, including excavation, heavy machinery use, downstream improvements, and construction of temporary and permanent access roads, the embankment, ancillary features, and berms. Most of the construction-related disturbance would occur on private land, and therefore construction-related visual effects are not subject to conformance with VRM class management objectives. Of the 203.62 acres of disturbance that would occur on BLM land, 197.17 acres occurs in VRM Class II and 6.45 acres occurs in VRM Class IV. Most of the visual contrast that would occur in VRM Class II areas would be from the reservoir itself (120.02 acres). Construction activities would be moderately visible to the public using WY 31 and some local residents for the duration of construction (between 1 and 2 years). At KOPs 1 and 5, because viewers would be travelling fast along WY 31, the construction-related disturbance would likely attract the attention of a casual viewer for a short time. Construction-related visual effects would not be visible from KOP 7.

Operation-related visual effects could occur with the presence of the proposed reservoir and ancillary facilities at all three KOPs. The main embankment (1.82 acres on VRM Class II) would be the project element that would provide the most visual contrast with the surrounding landscape, but would not be visible from KOP 7. From KOP 1, the main embankment would create very little visual contrast with the surrounding landscape (see Figure 3.14-3, KOP 1 simulation). At KOP 5, the main embankment, outlet works, access roads, and perimeter fence would be visible for a few seconds to highway travelers because viewers would be moving quickly along the road, and project elements would not be likely to attract the attention of a casual traveler below the main embankment (see Figure 3.14-4, KOP 5 simulation). The main embankment would repeat the form and line of the surrounding hillsides visible from KOPs 1 and 5 and would be vegetated to match the surrounding vegetative cover, minimizing the level of visual contrast. The reservoir would be somewhat visible from KOP 7 and would appear as a lake with no facilities visible; the visual change would be restricted to the upper end of the reservoir where rolling hills and the Alkali Creek drainage are currently present (see Figure 3.14-5, KOP 7 simulation). Overall, the presence of a reservoir, embankments, facilities, access roads, and perimeter fence would create a visual contrast with the landscape. However, because of the combination of generally low viewer concern and application of best management practices described in the WFO RMP (BLM 2015a), the presence of these project elements would not result in an adverse viewshed effect, nor would it exceed the visual management objectives of Class II or IV.

Figure 3.14-3. Key observation point 1 showing existing (top) and simulation (bottom).

Figure 3.14-4. Key observation point 5 showing existing (top) and simulation (bottom).

Figure 3.14-5. Key observation point 7 showing existing (top) and simulation (bottom).

3.14.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

The effects from the Modified Proposed Action would be the same as those discussed for the Proposed Action.

3.14.5 Summary of Effects

Table 3.14-2 presents a summary of the effects to visual resources under all alternatives.

Table 3.14-2. Visual Resources Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would surface-disturbing activities and the construction of the embankments and associated facilities affect the viewshed, including the viewshed of the Red Gulch/Alkali National Backcountry Byway?	No effect	When viewed from the selected KOPs, surface disturbance from construction of the main embankment, outlet works, access roads, and perimeter fence would be visible but would be consistent with the surrounding landscape, and the views from the KOPs would only last for a few seconds to travelers, and would not be likely to attract the attention of a casual traveler. The viewshed looking toward the proposed reservoir from the Red Gulch/Alkali National Backcountry Byway would not attract the attention of the casual observer (see Figure 3.14-5).	Same as the Proposed Action
Would the project exceed the management objectives for VRM classes?	No effect	The Proposed Action would be consistent with VRM management objectives of the WFO RMP.	Same as the Proposed Action

3.14.6 Mitigation Measures

Effects to visual resources would be avoided and/or minimized by following applicable recommended best management practices for visual resources in the WFO RMP (BLM 2015a:C.4.7).

3.14.7 Unavoidable, Adverse Effects

The visual effect the construction of the dam would have upon the landscape would be unavoidable and adverse.

The relatively open and unobstructed view from WY 31 north to the proposed reservoir (i.e., KOP 5) would preclude topographic screening of the dam, and the height (approximately 100 feet) and width (approximately 2,500 feet) are not likely to be hidden with any vegetation screening. The new access roads would probably remain visible from superior views (e.g., adjacent hilltops and ridgetops) because of the color contrasts created by exposed soil, loss of vegetation, and/or gravel surfacing.

3.15 Water Resources

This section discusses the effects from the project to water resources, which comprise surface water, stream morphology and sedimentation, groundwater, and water quality.

3.15.1 Issues and Indicators

3.15.1.1 SURFACE WATER

As part of the project's internal and external scoping process, the following surface water–related issues were identified:

- Would an increased surface water area from the reservoir affect local water resources?
- How would the project affect stream flows for Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek?

In coordination with BLM resource specialists, the following surface water–related indicators were developed to address these issues:

- Changes in surface water area
- Changes in stream flow

3.15.1.2 STREAM MORPHOLOGY AND SEDIMENTATION

As part of the project's internal and external scoping process, the following stream morphology and sedimentation–related issues were identified:

- How would changes in stream flow and in-channel structures affect stream morphology and channel stability, including changes to sediment transport?
- How would altering the ditches affect erosion potential and sediment transport in Paint Rock Creek and Medicine Lodge Creek?
- How would the dam affect sediment loads downstream of the reservoir?
- How would the dam affect sediment deposition on Alkali Creek upstream of the reservoir?

In coordination with BLM resource specialists, the following stream morphology and sedimentation–related indicators were developed to address these issues:

- Changes in flow (duration, magnitude, frequency) relative to dominant discharge (percentage in change in flow)
- Qualitative assessment of changes to sediment supply and transport capacity related to flow alterations and structures
- Changes to morphological form as described by channel evolution models
- Examination of impoundment effects to Alkali Creek

3.15.1.3 WATER QUALITY

As part of the project's internal and external scoping process, the following water quality–related issues were identified:

- How would surface disturbances affect water quality?
- How would normal releases from the reservoir affect downstream water quality?
- How would maintenance of sediment deposition behind structures affect water quality?
- What would the potential be for leaching of sulfate, salts, fertilizer, and pesticides into reservoir water, and what would be the potential short-term and long-term risks to water quality and human health?
- Would water quality meet standards for recreational purposes?
- Would the source water quality be affected?
- Would the project affect water treatment providers?
- Would the project affect source water protection areas?
- What is the potential for increased bank erosion leading to an increase in *Escherichia coli* (*E. coli*) downstream?

In coordination with BLM resource specialists, the following water quality–related indicators were developed to address these issues:

- Surface-water turbidity, specific conductance, and temperature compared to recreational water quality standards
- Surface water sulfate, dissolved gases, total dissolved solids (TDSs), fertilizer, pesticides, and *E. coli* concentrations compared to recreational water quality standards
- Water quality of the reservoir's source water
- Amount of surface water use for municipal drinking water supply
- Water quality of nearby source water protection areas

3.15.1.4 GROUNDWATER

As part of the project's internal and external scoping process, the following groundwater-related issue was identified:

- Would inundation affect groundwater volume, storage, flow, or quality?

In coordination with BLM resource specialists, the following groundwater-related indicators were developed to address this issue:

- Increase in recharge rates and storage
- Alteration of local and regional groundwater flow paths
- Influence on groundwater quality and use suitability

3.15.2 Affected Environment

3.15.2.1 SURFACE WATER

The analysis area for surface water comprises the following stream reaches in the Alkali Creek Reservoir service area: Paint Rock Creek and its tributaries Medicine Lodge Creek and Alkali Creek upstream to the point where irrigation diversions end, the Nowood River below the confluence with Paint Rock Creek downstream to the confluence with the Bighorn River, and the unnamed drainage used for the auxiliary spillway. This area was selected because this is the area served by the reservoir and where anticipated stream flow changes would occur. Potential change to stream flow in the Bighorn River ranges from a 2% increase on average in October and November to a 4% decrease on average in July. This flow change is considered small, and therefore the Bighorn River was not included in the analysis area.

Currently, no human-made water impoundments exist in the analysis area other than irrigation diversion structures, which are estimated to total less than 2 acres of surface area and account for less than 5 acre-feet of evaporation annually. Currently, on average, 18,400 acre-feet of surface water is consumptively used by crops in the analysis area annually.

Currently, stream flow in the analysis area is largely influenced by irrigation diversions and return flows. Natural stream flow is reduced from April through September because of irrigation diversions and is increased from October through March because of the lagging return of non-consumed irrigation water. Baseline stream flow data for the analysis area are provided in Appendix E. Baseline median stream flow is summarized in Table 3.15-1. Baseline stream flow data reflect current conditions in the analysis area. There is 3,150 acres of potentially irrigable permitted lands in the analysis area that are currently idle. All, some, or none of these lands could go into production in the future independent of the Proposed Action, which could change baseline conditions.

Table 3.15-1. Median Stream Flow in the Analysis Area (cfs)

Point Location	Water Year Type	January	February	March	April	May	June	July	August	September	October	November	December
Medicine Lodge Creek downstream of Anita Ditch	Wet	12	12	11	8	51	173	45	4	13	21	20	16
	Normal	12	12	10	9	61	99	8	3	8	20	20	16
	Dry	13	12	11	11	54	28	3	2	9	15	18	16
Paint Rock Creek downstream of Anita Supplemental Ditch	Wet	21	20	18	25	292	827	393	65	63	49	37	28
	Normal	21	19	18	26	305	576	157	46	44	43	36	28
	Dry	21	19	18	16	255	233	75	29	17	28	32	27
Alkali Creek downstream of Alkali Creek Reservoir	Wet	3	2	1	17	2	2	3	5	9	9	8	5
	Normal	3	2	1	16	2	3	4	6	11	8	8	5
	Dry	3	2	1	16	3	4	5	7	14	9	8	5

Point Location	Water Year Type	January	February	March	April	May	June	July	August	September	October	November	December
Paint Rock Creek upstream of Alkali Creek confluence	Wet	38	35	30	32	343	990	432	78	89	87	71	53
	Normal	38	34	30	35	369	703	168	56	72	79	71	52
	Dry	40	33	30	23	301	260	82	39	38	62	64	52
Paint Rock Creek downstream of Alkali Creek confluence	Wet	42	37	31	50	346	994	438	85	103	100	81	58
	Normal	42	37	31	50	375	708	175	65	86	89	79	57
	Dry	43	36	31	42	307	268	90	51	55	74	75	58
Paint Rock Creek at confluence with Nowood River	Wet	29	33	32	71	276	770	254	46	54	100	76	45
	Normal	32	32	31	64	304	642	106	30	45	78	72	45
	Dry	35	31	32	53	298	239	58	21	46	62	74	47
Nowood River at confluence with Bighorn River	Wet	172	189	471	396	926	1,571	502	88	144	271	232	182
	Normal	176	188	470	399	1,020	1,312	205	51	133	226	222	186
	Dry	184	185	468	411	1,008	470	115	30	121	179	214	189

3.15.2.2 STREAM MORPHOLOGY AND SEDIMENTATION

The analysis area for stream morphology and sedimentation comprises the following stream reaches: Medicine Lodge Creek from the Anita diversion to the confluence with Paint Rock Creek (2.5 miles), Paint Rock Creek from the Anita Supplemental Ditch diversion to the confluence with Alkali Creek (6 miles) and from the confluence with Alkali Creek down to the confluence with the Nowood River (7.7 miles), Alkali Creek within the impoundment footprint (2.1 miles) down to the confluence with Paint Rock Creek (2.3 miles), and the Nowood River from the confluence with Paint Rock Creek down to the confluence with the Bighorn River (25.2 miles). This analysis area was selected because this is the area where anticipated stream flow changes would occur.

Paint Rock and Medicine Lodge Creeks are perennial, alluvial riverine systems that are in transitional form as they enter the project area. These stream systems are characterized as Rosgen Cb-type channels (Anderson 2010; Rosgen 1994) because they transition from the steeper and relatively tight v-shaped valleys before entering the broader, unconfined valley floor near Hyattville. The valley floor consists of alluvium, where the channels cut through unconsolidated deposits of sand, gravel, and cobbles that have been transported to, and deposited on, the valley floor and floodplain through fluvial processes. The upper basin geology is predominately the Tensleep Formation. Sediment supply is driven from 1) upstream loading supplied to the system from the colluvium slopes, and 2) within the channels themselves. Proper functioning condition (PFC) surveys are limited temporally and spatially; however, both Medicine Lodge and Paint Rock Creek are in good PFC condition and appear to be stable within the surveyed segments of the upper watershed (Anderson 2010).

In contrast, further downstream in the watershed, approximately 7 miles upstream of the confluence with Paint Rock Creek, a geomorphic investigation of Medicine Lodge Creek at the Wildlife Habitat Management Area (WHMA) indicated the lower segment is functioning at risk. A Rapid Geomorphic Assessment Index score of the analysis area ranged between 0.25 and 0.42, which indicates the reach is in transition with instability dominated by aggradation and slight channel widening (WGFD and 5 Smooth Stones Restoration 2017). Channel surveys indicated that most of the WHMA reach is an over-wide C4-type, with some more stable B4c segments, and other segments highly unstable that have transitioned to a wide and entrenched channel, a Rosgen F4-type. Anthropogenic effects associated with channelization coupled with stream flow reductions are the main issues contributing to channel instabilities. Monthly background median stream flows in this reach are estimated to be reduced by 28% in April, 19% in May, and 19% in June from current irrigation withdrawals (Wenck 2018). The average, annual, natural, background peak stream flow is estimated to be reduced by 20% (Wenck 2018). Sediment loading is estimated to be 2,458 tons per year from streambank erosion, whereas natural conditions are estimated to be 135 tons per year (WGFD and 5 Smooth Stones Restoration 2017). Accelerated streambank erosion is attributed to aggradation, where point bars have built up sediments and constricted the channel to flow toward the opposite bank causing lateral migration and significant bank erosion. Medicine Lodge Creek has a sinuosity of 1.4 and a slope of 0.0123 feet per feet.

Paint Rock is flanked by gravel fan deposits and by sandstone formations (Morrison, Frontier) as it enters the project limits with an average sinuosity of 1.2 and a slope of 0.0164 feet per feet (Anderson 2010). Monthly background median stream flows are estimated to be reduced by 28% in April, 12% in May, and 9% in June upstream of the Anita Supplemental Ditch (Wenck 2018). The average, annual, natural, background peak stream flow is estimated to be reduced by 9% (Wenck 2018). These existing water withdrawals have likely affected stream morphology with aggradation issues similar to observed effects in the Medicine Lodge WHMA reaches. Historical aerials show evident point bar growth between 1994 and 2014. Effects are less pronounced than Medicine Lodge because Paint Rock Creek has less of a reduction to natural peak stream flows and there are fewer agricultural encroachments leaving a more robust riparian corridor. Downstream of the Anita Supplemental Ditch, the valley slope decreases (0.0049 feet per feet), and the channel dissipates energy by meander form, eroding sediments from one location and depositing them at another location in a balanced process of degradation and aggradation that serves as natural grade control. Paint Rock Creek becomes a Rosgen C-type channel, which has a high risk for instability associated with impacts caused from a reduction in stream flows. The floodplain is relatively unconfined, and the channel has a high sinuosity of 1.5. The alluvial channel appears to be stable, with localized degradations occurring at channelized segments for bridge alignments, and bank erosion areas where the channel has cut into agricultural lands that lack sufficient riparian vegetation.

The Nowood River is classified as a meandering alluvial channel, a Rosgen C-type for most of its extent, with some locations where entrenchment ratios indicate the channel is trending toward an F-type channel and incised floodplain (Anderson 2010). Throughout most of its extent, the Nowood River appears to have access to its floodplain on at least one of its banks. Sinuosity within the middle to lower reaches ranges from 1.7 to 2.2. A detailed geomorphic investigation of the Nowood River could likely result in alternating reaches of C-type and F-type channels (Anderson 2010). Five different locations have been surveyed by the BLM since 1992; these assessments are site specific and represent isolated segments where the surveys were conducted. These repeated surveys show that all of the five locations in the Nowood below the confluence with Paint Rock creek have a good PFC condition rating. Natural, background, average, peak stream flow has been reduced by 16% downstream of the Paint Rock confluence and reduced by 32% at the confluence with the Big Horn River (Wenck 2018).

Alkali Creek is an intermittent channel characterized as a Rosgen G-type in the upper portion of the watershed. The channel is steeper and flanked by bedrock to the east and slope wash colluvium to the west. Near the upstream extents of the proposed reservoir, Alkali Creek transitions to a Rosgen F-type channel, where slopes are shallower and the channel meanders across an inset floodplain. Sediment supplied to the system is likely predominately fine material derived from the shales (Mowry and Thermoplis) and from the silty sandstone Morrison Formation. The PFC index indicated good condition within the F-type reach within and downstream of the proposed reservoir, with an isolated “At-Risk” location upstream of the proposed reservoir (Anderson 2010). Both stream types F and G have naturally high bank erosion rates and are sensitive to anthropogenic disturbances with poor recovery potential (Rosgen 2006).

3.15.2.3 WATER QUALITY

The analysis area for water quality includes the Alkali Creek watershed above and below the proposed reservoir and Paint Rock Creek above the Anita Supplemental Ditch diversion and Medicine Lodge Creek above the Anita Ditch diversion, because these are the principal sources of water diverted to the reservoir. The analysis area also includes Paint Rock Creek and Medicine Lodge Creek below these diversions and the Nowood River above its confluence with the Bighorn River. This area was selected because the surface water from the upstream areas would contribute to the water stored in the reservoir, the surface that underlies the reservoir would chemically interact with the reservoir water, and water quality downstream could be affected by reservoir releases.

The USGS and Trihydro obtained water quality data for Alkali Creek. The USGS (2018) data indicate the specific conductance in the creek ranged from 2,800 micro Siemens per centimeter (µS/cm) in May 1976 to 2,420 µS/cm in September 1976. In contrast, Trihydro (2016a) reported a specific conductance of 863 µS/cm in July 2014. Trihydro measured a TDS concentration for Alkali Creek of 660 mg/L and a sulfate concentration of 354 mg/L. No WDEQ surface water quality standards exist for TDS and sulfate; however, the EPA has established secondary drinking water standards of 500 mg/L and 250 mg/L, respectively, based on aesthetic effects such as taste and odor. TDS and sulfate concentrations in Alkali Creek are likely elevated because of contact with the gypsum-rich sedimentary rocks upstream of the proposed reservoir area. Salts and sulfates are likely transported in entrained sediment or in dissolved form, and may be deposited downstream. The proposed reservoir area overlies the Cloverly and Morrison Formations, which do not present the same issue.

With respect to Paint Rock Creek, the available water quality data suggest that the quality varies seasonally. The USGS reported specific conductance values of 270 µS/cm in May 1976 and 730 µS/cm in September 1976 upstream of Alkali Creek, and 790 µS/cm in May 1976 and 1130 µS/cm in September 1976 downstream of Alkali Creek. USGS sampling of this creek near Hyattville in 1975 revealed sulfate and TDS concentrations of 370 and 688 mg/L, respectively, in September, and 13 and 81 mg/L, respectively, in June. Trihydro's (2016a) sampling in July 2014 indicated a TDS concentration of 40 mg/L and a sulfate concentration of 3 mg/L.

Paint Rock Creek downstream of the reservoir area was previously listed as a 303(d)-listed creek and is still listed as impaired (Category 4A) with an EPA-approved total maximum daily load (TMDL) (WDEQ 2016). The creek is listed as impaired for fecal coliform from its confluence with the Nowood River to a point 5.2 miles upstream. The creek is listed primarily because of rangeland sources of *E. coli* that contributed to concentrations exceeding standards for the creek's primary contact recreation designated use class. A TMDL for this creek was approved by the EPA in April 2014 (RESPEC 2013), and current *E. coli* concentration and load in the Paint Rock Creek TMDL reach are shown in Table 3.15-2. Exceedances in water quality standard for *E. coli* concentration (126 colony forming units [cfu]/100 milliliters [mL] from May through September and 630 cfu/100 mL from October through April) and *E. coli* TMDL are occurring currently in certain months and hydrologic conditions (indicated in bold in Table 3.15-2).

Table 3.15-2. Current *E. coli* Concentration and Load at Paint Rock Creek at Confluence with Nowood River

E. coli Concentration or Load	Water Year Type	March	April	May	June	July	August	September	October
Concentration (cfu/100 mL)	Wet	**656**	**347**	35	104	**287**	**140**	118	103
	Normal	**646**	**337**	33	**142**	**272**	**148**	103	99
	Dry	**674**	**393**	**769**	113	**222**	**138**	**731**	105
Load (10^9 cfu/day)	Wet	**508**	**600**	238	1,955	1,783	158	154	254
	Normal	497	**528**	249	2,222	**704**	108	115	187
	Dry	**536**	**515**	**5,613**	660	**315**	72	**831**	159

For Medicine Lodge Creek, similar seasonal variations in water quality have been recorded, and it has also been noted that the creek is subject to elevated levels of *E. coli*. The USGS (2018) measured a specific conductance of 365 µS/cm in May 1976 and 671 µS/cm in September 1976. Trihydro (2016a) reported in July 2014 a TDS concentration of 80 mg/L and a sulfate concentration of 14 mg/L. WDEQ (2012) reported that natural sources of *E. coli* have resulted in seasonally elevated concentrations in the creek between Round Lake and the Medicine Lodge Archaeological Site State Park. These concentrations affected the creek's suitability for primary contact recreation.

With respect to the Nowood River below its confluence with Paint Rock Creek, the overall quality of the river varies on a seasonal basis, and it is listed as an impaired river for fecal coliform. The USGS (2018) measured a specific conductance of 390 µS/cm in May 1976 and 1,200 µS/cm in September 1976, just below the confluence with Paint Rock Creek. Farther downstream above its confluence with the Bighorn River, the USGS (2018) measured a specific conductance of 445 µS/cm in May 1976 and 1,120 µS/cm in September 1976. The Nowood River is listed as impaired for fecal coliform from its confluence with the Bighorn River to a point 13.4 miles upstream (WDEQ 2016). This reach of the river was originally placed on the 303(d) list in 2002 because of fecal coliform from rangeland sources and exceedances of the contact recreation criterion. This reach of the river was delisted in 2014 and placed in Category 4A when the TMDLs were approved. Current *E. coli* concentration and load in the Nowood River TMDL reach are shown in Table 3.15-3. Exceedances in water quality standard for *E. coli* concentration (126 cfu/100 mL from May through September and 630 cfu/100 mL from October through April) and *E. coli* TMDL are occurring currently in certain months and hydrologic conditions (indicated in bold in Table 3.15-3).

Table 3.15-3. Current *E. coli* Concentration and Load at Nowood River at Confluence with Bighorn River

E. coli Concentration or Load	Water Year Type	March	April	May	June	July	August	September	October
Concentration (cfu/100 mL)	Wet	44	151	**228**	**307**	**233**	74	100	190
	Normal	43	145	**227**	**326**	**226**	86	95	192
	Dry	47	145	**445**	**304**	**200**	99	**337**	194
Load (10^9 cfu/day)	Wet	508	1,460	**5,156**	**11,803**	2,861	160	353	1,262
	Normal	497	1,412	**5,668**	**10,466**	1,134	108	307	1,062
	Dry	536	1,460	**10,983**	**3,491**	**564**	72	**995**	850

The Nowood River, Paint Rock Creek, Medicine Lodge Creek, and Alkali Creek are classified as 2AB surface waters (WDEQ 2013). Based on this classification, their designated uses include permanent and seasonal game fisheries, non-game fisheries, fish consumption, aquatic life other than fish, drinking water, recreation, wildlife, industry, agriculture, and scenic value uses (WDEQ 2018). Water quality standards are protective of these designated uses and are found in Chapter 1 (Wyoming Surface Water Quality Standards) of the Wyoming water quality rules and regulations. The primary source of municipal drinking water in the area is groundwater, and downstream municipalities use Paleozoic Aquifer groundwater for drinking water supply. Surface water is not used by water treatment providers but may support fish populations or spawning areas at least seasonally throughout the year.

3.15.2.4 GROUNDWATER

The analysis area for groundwater comprises the Alkali Creek watershed above and slightly below the Alkali Creek Reservoir for the life of the project, as well as the stream reach for Alkali Creek and the underlying water-bearing geologic formations within the watershed. This area closer to the proposed reservoir was selected because surface-water flows through Alkali Creek are currently the principal source of recharge to the local water-bearing geologic formations, and because the alluvial aquifer along Alkali Creek immediately downstream of the proposed dam would be most susceptible to changes from the impounded water and changes in stream flow. Based on Trihydro's (2016a) gaging data, the average flow of Alkali Creek ranges from 1.3 to 2.8 cfs between May and October. Some of this water is sourced from a flowing artesian well operated by the upstream landowner.

The water-bearing geologic formations in this area are considered minor aquifers. Swenson and Bach (1951) reported that the alluvium in the area typically consists of silt and clay with scattered lenses of sand and gravel. Libra et al. (1981) indicated that the Cloverly Formation consists of an upper sandstone, middle shale, and lower conglomeratic sandstone. The sandstones of this unit typically yield water under artesian pressure where confined. Yields are typically approximately 2 gallons per minute, with low transmissivity values of approximately 1 to 50 gallons per day per foot. Libra et al. (1981) reported hydraulic conductivities from 0.1 to 2.2 gallons per day per square foot, whereas Trihydro (2016a) reported up to 3.8 gallons per day per square foot at the proposed dam site. The underlying Morrison Formation consists of variegated sandy shale and mudstone with sandstone and conglomerate lenses. Libra et al. (1981) noted the sandstone lenses can produce small yields. Although groundwater in the alluvium generally follows the flow of Alkali Creek, the flow of groundwater through the Cloverly and Morrison Formations is thought to follow the natural dip of the geologic layers into the basin to the west.

Except for the Alkali Creek alluvium, groundwater quality from these water-bearing units generally deteriorates with distance from surface exposures of the rocks. Trihydro (2016a) reported Alkali Creek had a specific conductance of 863 µS/cm with a TDS concentration of 660 mg/L. The quality of the alluvial groundwater is likely similar based on the water quality data Taucher et al. (2012) summarized for alluvial and other aquifers in the Bighorn Basin. In Chapter 8 (Quality Standards for Wyoming Groundwaters) of the Wyoming water quality rules and regulations, the WDEQ sets a groundwater TDS concentration standard for Class I (domestic use) groundwater of less than 500 mg/L and a Class III (livestock use) standard of less than 5,000 mg/L. Trihydro (2016a) also noted that the water had a sulfate concentration of 354 mg/L, which exceeds the WDEQ domestic use standard of 250 mg/L, but not the livestock use standard of 3,000 mg/L. Libra et al. (1981) reported alluvial water quality deteriorates downstream along the Nowood River drainage from 126 mg/L TDS upstream to 2,370 mg/L downstream. Depending on distance from outcrop, groundwater in the Cloverly and Morrison Formations likely has a TDS concentration between 500 and 10,000 mg/L and a sodium sulfate composition (Libra et al. 1981; Taucher et al. 2012).

3.15.3 Methods of Analysis

3.15.3.1 SURFACE WATER

A historic consumptive use analysis and a surface water allocation model representation of the Nowood River watershed was developed for the *Nowood River Storage Level II Study Phase I Summary Report* and the *Nowood River Storage Level II Study Phase II Report* (Trihydro 2013, 2016a, 2018b). The modeling platforms StateCU and StateMod, respectively, were used for the consumptive use analysis and the surface water allocation model. The historic consumptive use model (StateCU) analysis defines the crop demand and irrigation water requirement based on climate conditions and crop type. The StateMod operates by allocating available water to demands (e.g., irrigation diversions, reservoir storage, instream flows) based on water right priority. The StateMod model simulates the watershed and identifies available flow, estimates shortages, and provides baseline stream flow data. The StateMod model was also used to simulate proposed project scenarios and to provide proposed condition results of stream flow and shortage reduction.

Reservoir evaporation is simulated in the StateMod model based on user-defined monthly evaporation rates and simulated end of month reservoir surface area.

Stream flow is simulated in the StateMod model and reflects the influence of humans on natural flows. Irrigation diversions, return flows, and reservoir operations (e.g., storage, release, evaporation, seepage) are simulated to predict stream flow. The StateMod model is operated on a monthly timestep, and the analysis period is from 1973 through 2017. The data presented were summarized to dry, normal, and wet water years, which provide a range of hydrologic conditions. Longer duration snowmelt events are reflected in the monthly stream flow data; short duration rainstorm events are beyond the capability of the monthly analysis.

The unnamed drainage that the auxiliary spillway discharges to could see flow during extreme precipitation events (greater than the 100-year recurrence interval storm) (Trihydro 2016a). The inflow design flood model (Trihydro 2016a) is used to estimate peak flow in the auxiliary spillway drainage.

3.15.3.2 STREAM MORPHOLOGY AND SEDIMENTATION

Stream channels are formed and maintained by a dominant discharge considered to be the most effective for moving sediment and water; forming and changing point bars, meander bends, riffle-pool complexes; and other intrinsic processes that maintain quasi-equilibrium with channel form. Lane's balance describes this equilibrium stability concept: when discharge is disrupted, the balance with stream slope, and sediment load and size, is offset and the imbalance may result to degradation or aggradation problems (Lane 1954). Wolman and Miller (1960) found that the dominant discharge was the most effective indicator of total sediment load capacity rather than extreme flood events. Within the context of this EIS, dominant discharge is considered bankfull discharge.

Bankfull discharge and its unique channel dimensions provide consistent measures from which channel conditions can be characterized and related to streams of similar morphology (Foster 2012). Regional curves developed for the Rocky Mountain Hydrologic Region in Wyoming with below 25 inches mean annual precipitation were referenced to relate drainage area to bankfull discharge (Foster 2012). Identification of bankfull discharge and its associated channel dimensions are critical steps in the channel stability assessment process and in determining departure from stream channel stability (Rosgen 2006). Medicine Lodge Creek's average bankfull discharge with a return interval of 1.5 years is estimated to be 373 cfs, as verified in the field and calibrated with gage station analysis (WGFD and 5 Smooth Stones Restoration 2017). In comparison, the 1.5-year discharge based on instantaneous peak flow data shows a bankfull discharge of 544 (USGS 06273000), and the Wyoming Regional Curve (Foster 2012) estimates a bankfull flow of 637 cfs. The field-verified bankfull discharge from the WHMA study reflects current conditions and the stream's response to existing water withdrawals. The dominant discharge period for Medicine Lodge Creek ranges from May 22 to June 10, a 21-day period (USGS 06273000).

Regional curves generally have an excellent correlation coefficient and low variance due to the predominance and consistency in their geographical setting (Rosgen 2006). Using the regional curve from the Foster (2012) study and plotting the field-calibrated bankfull flow (WGFD and 5 Smooth Stones Restoration 2017) onto this curve indicates a watershed response to existing water withdrawals. A mini regional curve was developed to determine current bankfull flows for the study area.

Based on the watershed response and mini-regional curve, Paint Rock Creek's bankfull discharge near the Anita Supplemental Ditch is 719 cfs, and the dominant discharge occurs from May 21 to June 24, a 36-day period; USGS 06272500. Paint Rock Creek's bankfull discharge at the confluence with Medicine Lodge Creek is approximately 1,092 cfs. The Nowood River's bankfull discharge is approximately 3,328 cfs near the confluence with Paint Rock Creek.

Potential reductions to the bankfull discharge and qualitative sediment loading were evaluated to describe potential effects that may result from the proposed project. Channel stability is generally qualified as follows: when there is an increase in water supply and/or a decrease in sediment (such as the Proposed Action in Alkali Creek), the channel responds with an increase in slope, leading to bed erosion and vertical channel instability. A decrease in water supply and/or an increase in sediment (such as the Proposed Action in Medicine Lodge Creek, Paint Rock Creek, and the Nowood River) generally leads to excess sediment deposition, aggradation and channel widening, floodplain contraction, and lateral channel instability.

Annual peak flows within the Nowood River, Medicine Lodge Creek, and Paint Rock Creek are in response to snowmelt, whereas the peak flows from their intermittent tributaries are typically in response to individual events, such as high-intensity rainfall events or rapid snowmelt events. Therefore, dominant discharge was not determined for Alkali Creek; rather, qualitative changes in the sediment transport and morphological form are evaluated.

Channel evolution models (Rosgen 1994) were used to characterize morphological changes that are anticipated from the proposed project.

3.15.3.3 WATER QUALITY

The analysis of potential changes to water quality from the project included a review of baseline conditions using data collected as part of the *Nowood River Storage Level II Study Phase II Report* (Trihydro 2016a), from the USGS National Water Information System (USGS 2018c), and from the *E. coli* TMDL for the Bighorn River watershed (RESPEC 2013). These data were used to assess existing soil and water quality conditions for surface water in Alkali Creek, Paint Rock Creek, Medicine Lodge Creek, and the Nowood River. Results were qualitatively assessed to predict the effect on water use and the resulting quality of downstream waters from surface disturbances, storage in the reservoir, and normal release.

In addition, a model using monitoring data from the *E. coli* TMDL for the Bighorn River watershed (RESPEC 2013) was built to estimate *E. coli* concentrations and loads in the two TMDL reaches because of stream flow changes predicted by the StateMod model. This model was built using a basic mass-loading balance approach with no decay. The two parameters that loading depends on are flow (cfs) and *E. coli* concentration (cfu/100 mL). Monitoring data included the concentration of *E. coli* at three sites as shown in Figure E-1, Appendix E: Paint Rock 1, Paint Rock 2, and Nowood 3.

Stream flow data were obtained from the StateMod model at these three sites. The following modeling assumptions used:

- The areas in between the water quality monitoring sites were lumped together to assume a single average concentration estimate based on the load and flow difference at upstream and downstream water quality sites.
- The monthly *E. coli* geometric mean concentration at each water quality monitoring site was estimated using monitored data from 2002 to 2010.
- Monthly median flow at each water quality site was assumed to be the No Federal Action normal year value.

Because of the nature of a lumped model, further source segregation (overland flow versus stream flow) cannot be accomplished for the two areas in between the water quality monitoring sites. This could cause bias in the prediction to overlook the impact of these sources. However, this model does not account for *E. coli* decay in the process. The conservative nature of the model will therefore overpredict the *E. coli* concentration. *E. coli* concentration also depends on multiple factors. Other than decay, it is also highly affected by runoff. An increase in runoff volume will carry more mass-load into the stream. However, this does not necessarily increase the concentration due to the dilution effect from increased runoff volume. Therefore, predicted changes in loadings should be looked at in addition to the concentration changes to better understand the effect of runoff.

3.15.3.4 GROUNDWATER

The analysis of potential changes to groundwater from the project included a review of baseline conditions using data collected as part of the *Nowood River Storage Level II Study Phase I Summary Report* and the *Nowood River Storage Level II Study Phase II Report* (Trihydro 2013, 2016a), as well as regional groundwater assessments conducted in the Bighorn Basin (Libra et al. 1981; Swenson and Bach 1951). These data were used to assess existing flow direction and water quality conditions for groundwater and Alkali Creek. The quality of water in the main contributors to the proposed reservoir—Paint Rock Creek, Medicine Lodge Creek, and the Anita Ditch—were also considered and were used to predict the use suitability of reservoir water. The proposed engineering design was used to evaluate the potential inundation area and aid in the qualitative assessment of recharge rates.

3.15.4 Environmental Effects

3.15.4.1 ALTERNATIVE A: NO FEDERAL ACTION

If the Alkali Creek Reservoir is not constructed, existing effects to water resources would remain. Potentially irrigable permitted acreage could go into production independent of the Proposed Action; however, it is unknown to what extent. If none of the potentially irrigable permitted acreage goes into production (i.e., the amount of irrigated acreage does not change from current conditions) (Modeling Scenario 2), then stream flow would be unchanged. If all potentially irrigable permitted acreage (3,150 acres) goes into production independent of the Proposed Action (Modeling Scenario 3), then stream flow would be as shown in Table 3.15-4.

Table 3.15-4. Median Stream Flow in the Analysis Area (cfs) under Modelling Scenario 3

Point Location	Water Year Type	January	February	March	April	May	June	July	August	September	October	November	December
Medicine Lodge Creek downstream of Anita Ditch	Wet	12	12	11	8	48	166	37	6	6	20	20	16
	Normal	12	12	10	9	57	88	14	6	5	19	20	16
	Dry	13	11	11	11	47	19	7	6	6	13	18	16
Paint Rock Creek downstream of Anita Supplemental Ditch	Wet	21	20	18	26	293	827	391	63	61	49	37	28
	Normal	21	19	18	26	307	575	153	48	45	43	36	27
	Dry	21	19	18	18	253	231	81	29	15	29	31	27
Alkali Creek downstream of Alkali Creek Reservoir	Wet	3	2	1	17	2	2	4	10	10	9	8	5
	Normal	3	2	1	16	2	3	4	9	10	8	7	4
	Dry	3	2	1	16	2	4	6	13	13	9	8	5
Paint Rock Creek upstream of Alkali Creek confluence	Wet	37	35	30	31	332	981	416	72	75	79	69	51
	Normal	37	34	30	35	359	690	160	56	59	72	67	50
	Dry	38	32	30	23	286	247	84	37	30	53	61	49
Paint Rock Creek downstream of Alkali Creek confluence	Wet	42	37	31	50	338	987	429	92	92	96	80	58
	Normal	41	36	31	50	367	700	173	76	78	86	78	57
	Dry	42	35	31	42	295	261	104	57	50	68	73	56
Paint Rock Creek at confluence with Nowood River	Wet	28	33	32	70	270	762	238	46	44	97	75	44
	Normal	31	31	31	66	296	616	98	38	43	77	72	45
	Dry	34	30	32	55	285	227	51	27	42	59	71	46
Nowood River at confluence with Bighorn River	Wet	178	192	472	396	895	1,499	380	59	138	287	248	193
	Normal	184	190	470	399	968	1,159	113	29	117	245	239	196
	Dry	188	185	468	412	916	379	21	27	107	189	223	197

There would be no negative or positive effects to stream morphology. PFC index baseline conditions would be maintained. In addition, prevailing water quality conditions in the creeks near the proposed reservoir would continue, and seasonal variability in quality would persist. Water would continue to meet standards for primary contact recreation, but would not be used as the primary water source for drinking water downstream. Prevailing groundwater conditions would continue, groundwater in the alluvial aquifer would continue to interact with surface water in Alkali Creek, and water levels in the aquifer would be directly affected by seasonal changes in stream flow. Given direct hydraulic communication between the alluvium and the Cloverly and Morrison Formations, some of the alluvial groundwater would likely continue to recharge these minor aquifers. Water quality in these aquifers would likely continue to exceed WDEQ standards for domestic use.

3.15.4.2 ALTERNATIVE B: PROPOSED ACTION

3.15.4.2.1 Surface Water

Modeling Scenario 1

Evaporation from the proposed reservoir surface was simulated with potentially irrigable permitted acreage in production (i.e., Modeling Scenario 1), with results showing an additional depletion of 500 acre-feet of water on average from the analysis area annually. Currently, less than 5 acre-feet is evaporated from human-made water surface areas in the analysis area. The water stored in the reservoir would be legally available water, and this depletion should not affect other water users in the analysis area. This depletion would minimally affect water resources in the analysis area and would contribute to the effect of the Proposed Action on stream flows. Potential effects to other stream flow–dependent resources are addressed in the Stream Morphology and Sedimentation section below and in Section 3.18 Terrestrial and Aquatic Wildlife.

Consumptive use of surface water from crop consumption and reservoir evaporation is estimated to increase 42% on average in the analysis area under the Proposed Action. This is because of irrigation of additional land that is permitted but currently not irrigated and because of the use of stored water. Currently, 18,400 acre-feet of surface water is consumptively used in the analysis area annually on average. This is expected to increase to 26,200 acre-feet under the Proposed Action with potentially irrigable permitted acreage in production.

If the potentially irrigable permitted acreage goes into production as a result of the Proposed Action, then the total effect to stream flow is as shown in Table 3.15-5. These effects would be attributed to the proposed reservoir. The potentially irrigable permitted acreage could go into production independent of the Proposed Action; however, it is unknown to what extent. If all the potentially irrigable permitted acreage goes into production independent of the Proposed Action, then the portion of the total effects to stream flow that are associated with the reservoir alone are shown in Table 3.15-9. The portion of the total effects to stream flow that are associated with the potentially irrigable permitted acreage going into production independently is described in the No Federal Action. If none of the potentially irrigable permitted acreage goes into production (i.e., the amount of irrigated acreage does not change from current conditions), then the effect to stream flow would be solely attributable to the reservoir and is as shown in Table 3.15-7.

The effects of the Proposed Action on stream flow at specific locations as simulated in the StateMod model are summarized below. The effects could range, as discussed in the paragraph above, and are summarized in Tables 3.15-5 through 3.15-9. These tables summarize the expected change in median stream flow during normal, wet, and dry water years. Additional information is provided in Appendix E. Tables 3.15-5 and 3.15-7 indicate months with a change that is greater than 10%. The percentage change and flow change are listed.

The reservoir would divert available water from both Paint Rock Creek and Medicine Lodge Creek in May and June and would store available water in Alkali Creek from April through September with a 0.4-cfs bypass requirement. The StateMod model indicates that the reservoir would divert water from Paint Rock and Medicine Lodge Creeks in May only. Stream flow in Paint Rock Creek below the confluence of Alkali Creek would be reduced in April because of the storage of Alkali Creek water and in May because of the storage of Paint Rock and Medicine Lodge Creek water. The reservoir would also capture available flow in Alkali Creek in April and May and would reduce Alkali Creek flow to the bypass flow of 0.4 cfs.

Stream flow in Alkali Creek downstream of the reservoir would increase in July and August in dry years because of reservoir releases. Stream flows would be reduced in Medicine Lodge Creek and Paint Rock Creek above the Alkali Creek confluence because of irrigation diversions by exchange and irrigation of potentially irrigable permitted but idle acres. The additional 3,150 potentially irrigable permitted acres that may be irrigated with the project would divert additional stream flow, which would cause flow reductions in reaches in the analysis area. This would occur most notably in the Nowood River reach of the analysis area where stream flows would be reduced in June, July, and August. Approximately 75% of the potentially irrigable permitted acres that may be irrigated with the project occurs in the Nowood River reach of the analysis area. These additional irrigated acres divert additional stream flow in normal and wet years in July and August causing stream flow reductions. In dry years, these additional irrigated acres 1) divert additional stream flow in June and July causing stream flow reductions and 2) use storage water in August and October causing stream flow increases because of additional return flow.

Stream flow would increase in Medicine Lodge Creek upstream of Anita Ditch in July, August, and September and downstream of Anita Ditch in July and August in normal and dry years because of additional irrigated acreage under the Anita and George Bayne Ditches calling water down from upper diversions on Medicine Lodge Creek. Stream flow would increase in Paint Rock Creek downstream of the Alkali Creek confluence and the Nowood River downstream of the confluence with Paint Rock Creek in normal and dry years in August because of reservoir releases. The reservoir releases would be diverted by additional and currently irrigated acreage in these reaches. Stream flow would decrease in June through September in Paint Rock Creek downstream of the Alkali Creek confluence and the Nowood River downstream of the confluence with Paint Rock Creek because of the irrigation of potentially irrigable permitted but idle acres. Potential effects to other stream flow–dependent resources are addressed under subsections of Section 3.15 Water Resources and 3.18 Terrestrial and Aquatic Wildlife.

Table 3.15-5. Changes in Stream Flow that are Greater than 10% under Modelling Scenario 1

Point Location	Months with Greater-Than-10% Decrease			Months with Greater-Than-10% Increase		
	Dry Year	Normal Year	Wet Year	Dry Year	Normal Year	Wet Year
Medicine Lodge Creek downstream of Anita Ditch	May -19%, -10 cfs June -31%, -9 cfs September -27%, -2 cfs October -10%, -2 cfs	May -18%, -11 cfs June -11%, -11 cfs September -32%, -3 cfs	May -15%, -8 cfs July -18%, -8 cfs September -52%, -7 cfs	July +105%, 3 cfs August +248%, 4 cfs	July +71%, 6 cfs August +72%, 2 cfs	August +57%, 2 cfs
Paint Rock Creek downstream of Anita Supplemental Ditch	May -14%, -37 cfs August -13%, -4 cfs	May -10%, 30 cfs	May -12%, -34 cfs	None	None	None
Alkali Creek downstream of Alkali Creek Reservoir	April -98%, -16 cfs May -88%, -3 cfs	April -98%, -16 cfs May -81%, -2 cfs June -13%, -0.4 cfs	April -98%, -16 cfs May -51%, -1 cfs	July +533%, 27 cfs August +423%, 30 cfs	July +27%, 1 cfs August +466%, 28 cfs	July +27%, 1 cfs August +178%, 9 cfs
Paint Rock Creek upstream of Alkali Creek confluence	May -18%, -54 cfs August -20%, -8 cfs	May -13%, -48 cfs August -11%, -6 cfs September -15%, -11 cfs	May -17%, -57 cfs September -11%, -9 cfs	None	None	None
Paint Rock Creek downstream of Alkali Creek confluence	April -42%, -18 cfs May -18%, -54 cfs	April -24%, -12 cfs May -13%, -48 cfs	April -33%, -17 cfs May -17%, -57 cfs	July +49%, 44 cfs August +29%, 15 cfs	August +34%, 22 cfs	August +26%, 22 cfs
Paint Rock Creek at confluence with Nowood River	April -23%, -12 cfs May -24%, -71 cfs	April -20%, -13 cfs May -13%, -39 cfs	April -25%, -17 cfs	July +51%, 30 cfs August +93%, 20 cfs	August +78%, 23 cfs	August +34%, 15 cfs
Nowood River at confluence with Bighorn River	May -14%, -142 cfs June -19%, -88 cfs July -71%, -82 cfs	June -12%, -153 cfs July -45%, -92 cfs August -30%, -15 cfs	July -24%, -121 cfs August -33%, -29 cfs	August +18%, 5 cfs October +14%, 25 cfs	None	October +11%, 31 cfs

Average, simulated, end-of-month contents for the proposed Alkali Creek Reservoir with potentially irrigable permitted acreage in production are summarized in Table 3.15-6. Additional information is provided in Appendix E.

Table 3.15-6. Average, Simulated, End-of-Month Contents (acre-feet) under Modelling Scenario 1

January	February	March	April	May	June	July	August	September	October	November	December
5,299	5,297	5,277	6,078	7,870	7,810	7,015	5,457	5,364	5,343	5,336	5,328

Modeling Scenario 2

Evaporation from the proposed reservoir surface without potentially irrigable permitted acreage in production (i.e., Modelling Scenario 2) would average 560 acre-feet of water annually. This is more evaporation than the scenario with potentially irrigable permitted acreage in production because the reservoir would be used less and would have more water in storage, creating a larger surface area and more evaporation. The water stored in the reservoir would be legally available water, and this depletion should not affect other water users in the analysis area. This depletion would minimally affect water resources in the analysis area and would contribute to the effect of the Proposed Action on stream flows. Potential effects to other stream flow–dependent resources are addressed in Section 3.15.4.2.2 Stream Morphology and Sedimentation and in Section 3.18 Terrestrial and Aquatic Wildlife.

Consumptive use of surface water from crop consumption and reservoir evaporation is estimated to increase 3% on average in the analysis area under the Proposed Action without potentially irrigable permitted acreage in production. Currently, 18,400 acre-feet of surface water is consumptively used in the analysis area annually on average. This is expected to increase to 19,000 acre-feet under the Proposed Action with potentially irrigable permitted acreage in production.

If none of the potentially irrigable permitted acreage goes into production (i.e., the amount of irrigated acreage does not change from current conditions), then the effect to stream flow would be solely attributable to the reservoir and would be as shown in Table 3.15-7. Stream flow reductions would occur in April downstream of the reservoir because of the storage of Alkali Creek water. Stream flow increases would occur in August on upper Paint Rock Creek because of the irrigation diversions by exchange. Stream flow effects would be limited because of the low use of the reservoir.

Table 3.15-7. Changes in Stream Flow that are Greater than 10% under Modelling Scenario 2

Point Location	Months with Greater-Than-10% Decrease			Months with Greater-Than-10% Increase		
	Dry Year	Normal Year	Wet Year	Dry Year	Normal Year	Wet Year
Medicine Lodge Creek downstream of Anita Ditch	None	None	None	None	None	None
Paint Rock Creek downstream of Anita Supplemental Ditch	August -16%, -5 cfs	None	None	None	None	None
Alkali Creek downstream of Alkali Creek Reservoir	April -77%, -12 cfs	April -69%, -11 cfs May -59%, -1 cfs	April -70%, -12 cfs	None	None	July +20%, 1 cfs
Paint Rock Creek upstream of Alkali Creek confluence	None	None	None	None	None	None
Paint Rock Creek downstream of Alkali Creek confluence	April -28%, -12 cfs	April -22%, -11 cfs	April -19%, -10 cfs	None	None	None
Paint Rock Creek at confluence with Nowood River	April -18%, -10 cfs	April -16%, -10 cfs	April -15%, -10 cfs	None	None	None
Nowood River at confluence with Bighorn River	None	None	None	None	None	None

Average, simulated, end-of-month contents for the proposed Alkali Creek Reservoir without potentially irrigable permitted acreage in production are summarized in Table 3.15-8. Additional information is provided in Appendix E.

Table 3.15-8. Average, Simulated, End-of-Month Contents (acre-feet) under Modelling Scenario 2

January	February	March	April	May	June	July	August	September	October	November	December
7,198	7,195	7,170	7,731	7,865	7,784	7,566	7,312	7,254	7,228	7,218	7,209

Modeling Scenario 3

Evaporation from the proposed reservoir surface with potentially irrigable permitted acreage in production independent of the Proposed Action (i.e., Modelling Scenario 3) would average 500 acre-feet of water annually. The water stored in the reservoir would be legally available water, and this depletion should not affect other water users in the analysis area. This depletion would minimally affect water resources in the analysis area and would contribute to the effect of the Proposed Action on stream flows. Potential effects to other stream flow–dependent resources are addressed in Section 3.15.4.2.2 Stream Morphology and Sedimentation below and in Section 3.18 Terrestrial and Aquatic Wildlife.

Consumptive use of surface water from crop consumption and reservoir evaporation is estimated to increase 5% on average in the analysis area under the Proposed Action with potentially irrigable permitted acreage in production independent of the Proposed Action. In all, 24,900 acre-feet of surface water would be consumptively used in the analysis area annually on average if the potentially irrigable permitted acreage went into production independent of the Proposed Action. This is expected to increase to 26,200 acre-feet under the Proposed Action.

There is potential for the potentially irrigable permitted acreage to go into production independent of the Proposed Action; however, it is unknown to what extent. If all the potentially irrigable permitted acreage goes into production independent of the Proposed Action, then the portion of the total effects to stream flow that are associated with the reservoir alone are shown in Table 3.15-9. The portion of the total effects to stream flow that are associated with the potentially irrigable permitted acreage going into production independently are described in the No Federal Action.

Table 3.15-9. Changes in Stream Flow that are Greater than 10% under Modeling Scenario 3

Point Location	Months with Greater-Than-10% Decrease			Months with Greater-Than-10% Increase		
	Dry Year	Normal Year	Wet Year	Dry Year	Normal Year	Wet Year
Medicine Lodge Creek downstream of Anita Ditch	None	May -12%, -7 cfs	None	None	None	None
Paint Rock Creek downstream of Anita Supplemental Ditch	May -14%, -35 cfs July -15%, -12 cfs August -13%, -4 cfs	May -11%, -32 cfs August -11%, -5 cfs	May -12%, -35 cfs	None	None	None
Alkali Creek downstream of Alkali Creek Reservoir	April -97%, -15 cfs May -82%, -2 cfs	April -98%, -16 cfs May -76%, -1 cfs	April -98%, -16 cfs May -45%, -1 cfs	July +412%, 26 cfs August +188%, 24 cfs	August +265%, 25 cfs	August +49%, 5 cfs
Paint Rock Creek upstream of Alkali Creek confluence	May -14%, -39 cfs July -11%, -9 cfs August -16%, -6 cfs	May -11%, -38 cfs August -11%, -6 cfs	May -14%, -46 cfs	September +13%, 4 cfs	None	None
Paint Rock Creek downstream of Alkali Creek confluence	April -42%, -18 cfs May -14%, -43 cfs	April -23%, -12 cfs May -11%, -40 cfs	April -33%, -17 cfs May -15%, -50 cfs	July +29%, 30 cfs August +16%, 9 cfs September +15%, 7 cfs	August +16%, 12 cfs	August +17%, 15 cfs
Paint Rock Creek at confluence with Nowood River	April -25%, -14 cfs May -20%, -57 cfs	April -22%, -14 cfs May -10%, -30 cfs	April -24%, -17 cfs	July +73%, 37 cfs August +52%, 14 cfs September +20%, 8 cfs	August +40%, 15 cfs	August +33%, 15 cfs September +14%, 6 cfs
Nowood River at confluence with Bighorn River	None	None	None	July +59%, 12 cfs August +30%, 8 cfs October +13%, 14 cfs	August +23%, 7 cfs	None

The unnamed drainage that the auxiliary spillway discharges into could see a maximum flow rate of 15,000 cfs during the probable maximum flood. The drainage could be eroded and could require repairs when activated by flood events caused by storms greater than the 100-year recurrence interval.

3.15.4.2.2 Stream Morphology and Sedimentation

Alkali Creek would be affected through the 2.1-mile reach impounded by the reservoir. Upstream of the reservoir, Alkali Creek may have aggradation and associated bank erosion issues caused from the backwater creating shallower water surface slopes as the channel converges with the reservoir. The reduced slope and energy to convey sediment would likely cause the channel to respond by widening and depositing material, potentially forming multiple channels near the reservoir mouth. The existing channel is in good PFC condition. The Proposed Action has the potential to degrade the PFC baseline condition that is impacted by backwater fluctuations and a reduced energy slope. The reach upstream of the reservoir would likely have excess sediment deposition leading to channel instability, bank erosion, a reduced width-to-depth ratio and a wider channel. Downstream of the proposed reservoir, the channel would have a significant increase in flow magnitude and duration, and a decrease in sediment supply that is impounded by the proposed reservoir. The significant increase in flows coupled with the sediment-starved water would cause the G-type channel to become highly unstable, degraded, and more incised. Channel structures are proposed to mitigate potential down cutting and stability issues associated with the altered sediment loading and hydrograph. These structures would change the morphology from a Rosgen F-type to a Bc-type (upper more confined segment) and C-type (lower segment near valley floor), which are more stable channel forms for the proposed altered hydrology and sediment reduction (Rosgen 1996).

The Proposed Action would enlarge the Anita Ditch in Medicine Lodge Creek to convey an additional maximum diverted flow of 100 cfs, and an average diverted flow of 12 cfs during the dominant discharge period. The Proposed Action would reduce the magnitude and duration of bankfull flows on average by 3%, with a maximum potential reduction of 27%. The maximum potential reduction to bankfull flows includes idle lands in production. The median flow during the dominant discharge period would be reduced by 3% from the Proposed Action and by 17% with idle lands in production. The change in the magnitude and duration of bankfull flows would decrease the energy to transport sediment, thereby reducing the sediment transport capacity and lead to stability issues as generally described above by the Lanes Balance concept. Channels typically respond by first aggrading and widening, leading to bank erosion, then by contracting and narrowing leading to vegetation encroachment and loss of riparian and overbank habitats. During this process, the channel may have reduced in-channel habitat complexity, reduced riparian and wetland fringe habitats, and an increase in non-point source pollution from streambank erosion; as well as consequently threaten adjacent land owners with the loss of productive agricultural lands. From the proposed Anita Ditch to the confluence with Paint Rock Creek, the channel has the potential to decrease in stability as the channel evolves and changes morphological form from a Rosgen Cb-type to a D-type (localized braided segments) to a G-type to an F-type, and eventually back to a C-type with an inset floodplain.

The proposed widening of the Anita Ditch would likely cause local sedimentation issues in Medicine Lodge. The existing location is located at the crossover of an active meander bend. Alluvial streams are subject to both lateral and longitudinal movement through the formation and destruction of bends. Meanders are formed by the process of erosion and sloughing of the banks on the outside of bends, and by corresponding deposition of sediment on the inside of bends to form point bars. These point bars construct the bend and cause erosion in the bend to continue, accounting for deposition and longitudinal migration of the meandering channels. Widening of the ditch at the existing location may lengthen the meander bend with a larger radius of curvature, which may exacerbate existing sedimentation issues at the diversion as the upstream point bar grows, and cause a corresponding adjustment to the opposite bank that is currently eroding and lacks sufficient bank vegetation.

The Anita Supplemental Ditch is proposed to be widened to increase the capacity to divert flows on Paint Rock Creek. The Anita Supplemental Ditch is located on the inside of a meander bend at an active point bar, and the proposed widening of the ditch could exacerbate current sedimentation issues. The Proposed Action has the potential to divert a maximum of 150 cfs from Paint Rock Creek and an average diverted flow of 17 cfs during the dominant discharge period. The Proposed Action would reduce the magnitude and duration of bankfull flows on average less than 2%, with a maximum potential reduction of 21%. Downstream of the confluence with Medicine Lodge Creek, the proposed diverted flows (Anita and Anita Supplemental Ditches) have the potential to reduce the dominant discharge on average 29 cfs approximately 3%, and a maximum potential of 150 cfs approximately a 14% reduction. Changes in the magnitude and duration of the dominant discharge would have an incremental effect on stream morphology similar to typical responses described above. The reduced flows during the dominant discharge period would lead to a corresponding response in the sediment transport capacity and cross-sectional area, leading to an increase in the width to depth ratio, channel entrenchment, and loss of overbanking flows. Paint Rock Creek has the potential to change morphological form from a Rosgen Cb type to a G-type to an F-type and eventually back to a C-type while the channel adjusts to the new flow regime and establishes equilibrium with an inset floodplain.

Sediment supplied to Paint Rock Creek from Alkali Creek would be captured by the impoundment. There are no plans to flush accumulated sediments to restore reservoir capacity, or to augment sediment loading to downstream reaches. The fine sediment supplied from Alkali Creek would be negligible compared to total sediment loads because there are numerous intermittent and ephemeral tributaries and local alluvial fan deposits that provide sediment input into the lower segment of Paint Rock Creek. Downstream of the Alkali Creek confluence, the increase in flows during the irrigation delivery period (July–September) may pose local instability issues at exposed bank areas at the lower level, leading to bank erosion. This winnowing of fine bank materials and erosion at the toe of the bank may influence channel instabilities and increase the suspended sediment load; however, these flows would not be of magnitude to affect stream morphology.

The Proposed Action average stream flow in the Nowood River would reduce bankfull flows by less than 0.3%, with a maximum potential reduction of 8% near the confluence with Paint Rock. The average peak flow in the Nowood River at the confluence with the Big Horn River would be reduced by 10% during the dominant discharge period with idle lands in production. The Proposed Action would incrementally reduce the dominant discharge, adding to the current flow depletions and associated changes in channel form, which may exacerbate the current trend of transitioning from a Rosgen C-type to a more entrenched channel characterized as an F-type channel with an inset floodplain.

3.15.4.2.3 Water Quality

If the Alkali Creek Reservoir is constructed, there is potential that water quality changes could be experienced both during construction and during the life of the project. These changes would be related to how long water is stored in the reservoir before release, the timing and volume of water released downstream, the timing of diversions from Paint Rock and Medicine Lodge Creeks, the amount of water diverted to the reservoir, and the quantity and quality of the water flowing in the streams during different periods of the year.

If the Alkali Creek Reservoir is constructed, changes to water quality in the reservoir and downstream areas are anticipated. The magnitude and timing of these effects would primarily depend on the volume of water released from storage and when the release occurs.

Reservoir design capacity would be sufficient to store incoming water from Alkali Creek, as well as diverted water from Paint Rock and Medicine Lodge Creeks, and therefore, it should not affect the quality of the source water. Assuming best management practices and a normal release schedule, the reservoir would not back up into Alkali Creek beyond the inundation area or disturb upgradient portions of the Alkali Creek watershed. The point of diversion from Paint Rock and Medicine Lodge Creek would also be far enough upstream of the reservoir that it would not be affected by reservoir releases or disturbance during construction. Water quality immediately adjacent to rock weirs and the diversion headgates along Paint Rock and Medicine Lodge Creek may have a lower turbidity because sediment would be captured behind these structures. Periodic maintenance of the sediment deposition behind these retention and diversion structures, including the reservoir dam, may temporarily increase turbidity, but the magnitude and extent of this effect would be limited. No additional changes to the source water quality in Alkali Creek, Paint Rock Creek, or Medicine Lodge Creek are anticipated, and only downstream effects of the reservoir construction and operation are considered in the remainder of this section.

Normal reservoir releases would likely improve downstream water quality in Paint Rock Creek, Alkali Creek, and the Nowood River. Water would be diverted from Paint Rock and Medicine Lodge Creeks during spring runoff, between mid-April and late June, when flow volume is high. Taking water from the creeks during this time would also reduce the potential for downstream bank erosion. The quality of the water diverted to the reservoir would also be of a higher quality than is typically found in the creeks in the late summer, when stored water would be released to provide late summer irrigation. In addition, the reservoir would capture sediment and reduce overall turbidity loads, further increasing the quality of released water. The resulting downstream water quality would likely observe decreases in TDS and sulfate. The potential for downstream bank erosion during late-summer releases would remain low because the volume of water moving through the stream reaches at that time would still be less than is typical during spring runoff. Because the potential for bank erosion would not increase as a result of reservoir operation, there would be no increased concentrations of sediment as a result of the annual operation of the facility.

Because the main sources of water to the reservoir would be high-quality spring runoff from Paint Rock and Medicine Lodge Creeks, the water quality of the reservoir should be acceptable for the proposed recreational and other uses; however, there is some uncertainty with respect to *E. coli* given the lack of data collected to date. The quality of the water impounded in the reservoir may deteriorate somewhat because of the lesser quality of inflowing Alkali Creek water in the summer; however, based on the sampling Trihydro (2016a) completed in July 2016, the water may remain suitable for recreational use. Diversion into the proposed reservoir would occur during spring runoff when water temperatures from runoff areas would be colder (10 to 12 degrees Celsius). The TMDL identified the driver of downstream *E. coli* impairments as rangeland. *E. coli* bacteria in surface water used for primary contact recreation can pose a risk to human health in two ways: 1) it can be an indicator of excess nutrients and sediment runoff from anthropogenic land uses that involve livestock and manure and other non-anthropogenic land uses, which facilitates algae blooms and other conditions that impair recreation; or 2) certain types of bacteria have potential to cause enteric illness.

High late-summer temperatures within the reservoir could provide favorable conditions for some bacterial growth in the upper layer of the basin. However, it is important to consider that the morphometry of the proposed basin lends itself to thermal stratification and that the location of the low-level outlet is at the bottom of the basin, potentially in cooler water if a thermocline develops. The residence time within the proposed basin should provide some nutrient and sediment load reduction downstream due to settling. Sediment, and the nutrient bound to it, or bacteria would settle in the proposed reservoir. Reservoir turnover could re-suspend *E. coli* and nutrients leading to algal blooms.

The lower temperatures near the outlet could limit *E. coli* source population. Any seed bacteria discharged should be in cooler water being discharged into a stream with ultraviolet exposure and higher flow rates. The reservoir discharges to a stream with a minimal depth and low enough turbidity for ultraviolet penetration to provide some mitigation for growth of bacteria downstream. Generally, bacteria grow best in streams during low-flow, late-summer conditions where sediment re-growth is a primary driver. Increasing the flow during these times, as proposed, should reduce temperature, and therefore growth, and would provide a dilutive effect on *E. coli*. Selective withdrawal from the reservoir may release warmer water near the reservoir surface to reduce effects to the downstream fishery in Alkali Creek. This could affect downstream *E. coli* concentrations.

The effects to *E. coli* in the TMDL reaches of lower Paint Rock Creek and the lower Nowood River were estimated using a basic mass/loading balance model. The results of this analysis are shown in Table 3.15-10 through Table 3.15-12. *E. coli* concentration under most hydrologic conditions is predicted to go up during reservoir fill, and *E. coli* load is predicted to go down. Exceedances in water quality standard for *E. coli* concentration (126 cfu/100 mL from May through September and 630 cfu/100 mL from October through April) and *E. coli* TMDL are predicted to continue in certain months and hydrologic conditions (indicated in bold in the tables below).

Table 3.15-10. Predicted *E. coli* Concentration and Load in the TMDL Reaches under Modeling Scenario 1

E. coli Concentration or Load	Water Year Type	March	April	May	June	July	August	September	October
Paint Rock Creek at Confluence with Nowood River									
Concentration (cfu/100 mL)	Wet	**656**	448	33	105	**303**	106	**128**	103
		0%	29%	-5%	1%	6%	-24%	9%	0%
	Normal	**646**	412	34	**128**	**280**	118	108	98
		0%	22%	3%	-10%	3%	-20%	4%	0%
	Dry	**673**	503	**998**	98	**241**	**129**	761	106
		0%	28%	30%	-13%	9%	-6%	4%	1%
Load (10^9 cfu/day)	Wet	**508**	**585**	210	1,955	1,771	160	158	255
		0%	-2%	-12%	0%	-1%	1%	2%	1%
	Normal	497	**517**	224	**1,929**	**685**	153	118	188
		0%	-2%	-10%	-13%	-3%	42%	3%	0%
	Dry	**536**	504	**5,555**	543	517	130	**940**	167
		0%	-2%	-1%	-18%	64%	81%	13%	5%
Nowood River at Confluence with Bighorn River									
Concentration (cfu/100 mL)	Wet	44	155	**228**	**301**	**256**	111	103	195
		0%	3%	0%	-2%	10%	50%	3%	3%
	Normal	43	149	**231**	**303**	**268**	**175**	96	196
		0%	3%	2%	-7%	19%	102%	2%	2%
	Dry	47	150	**490**	**261**	**631**	**151**	**370**	199
		0%	3%	10%	-14%	216%	53%	10%	2%
Load (10^9 cfu/day)	Wet	508	1,456	**4,852**	**11,023**	**2,388**	160	365	1,443
		0%	0%	-6%	-7%	-17%	0%	3%	14%
	Normal	497	1,390	**5,228**	**8,598**	**744**	**153**	289	1,188
		0%	-2%	-8%	-18%	-34%	41%	-6%	12%
	Dry	536	1,422	**10,384**	**2,437**	**517**	**130**	**1,095**	990
		0%	-3%	-5%	-30%	-8%	80%	10%	16%

Table 3.15-11. Predicted *E. coli* Concentration and Load in the TMDL Reaches under Modeling Scenario 2

***E. coli* Concentration or Load**	**Water Year Type**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**
Paint Rock Creek at Confluence with Nowood River									
Concentration (cfu/100 mL)	Wet	**657**	447	35	104	**286**	**139**	117	103
		0%	16%	0%	0%	0%	-1%	0%	0%
	Normal	**647**	393	93	**142**	**272**	**148**	103	99
		0%	17%	1%	0%	0%	0%	0%	0%
	Dry	**669**	494	**2,220**	113	**218**	110	**713**	105
		0%	20%	1%	0%	-2%	-20%	-2%	1%
Load (10^9 cfu/day)	Wet	**508**	**660**	238	1,955	1,783	158	154	254
		0%	-1%	0%	0%	0%	0%	0%	0%
	Normal	498	**519**	681	**2,222**	**704**	108	114	188
		0%	-2%	0%	0%	0%	0%	0%	0%
	Dry	**532**	**528**	**15,982**	660	**315**	58	**858**	162
		0%	-2%	0%	0%	0%	-18%	3%	2%
Nowood River at Confluence with Bighorn River									
Concentration (cfu/100 mL)	Wet	44	161	**228**	**307**	**232**	74	100	190
		0%	2%	0%	0%	0%	-1%	0%	0%
	Normal	43	148	**246**	**326**	**226**	86	94	192
		0%	2%	0%	0%	0%	0%	0%	0%
	Dry	46	150	**869**	**304**	**198**	80	**337**	194
		0%	2%	0%	0%	-1%	-19%	0%	0%
Load (10^9 cfu/day)	Wet	508	1,522	**5,156**	**11,803**	2,861	160	353	1,262
		0%	0%	0%	0%	0%	0%	0%	0%
	Normal	498	1,402	**6,126**	**10,466**	1,133	108	307	1,062
		0%	-1%	0%	0%	0%	0%	0%	0%
	Dry	532	1,464	**21,359**	**3,491**	**564**	59	**1,022**	859
		0%	-1%	0%	0%	0%	-18%	3%	1%

Table 3.15-12. Predicted *E. coli* Concentration and Load in the TMDL Reaches under Modeling Scenario 3

***E. coli* Concentration or Load**	**Water Year Type**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**
Paint Rock Creek at Confluence with Nowood River									
Concentration (cfu/100 mL)	Wet	**656**	461	27	105	**303**	106	**128**	103
		0%	29%	-10%	0%	0%	-25%	-9%	0%
	Normal	**646**	423	34	**128**	**280**	118	108	98
		0%	25%	1%	0%	-2%	-11%	-1%	0%
	Dry	**673**	517	**998**	98	**241**	**129**	**761**	106
		0%	30%	24%	0%	-18%	11%	4%	2%
Load (10^9 cfu/day)	Wet	**508**	**602**	172	1,955	1,771	160	158	255
		0%	-2%	-14%	0%	0%	0%	4%	4%
	Normal	497	**531**	224	**1,929**	**685**	153	118	188
		0%	-2%	-10%	0%	0%	25%	3%	1%
	Dry	**536**	**518**	**5,555**	543	517	130	**940**	167
		0%	-2%	-1%	0%	42%	69%	25%	11%
Nowood River at Confluence with Bighorn River									
Concentration (cfu/100 mL)	Wet	44	157	**226**	**301**	**256**	111	103	195
		0%	3%	0%	0%	0%	0%	-3%	0%
	Normal	43	150	**231**	**303**	**268**	175	96	196
		0%	3%	2%	0%	-1%	2%	-1%	0%
	Dry	47	151	**490**	**261**	**631**	**151**	**370**	199
		0%	3%	6%	0%	-11%	31%	8%	0%
Load (10^9 cfu/day)	Wet	508	1,472	**4,814**	**11,023**	**2,388**	160	365	1,443
		0%	0%	-2%	0%	0%	0%	2%	5%
	Normal	497	1,405	**5,228**	**8,598**	**744**	**153**	289	1,188
		0%	-1%	-2%	0%	-1%	25%	4%	1%
	Dry	536	1,436	**10,384**	**2,437**	**517**	**130**	**1,095**	990
		0%	-3%	0%	1%	42%	69%	22%	8%

Given the lack of water quality data and uncertainty in water quality effects, an adaptive management approach is warranted. An AMP that addresses *E. coli* and other water quality issues will be developed before the ROD is published (see Section 3.15.6). Increases in recreational or wildlife activity or the leaching of the sediments at the bottom of the reservoir may also affect reservoir water quality. The history of high *E. coli* levels in Paint Rock Creek and the Nowood River indicates the potential for related issues in the watershed. However, most of the rangeland sources that caused the site to be listed on the 303(d) list are located downstream of the proposed reservoir site and would not affect reservoir water quality. The increase in recreation and wildlife in the area could affect *E. coli* concentrations/loading in the water within the analysis area. This further supports the need for an AMP.

Given the small size of the upstream watershed and lack of large-scale chemical applications, the potential for significant volumes of fertilizer or pesticides leaching from the soil would be negligible. Other measured contaminants such as sulfate and salts do not have primary contact recreation water quality standards and would not be a concern for leaching. Leaching of these constituents may affect water quality by increasing sulfate and specific conductivity of the reservoir water, but would not affect the ability of the water to meet standards for recreational purposes.

Surface disturbance during construction would temporarily raise the potential for additional sediment loading and turbidity, but that effect would be minor and would end with the close of construction. The construction of a detention pond would help control flow of site runoff down Alkali Creek and would settle suspended sediment from stormwater runoff. Following construction activities, water quality in the reservoir would improve over time as water is added to the reservoir and as sediment from surface disturbances settles. Assuming the use of these best management practices and compliance with the stormwater permit, no effects on long-term water quality in the reservoir or downstream are anticipated as a result of construction. After construction concludes, no additional surface disturbances would be scheduled to occur on-site.

The project area is not located within a drinking water source protection area, and there are no source water protection areas immediately downstream. The source water protection areas for the downstream municipalities, Hyattville, Manderson, Basin, and Greybull, would not be affected by the Proposed Action because they are upstream of this proposed reservoir. Furthermore, the Proposed Action would not affect any water treatment providers downstream because deep aquifer groundwater would remain the primary water source for municipal drinking water.

3.15.4.2.4 Groundwater

If the Alkali Creek Reservoir is constructed, the filling and maintenance of this reservoir would affect groundwater conditions, primarily with regard to volume, storage, and quality. No effects to regional groundwater flow directions are anticipated.

The quantity of groundwater that may be recharged to minor aquifers is anticipated to be relatively small because of the primarily fine-grained composition of the underlying water-bearing units. With the initial filling, the reservoir would concentrate water over a progressively larger area that is underlain by alluvium as well as Cloverly and Morrison Formation sedimentary rocks. Depending on the permeability of these units at the reservoir contact, some water would infiltrate and recharge these minor aquifers, and some would saturate the surrounding rocks until the water can penetrate no further. When the reservoir is full, the potential to recharge groundwater from the reservoir would be at its peak because the potential energy required to move water down into the minor aquifers would be at its maximum. Although this would contribute to groundwater recharge, the overall increase in recharge rate is expected to be minor because of the low hydraulic conductivities of the underlying units.

Even at peak infiltration conditions, recharge rates are not anticipated to be high enough to change the regional direction of groundwater flow in the Cloverly and Morrison Formations. Channel changes along Alkali Creek may affect recharge conditions, but the low hydraulic conductivities of the underlying units would dictate recharge rates. Trihydro (2016a) estimated seepage losses through the main dam and foundation to be 2.8 gallons per minute over the length of the dam. The infiltrating water and the installation of impermeable groundwater flow barriers would affect flow paths in the alluvial aquifer directly around and underneath the reservoir, by significantly limiting the flow of alluvial groundwater downstream along Alkali Creek. However, significant mounding conditions are not expected to occur within the deeper aquifers, given the low recharge rate. Any seasonal mounding that does occur is expected to dissipate quickly with distance from the reservoir and to have little effect on regional groundwater flow paths in the deeper aquifers.

Groundwater quality of any of the minor aquifers would likely be enhanced through recharge of water stored in the reservoir. Trihydro (2016a) reported TDS and sulfate concentrations for Paint Rock Creek, Medicine Lodge Creek, and the Anita Ditch that ranged from 40 to 90 mg/L and 3 to 24 mg/L, respectively. These would be the principal sources of water in the reservoir, and would contain far fewer dissolved solids than Alkali Creek. Because of this improvement in quality, the quality of groundwater in the Cloverly and Morrison Formations immediately downgradient of the reservoir would likely improve and the water would have fewer dissolved solids and lower sulfate concentrations than recorded during the baseline studies. This condition would apply to all the minor aquifers.

3.15.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

3.15.4.3.1 Surface Water

Evaporation from the proposed reservoir surface was simulated, with results showing the same depletion (500 acre-feet) as under the Proposed Action. This depletion should not affect other water users in the analysis area. This depletion would minimally affect water resources in the analysis area and would contribute to the effect of the project on stream flows.

Consumptive use of surface water from crop consumption and reservoir evaporation is projected to be the same as the Proposed Action and is estimated to increase 42% on average in the analysis area with the project.

The effect of the Modified Proposed Action on stream flow at specific locations as simulated in the StateMod model are provided in Appendix E. The Modified Proposed Action could reduce effects to stream flow by limiting the amount of water that can be diverted from Paint Rock Creek and Medicine Lodge Creek and supplied to Alkali Creek Reservoir. However, based on the StateMod simulation, changes in stream flow are unchanged from the Proposed Action. This is because of the relatively low use of the proposed reservoir and approximately 45% of the reservoir supply on average coming from Alkali Creek. On average, 2,800 acre-feet would be supplied to the reservoir. On average, 1,300 acre-feet of Alkali Creek water would be captured in the reservoir in April and May. The remaining unfilled portion of the reservoir would typically fill from Paint Rock Creek and Medicine Lodge Creek in May. Water supply to Alkali Creek Reservoir from Paint Rock Creek and Medicine Lodge Creek would average 1,500 acre-feet with a maximum simulated supply of 5,600 acre-feet. The StateMod model operates on a monthly time step and does not capture instantaneous diversion rates. Instantaneous diversion rates may approach the supply canal capacities. Potential effects to other stream flow–dependent resources are addressed under other subsections of Section 3.15 Water Resources and Section 3.18 Terrestrial and Aquatic Wildlife.

The unnamed drainage that the auxiliary spillway discharges into could see a maximum flow rate of 15,000 cfs during the probable maximum flood. The drainage could be eroded and could require repairs when activated by flood events caused by storms greater than the 100-year recurrence interval. Modification of the spillway would keep flood flows in the unnamed drainage and out of Alkali Creek for a greater distance than the Proposed Action and could cause erosion to a greater length of the unnamed drainage.

3.15.4.3.2 Stream Morphology and Sedimentation

The Modified Proposed Action would have the same effects on stream morphology and sedimentation as the Proposed Action to Alkali Creek and the Nowood River.

Paint Rock Creek would be affected by the modified filling time by extending the filling time period by 20 days during the dominant discharge period. The proposed scenario would reduce the maximum diverted amount to 80 cfs, potentially reducing the dominant discharge by 11% in the upper segment, and approximately 7% in the lower segment downstream of the Medicine Lodge Creek confluence. Similar to the Proposed Action, there would be an incremental effect to the dominant discharge; however, less pronounced. Relocating the Anita Supplemental Ditch upstream to a more stable location would have less maintenance issues associated with debris and sediment accumulation and channel stability.

The Modified Proposed Action would change the filling scenario to 115 cfs and change the filling scenario from 30 days to 50 days. The Modified Proposed Action has a maximum potential to reduce bankfull discharge by 9% reduction, which would cause less of an incremental reduction to dominant discharge flows.

3.15.4.3.3 Water Quality

The effects from the Modified Proposed Action to water quality would be the same as those discussed for the Proposed Action.

3.15.4.3.4 Groundwater

The effects from the Modified Proposed Action to groundwater would be the same as those discussed for the Proposed Action.

3.15.5 Summary of Effects

Table 3.15-13 presents a summary of the effects to water resources under all alternatives.

Table 3.15-13. Water Resources Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
Would an increased surface water area from the reservoir affect local water resources?	No effect	There would be an additional depletion of 500 acre-feet of water from evaporation. Water resources in the analysis area would be minimally affected.	Same as the Proposed Action
How would the project affect stream flows for Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek?	Under Modelling Scenario 2 (without potentially irrigable permitted acreage in production), stream flow would be unchanged. Under Modelling Scenario 1 (with potentially irrigable permitted acreage in production), stream flow changes would be as follows: Stream flow in Alkali Creek would increase up to 27% (1 cfs) and up to 87% (5 cfs) in July and August, respectively. Stream flow in Alkali Creek would decrease up to 33% (1 cfs) in May. Decreases in stream flow in Paint Rock Creek would occur in July, September, and October, ranging from 1 to 14 cfs. Decreases in stream flow in Medicine Lodge Creek would occur in May, June, July, September, and October, ranging from 1 to 11 cfs. Stream flow decreases up to 82% may occur in the lower Nowood River in June, July, August, and September. Increases in stream flow in Paint Rock Creek would occur in July and August, ranging from 1 to 14 cfs. Increases in stream flow in the lower Nowood River would occur in October, ranging from 1 to 21 cfs.	Under Modelling Scenario 1 (with potentially irrigable permitted acreage in production), stream flow changes would be as follows: Stream flow in Alkali Creek would increase up to 533% (27 cfs) and 423% (30 cfs) in July and August, respectively. Stream flow in Alkali Creek would decrease to 0.4 cfs (base flow) in April and May. Decreases in stream flow in Paint Rock Creek would occur in April, May, August and September and would range from 1 to 71 cfs. Decreases in stream flow in Medicine Lodge Creek would occur in May, June, July, and September and would range from 1 to 11 cfs. Stream flow decreases up to 71% may occur in the lower Nowood River in May, June, July, and August. Increases in stream flow in Paint Rock and Medicine Lodge Creeks would occur in July, August, and September and would range from 1 to 44 cfs. Increases in stream flow in the lower Nowood River would occur in August and October ranging from 1 to 25 cfs. Under Modelling Scenario 2 (without potentially irrigable permitted acreage in production), the following stream flow changes would occur: Stream flow in Alkali Creek would increase up to 20% (1 cfs) July. Stream flow in Alkali Creek would decrease up to 77% (12 cfs) and 59% (1 cfs) in April and May, respectively. Decreases in stream flow in Paint Rock Creek would occur in April, May, and August, ranging from 1 to 20 cfs. Stream flow in Medicine Lodge Creek would not change. Stream flow decreases up to 3% may occur in the lower Nowood River in April and May. Increases in stream flow in Paint Rock Creek and in the lower Nowood River would occur in July, August, and September, ranging from 1 to 3 cfs. Under Modelling Scenario 3 (with potentially irrigable permitted acreage in production independent of the Proposed Action), stream flow effects attributed solely to the proposed reservoir (comparing the No Action with potentially irrigable permitted acres to Proposed Action with potentially irrigable permitted acres) are as follows: Stream flow in Alkali Creek would increase up to 412% (26 cfs) and up to 265% (25 cfs) in July and August, respectively.	Same as the Proposed Action

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
		Stream flow in Alkali Creek would decrease up to 98% (16 cfs) and 82% (2 cfs) in April and May, respectively. The 0.4-cfs minimum bypass would remain in Alkali Creek in April and May. Decreases in stream flow in Paint Rock Creek would occur in April, May, July, and August, ranging from 1 to 57 cfs. Decreases in stream flow in Medicine Lodge Creek would occur in May, July, and August, ranging from 1 to 7 cfs. Stream flow decreases up to 6% may occur in the lower Nowood River in April and May. Increases in stream flow in Paint Rock Creek would occur in July, August, September, and October ranging from 1 to 37 cfs. Increases in stream flow in the lower Nowood River would occur in July, August, September, and October ranging from 1 to 15 cfs.	
How would changes in stream flow and in-channel structures affect stream morphology and channel stability, including changes to sediment transport?	No effect	Reduced transport capacity in Medicine Lodge Creek would occur, potentially leading to channel instabilities and a change in channel form. Potential deposition in Alkali Creek (upper segment) would occur, leading to channel instabilities and a change in channel form, Impoundment of 2.1 miles of Alkali Creek would occur. Change in channel type resulting from stabilization structures in Alkali Creek would occur.	Same as the Proposed Action
How would altering the ditches affect erosion potential and sediment transport in Paint Rock Creek and Medicine Lodge Creek?	No effect	There would be diversion ditch enlargements and potential local effects causing sedimentation (Paint Rock) and lateral adjustments (Medicine Lodge).	Same as the Proposed Action
How would the dam affect sediment loads downstream of the reservoir?	No effect	Sediment loads downstream of the dam would decrease. The reduced fine sediment supply in Paint Rock Creek would be negligible compared to total loading. Potential head-cutting and stability issues should be mitigated somewhat by channel structures. The upper channel segment's morphology would change from a Rosgen F-type to a Bc-type and the lower segment to a C-type, which is a more stable channel form.	Same as the Proposed Action
How would the dam affect sediment deposition on Alkali Creek upstream of the reservoir?	No effect	Reduced slope and energy would likely widen the channel and increase deposition, potentially forming multiple channels near the reservoir mouth. Channel may destabilize from a Rosgen G-type to an F-type.	Same as the Proposed Action
How would surface disturbances affect water quality?	No effect	Negligible to minor effects would occur and would be short term during construction.	Same as the Proposed Action

Issue	**Alternative A: No Federal Action**	**Alternative B: Proposed Action**	**Alternative C: Modified Proposed Action**
How would normal releases from the reservoir affect downstream water quality?	No effect	Minor effects would occur on temperature and dissolved oxygen concentrations. *E. coli* concentration during reservoir fill is predicted to increase and load is predicted to decrease. Improvement in water quality parameters would occur from decreased turbidity, sulfate concentrations, and specific conductance.	Same as the Proposed Action
How would maintenance of sediment deposition behind structures affect water quality?	No effect	Negligible to minor effects on turbidity would occur.	Same as the Proposed Action
What would the potential be for leaching of sulfate, salts, fertilizer, and pesticides into reservoir water, and what would be the potential short-term and long-term risks to water quality and human health?	No effect	Negligible leaching of fertilizer and pesticides would occur. Minor leaching of sulfate and salts would occur but would pose no risks to human health.	Same as the Proposed Action
Would water quality meet standards for recreational purposes?	No effect	Water quality would support recreational use because of the settling of sediment, large reservoir volumes, and long residence time.	Same as the Proposed Action
Would the source water quality be affected?	No effect	Effects would be negligible.	Same as the Proposed Action
Would the project affect water treatment providers?	No effect	Effects would be negligible.	Same as the Proposed Action
Would the project affect source water protection areas?	No effect	Effects would be negligible.	Same as the Proposed Action
What is the potential for increased bank erosion leading to an increase in *E. coli* downstream?	Negligible	Effects would be negligible.	Same as the Proposed Action
Would inundation affect groundwater volume, storage, flow, or quality?	No effect	A minor increase in groundwater volume and storage is anticipated in the underlying aquifers. No effects to regional groundwater flow direction are anticipated. An improvement in overall water quality is anticipated.	Same as the Proposed Action

3.15.6 Mitigation Measures

The following mitigation measures are proposed for water resources:

- Mitigation for the proposed structures (ditch enlargements, Alkali Creek channel stabilization and culvert enlargements) shall be designed wherever feasible using Natural Channel Design techniques in conjunction with specific biological recommendations from the WGFD. Natural Channel Design considers a stable dimension, pattern, and profile in regard to the dominant discharge and associated sediment transport and should generally follow techniques outlined for alluvial channels in NRCS's *Stream Restoration Design* (NRCS 2007c), and/or methods and treatments outlined in the *Stream Restoration A Natural Channel Design Handbook* (North Carolina Stream Restoration Institute 2007). Where feasible, proposed channel stabilization structures shall be designed to provide functional lift and therefore be self-mitigating.
- An AMP to address water quality issues will be developed before the publication of the ROD to inform the WDEQ 401 certification process. Table 3.15-14 briefly describes the desired condition and evaluation and potential corrective actions for each water quality issue.

Table 3.15-14. Water Quality Issues, Desired Conditions, and Development of an Adaptive Management Plan

Potential Water Quality Issue	Desired Condition (Indicators and Thresholds)	Evaluation and Potential Corrective Actions
Exacerbation of existing *E. coli* impairment in Paint Rock Creek	There is no net increase in *E. coli* loading to the impaired segment of Paint Rock Creek.	The project proponent will develop an AMP that includes monitoring to evaluate *E. coli* loading to the impaired reach of Paint Rock Creek and a suite of possible corrective actions that could be implemented upon a determination that a departure from the desired condition is associated with reservoir construction and/or operation.
Impacts to recreation in Alkali Creek Reservoir and Alkali Creek downstream of the reservoir	Alkali Creek Reservoir and Alkali Creek downstream of the reservoir are free from elevated *E. coli* and harmful cyanobacteria blooms that may pose risks to recreational activities.	The project proponent will develop an AMP that includes monitoring to evaluate *E. coli* and harmful cyanobacteria blooms in both waterbodies and a suite of possible corrective actions that could be implemented upon a determination that a departure from the desired condition is associated with reservoir construction and/or operation.
Impacts to aquatic life in Alkali Creek Reservoir and Alkali Creek downstream of the reservoir	Chemical and physical parameters in Alkali Creek Reservoir and Alkali Creek downstream of the reservoir are stable and within suitable ranges to sustain indigenous aquatic life.	The project proponent will develop an AMP that includes monitoring to evaluate chemical and physical parameters in both waterbodies and a suite of possible corrective actions that could be implemented upon a determination that a departure from the desired condition is associated with reservoir construction and/or operation.
Impacts to drinking water in Alkali Creek Reservoir	Alkali Creek Reservoir does not contain concentrations of metals or other compounds in concentrations known to limit use of water for human consumption.	The project proponent will develop an AMP that includes monitoring for chemical parameters known to occur in the underlying geologic material that may pose a risk for human consumption of the water at elevated concentrations.
Channel instability in Alkali Creek downstream of the reservoir	The Alkali Creek channel form is stable and supports the range of flows associated with reservoir operation.	The project proponent will develop an AMP that includes monitoring for channel stability and a suite of possible corrective actions that could be implemented upon a determination that a departure from the desired condition is associated with reservoir construction and/or operation.

3.15.7 Unavoidable, Adverse Effects

There would be no unavoidable, adverse effects to surface water, stream morphology and sedimentation, water quality, and groundwater.

3.16 Water Rights and Irrigation

This section describes potential effects to water rights and irrigators in the reservoir service area from the project.

3.16.1 Issues and Indicators

As part of the project's internal and external scoping process, the following water rights and irrigation issues were identified:

- How would a release of water from the proposed reservoir affect existing water rights and prioritization of exchanges?
- What would be the effects on supply and delivery of irrigation water for all users on the watershed?
- What would be the effects of increasing supplemental irrigation water on cropping and irrigation practices, crop production rates, and acres of irrigated lands?

In coordination with BLM resource specialists, the following water rights and irrigation indicators were developed to address these issues:

- Change in irrigation water supply as indicated by shortage reduction
- Cropping pattern changes, irrigation practice changes, change in consumptive use, and irrigated acres

3.16.2 Affected Environment

The analysis area for water rights and irrigation comprises stream reaches in the Alkali Creek Reservoir service area, which are Paint Rock Creek and its tributaries Medicine Lodge Creek and Alkali Creek up to the point where irrigation diversions end, and the Nowood River below the confluence with Paint Rock Creek downstream to the confluence with the Bighorn River. The service area identified in Figure 1.2-2 in Chapter 1 also defines the area within which irrigation effects are analyzed.

Annual shortages as indicated in the Nowood River StateMod model (Trihydro 2016a, 2018b) total 2,350 acre-feet and 6,030 acre-feet on average under current conditions and for Modelling Scenario 1 (with potentially irrigable permitted acreage in production), respectively. Most of the average shortage in the analysis area is located above the Alkali Creek Reservoir and is served by exchange (current conditions: 2,300/2,350 acre-feet × 100 = 98%) (Modelling Scenario 1: 4,610/6,030 acre-feet × 100 = 76%).

Currently, cropping patterns as indicated in the Nowood River StateMod model (Trihydro 2016a) in the analysis area consist primarily of alfalfa and grass pasture and hay with less amounts of spring grain, corn grain, and sugarbeets (Table 3.16-1). Irrigation practice as indicated in the Nowood River StateMod model in the analysis area consists primarily of unlined ditch conveyance. Flood irrigation application accounts for approximately 76% of the currently irrigated acreage, with sprinkler application serving the remaining acreage (24%). Crop yield data are reported by county by the USDA National Agricultural Statistics Service – Wyoming Field Office. Current crop production totals were estimated in the analysis area and are shown in Table 3.16-2. According to the Nowood River StateMod model, currently irrigated acreage in the analysis area totals 10,223 acres.

Table 3.16-1. Current Cropping Patterns in the Analysis Area

Location	Alfalfa (%)	Grass Pasture (%)	Corn Grain (%)	Spring Grains (%)	Sugarbeets (%)
Upper Paint Rock and Medicine Lodge Creek	40.5%	55.8%	3.2%	0.4%	0.0%
Lower Paint Rock Creek	49.5%	26.6%	13.5%	10.4%	0.0%
Alkali Creek	55.1%	26.4%	18.1%	0.4%	0.0%
Lower Nowood River	56.6%	12.0%	7.7%	19.4%	4.3%
Total	**50.4%**	**30.2%**	**10.6%**	**7.7%**	**1.1%**

Table 3.16-2. Current Crop Production in the Analysis Area

Alfalfa (tons)	Spring Grains (tons)	Dry Beans (tons)	Sugarbeets (tons)	Corn Grain (tons)	Grass Hay (tons)	Corn Silage (tons)
19,000	2,000	0	2,000	3,000	7,000	0

3.16.3 Methods of Analysis

It is difficult to predict the change in cropping patterns, irrigation practices, and irrigated acreage from additional supplemental irrigation water. A variety of factors contributes to each individual farmer's operation and rationale for changing their practice. However, the cropping patterns and irrigation practices in current use in the lower Greybull River watershed may be an indicator of the future changes that may occur in the analysis area with the addition of storage. The lower Greybull River watershed has a similar growing season to the analysis area and has irrigation water storage dating back to the 1930s with additional storage added in the 1950s and again in 2000. Based on this, the approach for this analysis is to use current conditions in the lower Greybull River watershed as an indicator of potential changes expected to occur with the addition of storage in the analysis area regarding cropping patterns, irrigation practices, and irrigated acreage.

Changes is crop yields were calculated through application of crop-water response analysis (which relates crop consumptive use and crop yield) and StateMod model predicted consumptive use.

Water allocation was simulated in the StateMod model and comparison of shortages between the baseline condition and "with project" condition determine the shortage reduction attributable to the project.

3.16.4 Environmental Effects

Assuming Alkali Creek Reservoir is constructed and using the impact indicators and methods of analysis described above, there is potential for changes to water rights and irrigation. These potential changes are considered with respect to each alternative.

3.16.4.1 ALTERNATIVE A: NO FEDERAL ACTION

If the Alkali Creek Reservoir is not constructed, existing effects to water rights and irrigation would remain. There is potential for the potentially irrigable permitted acreage to go into production independent of the Proposed Action; however, it is unknown to what extent. If none of the potentially irrigable permitted acreage goes into production (i.e., the amount of irrigated acreage does not change from current conditions) (Modeling Scenario 2), then existing effects to water rights and irrigation would remain. If all the potentially irrigable permitted acreage (3,150 acres) goes into production independent of the Proposed Action (Modeling Scenario 3), then crop yields and water shortages could increase.

3.16.4.2 ALTERNATIVE B: PROPOSED ACTION

Supply and delivery of irrigation water to users in the watershed may be affected by the Proposed Action. Regulation of existing water rights may occur by the State Board of Control – Wyoming State Engineer's Office while Alkali Creek Reservoir is filling. Under Wyoming water law, Alkali Creek Reservoir can limit (i.e., regulate) existing diversions to their water right appropriation while the reservoir is in priority and able to store available water. Historically and in accordance with Wyoming water law, existing diversions may divert beyond their water right appropriation as long as no other existing water right is affected (e.g., during free river [non-regulation] conditions). If an existing water right holder believes that their water right is being affected and they are not receiving their appropriation of water, they can contact the State Board of Control (i.e., place a call on the stream) to regulate the stream. The Alkali Creek Reservoir would have a junior (i.e., current day priority) water right to all other existing water rights and could only be filled when all other water right appropriations are satisfied; however, the existing water right holder of the Alkali Creek Reservoir would be able to place a call on the stream to cause the State Board of Control to regulate senior water rights down to their appropriation (i.e., senior water right holders may not be able to divert in excess of their appropriation while the reservoir is trying to fill). Although this may be viewed as an effect to an existing senior water right holder, it is allowed under Wyoming water law and therefore should not be considered as a project effect to existing water rights.

The StateMod model was set to operate in accordance with the "one fill rule," which means reservoirs are only allowed to store the volume that is vacant as of October 1 of each year. Furthermore, the StateMod model incorporates both surplus and excess water rights in accordance with Wyoming water law. These laws permit certain water rights to divert an additional 1 cfs per 70 acres irrigated.

Irrigation water shortages, as simulated in the StateMod model with and without the Alkali Creek Reservoir for Modelling Scenarios 1 and 2, are shown in Table 3.16-3 and Table 3.16-4, respectively. Most of the average shortage in the analysis area is located above the Alkali Creek Reservoir and served by exchange (current conditions: 2,300/2,350 acre-feet × 100 = 98%) (Modelling Scenario 1: 4,610/6,030 acre-feet × 100 = 76%). An exchange only works when there is water at the upstream location that is destined for irrigated acreage served directly by the reservoir. Shortage reduction is a measure of how well an alternative is able to meet the need and reduce shortages. Shortages in the analysis area under Modelling Scenario 1 could be reduced by 2,310 acre-feet (38%) on average with the Alkali Creek Reservoir. Shortages in the exchange portion of the analysis area (the area above Alkali Creek Reservoir on Paint Rock Creek, Medicine Lodge Creek, and Alkali Creek served by exchange) could be reduced by 1,040 acre-feet (23%) on average. Shortages on Medicine Lodge Creek, which is served by exchange, could be reduced by 350 acre-feet (11%) on average with the Alkali Creek Reservoir. The Alkali Creek Reservoir would be minimally effective at reducing shortages on Medicine Lodge Creek.

Table 3.16-3. Irrigation Water Shortage with and without Alkali Creek Reservoir under Modeling Scenario 1

Stream Reach	Modeling Scenario 1							
	Without Reservoir		With Reservoir (Proposed Action)		Average Shortage Reduction (acre-feet)	Average Shortage Reduction in 30% Shortest Years (acre-feet)	Shortage Reduction (%)	
	Average Shortage (acre-feet)	30% Shortest Years Avg. Shortage (acre-feet)	Average Shortage (acre-feet)	30% Shortest Years Avg. Shortage (acre-feet)				
Medicine Lodge Creek (served by exchange)	3,220	5,970	2,870	5,190	350	780	11%	13%
Paint Rock Creek above Alkali Creek (served by exchange)	730	1,660	180	600	550	1,060	75%	64%
Alkali Creek (served by exchange)	660	1,010	520	720	140	290	21%	29%
Paint Rock Creek below Alkali Creek (served directly)	70	170	0	10	70	160	100%	94%
Nowood River below Paint Rock Creek (served directly)	1,350	3,430	150	530	1,200	2,900	89%	85%
Total	**6,030**	**12,240**	**3,720**	**7,050**	**2,310**	**5,190**	**38%**	**42%**

Table 3.16-4. Irrigation Water Shortage with and without Alkali Creek Reservoir under Modeling Scenario 2

Stream Reach	Modeling Scenario 2							
	Without Reservoir		With Reservoir (Proposed Action)		Average Shortage Reduction (acre-feet)	Average Shortage Reduction in 30% Shortest Years (acre-feet)	Shortage Reduction (%)	
	Average Shortage (acre-feet)	30% Shortest Years Avg. Shortage (acre-feet)	Average Shortage (acre-feet)	30% Shortest Years Avg. Shortage (acre-feet)				
Medicine Lodge Creek (served by exchange)	1,780	4,020	1,770	4,000	10	20	1%	0.5%
Paint Rock Creek above Alkali Creek (served by exchange)	170	600	90	320	80	280	47%	47%
Alkali Creek (served by exchange)	350	630	260	430	90	200	26%	32%
Paint Rock Creek below Alkali Creek (served directly)	10	40	0	0	10	40	100%	100%
Nowood River below Paint Rock Creek (served directly)	40	140	0	0	40	140	100%	100%
Total	**2,350**	**5,430**	**2,120**	**4,750**	**230**	**680**	**10%**	**13%**

Using the lower Greybull River watershed as a reasonable indicator of potential future cropping patterns and irrigation practices, higher value crops may be implemented in the analysis area with the addition of storage. Using additional supplemental irrigation water to offset late-season irrigation shortages on existing crops and for drought protection is the least costly method for a farmer to increase production. Switching crops is costlier because of replanting and additional production costs. Increasing the amount of acreage farmed is costlier yet because of additional infrastructure requirements. Based on this, it is predicted that cropping patterns would change before additional acreage is brought into production. Implementation of more efficient irrigation practices, which would stretch stored water supplies further, may follow the addition of storage in the watershed. Sprinkler application currently covers 24% of the acreage in the analysis area. The lower Greybull River watershed has only 9% sprinkler application. Using lower Greybull River watershed as an indicator, sprinkler application may not increase beyond current conditions. However, funding assistance for sprinklers through the NRCS in Big Horn County is a competitive program where applicants are ranked based on potential improvement to resource concerns. Based on this, other factors may be involved in the prediction of changes to irrigation practice. The lower Greybull River watershed has a cropping pattern as shown in Table 3.16-5 (Wenck 2017). With the addition of water storage, it is predicted that cropping patterns in the analysis area would trend toward those found in the lower Greybull River watershed.

Table 3.16-5. Lower Greybull River Cropping Pattern and Predicted Change to the Analysis Area

Crop Type	Lower Greybull River (%)	Analysis Area Predicted Percentage Point Change (%)
Alfalfa	20%	-30%
Spring grains	25%	+17%
Dry beans	17%	+17%
Sugarbeets	17%	+16%
Corn grain	9%	-2%
Grass hay	7%	-23%
Corn silage	5%	+5%

An analysis was completed in the *Nowood River Storage Level II Study Phase II Report* (Trihydro 2016a) to estimate the potentially irrigable permitted acreage in the analysis area. This acreage is a subset of permitted acreage that is realistically irrigable but may not be currently irrigated. The potentially irrigable permitted acreage in the analysis area totals 13,374 acres. The amount of irrigated acreage in the analysis area may increase up to this amount (3,150-acre increase [+31%]).

Crop production is predicted to change under the Proposed Action, which makes additional irrigation water available and includes 3,150 additional irrigated acres. Total crop production in the analysis area under the Proposed Action was estimated and is shown in Table 3.16-6.

Table 3.16-6. Predicted Crop Production in the Analysis Area under the Proposed Action under Modeling Scenario 1

Alfalfa (tons)	Spring Grains (tons)	Dry Beans (tons)	Sugarbeets (tons)	Corn Grain (tons)	Grass Hay (tons)	Corn Silage (tons)
10,000	7,000	3,000	51,000	4,000	2,000	15,000

3.16.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

Irrigation water shortages as simulated in the StateMod model with and without Alkali Creek Reservoir under Modelling Scenario 1 are the same as the Proposed Action and are shown in Table 3.16-3. The Modified Proposed Action could be less effective at reducing shortages compared to the Proposed Action because of the smaller supply canal capacity, which could reduce the yield of the reservoir; however, the simulation model (which uses a monthly timestep and may not capture instantaneous flow rates of available water and canal capacity limitations) does not predict this. For example, if 1) water is only available for a short duration (e.g., 30 days) in Paint Rock and Medicine Lodge Creek, 2) no water is available in Alkali Creek, 3) the reservoir is at conservation pool elevation (i.e., requires 5,996 acre-feet to re-fill, and 4) the irrigation diversions in the Anita Ditch restrict the canal capacity to fill the reservoir to less than 100 cfs, then the reservoir may not fill and the yield of the reservoir would be reduced. In other words, if water is only available for a short duration at a flow rate that exceeds the available canal capacity, then some of the available water may not be able to be diverted and stored with the smaller canal capacity under the Modified Proposed Action and the reservoir may be less effective at reducing shortages. See Section 3.15.4.3.1 for additional discussion of reservoir supply.

Changes to cropping patterns, irrigation practice, crop production (yield), and irrigated acres are expected to be the same as under the Proposed Action.

3.16.5 Summary of Effects

Table 3.16-7 presents a summary of the effects to water rights and irrigation under all alternatives.

Table 3.16-7. Water Rights and Irrigation Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would a release of water from the proposed reservoir affect existing water rights and prioritization of exchanges?	No effect	No effect	Same as the Proposed Action
What would be the effects on supply and delivery of irrigation water for all users on the watershed?	No effect	Shortages under Modelling Scenario 1 (with potentially irrigable permitted acreage in production) in the analysis area could be reduced by 2,310 acre-feet (38%) on average. Shortages in the exchange portion of the analysis area could be reduced by 1,040 acre-feet (23%) on average. Shortages under Modeling Scenario 2 (without the potentially irrigable permitted acreage in production; i.e., currently irrigated acreage) could be reduced by 230 acre-feet (10%) on average. Shortages in the exchange portion could be reduced by 180 acre-feet (8%) on average.	Same as the Proposed Action
What would be the effects of increasing supplemental irrigation water on cropping and irrigation practices, crop production rates, and acres of irrigated lands?	No effect	Up to 3,150 additional acres may be irrigated. There would be an increase in spring grains, dry beans, corn, and sugarbeets. There would be a decrease in alfalfa and grass hay. Consumptive use of surface water would increase up to 7,800 acre-feet per year.	Same as the Proposed Action

3.16.6 Mitigation Measures

No mitigation measures are proposed for water rights and irrigation.

3.16.7 Unavoidable, Adverse Effects

There would be no unavoidable, adverse effects to water rights and irrigation.

3.17 Wetlands

This section addresses aquatic resources regulated under Section 404 of the CWA, including wetlands and surface waters. *Wetlands* are defined for regulatory purposes as "those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3, 40 CFR 230.3). This section also addresses riparian areas, which are unique vegetation communities that occur adjacent to waterways and wetlands.

3.17.1 Issues and Indicators

As part of the project's internal and external scoping process, the following wetlands issues were identified:

- How would changes to, or fluctuations in, water flow (diversions, water releases) affect the quality and quantity of wetlands along Paint Rock Creek and Medicine Lodge Creek downstream of the reservoir?
- How would reservoir inundation affect existing wetlands?
- What would be the effects of surface disturbance, including altering ditches and streams, on the hydrology of existing wetlands?

In addition, the following issues identified for riparian vegetation are discussed in this section:

- How would the downstream improvements change the vegetation community along Paint Rock Creek and Medicine Lodge Creek?
- What would be the effects to vegetation from converting Alkali Creek to a perennial stream?

Potential effects from the project include the permanent or temporary loss of wetlands and other waters from construction, and the permanent or temporary loss or modification of wetlands and other waters from operation of the new reservoir. Evaluation of effects to wetlands and surface waters is required for USACE Section 404 permits. The analysis presented here includes direct effects that would occur in the project area from construction and/or inundation, and indirect effects that may occur from changes in stream flows resulting from project operation in the Alkali, Paint Rock, and Medicine Lodge Valleys. Indirect effects to woody riparian vegetation is also addressed in this section, because these areas are usually adjacent to either wetlands or other waters and strongly influence the integrity and functions of the wetlands and surface waters.

In coordination with BLM resource specialists, the following wetlands indicators were developed to address these issues:

- Direct effects: acres of wetlands, other waters, or woody riparian that are permanently affected; acres of these resources temporarily affected during construction and subsequently restored; and acres within proposed wetland compensatory mitigation sites
- Indirect effects: estimated changes to wetland extent or condition based on modeled changes in stream flow volumes and timing

3.17.2 Affected Environment

The analysis area of direct effects to wetlands is the project area, including all areas of permanent and temporary disturbance from construction and inundation. These effects would be addressed during USACE Section 404 permitting. The analysis area for indirect effects includes all stream reaches from the point where water is diverted from Paint Rock Creek, Medicine Lodge Creek, and Alkali Creek downstream to the confluence with the Bighorn River. These are areas where hydrologic changes could affect wetlands and woody riparian vegetation.

For the direct effect analysis area, data on the distribution and characteristics of wetlands were developed using project-specific surveys in 2012 and 2017 (Trihydro 2018a). The results provided in Table 3.17-1, Figures 3.17-1 and 3.17-2, and Appendix G (detailed maps) are based on an analysis of GIS data provided by Trihydro and only include data from the analysis area. Three types of wetlands were observed in the analysis area: palustrine emergent (PEM), palustrine scrub-shrub (PSS), and palustrine forested (PFO). The palustrine system includes non-tidal wetlands dominated by vegetation, tidal wetlands with low salinity, and small and/or shallow ponds (Cowardin et al. 1979). Emergent wetlands are dominated by herbaceous vegetation such as sedges (*Carex* spp.) and rushes (*Juncus* spp.), scrub-shrub wetlands are dominated by woody shrubs and small trees less than 20 feet tall, and forested wetlands are dominated by woody vegetation more than 20 feet tall. Most of the wetlands in the direct effect analysis area are PEM. PSS wetlands occur at two locations along Alkali Creek, and only one small PFO wetland is near the east end of the Anita Supplemental Ditch.

Table 3.17-1. Wetlands and Surface Waters in the Project Area (Direct Effects Analysis Area)

Associated Waterbody	Area by Wetland Type* (acres)				Surface Waters (acres)
	PEM	PSS	PFO	Total	
Alkali Creek	4.84	0.40	0.00	5.24	2.63
Anita Ditch	4.83	0.00	0.00	4.83	7.67
Anita Supplemental Ditch	0.46	0.00	0.03	0.49	0.51
Medicine Lodge Creek	0.28	0.00	0.00	0.28	0.51
Paint Rock Creek	0.00	0.00	0.00	0.00	1.28
Total	**10.41**	**0.40**	**0.03**	**10.84**	**12.60**

National Wetland Inventory (NWI) wetland maps and aerial imagery (U.S. Fish and Wildlife Service [USFWS] 2016) were used to identify potential wetlands and woody riparian areas on the stream reaches downstream of the diversions on Paint Rock and Medicine Lodge Creeks and the Nowood River. The locations of wetland polygons were evaluated to select wetlands that appeared to result from surface and subsurface flows in the river valleys, and exclude wetlands that appeared to be related to irrigation return flows and ditches because these wetlands would not be affected by changes in creek flows. The NWI data are from the 1980s, and any mapped wetlands that no longer exist were removed from the analysis. Detailed information for Alkali Creek was available from Trihydro's aquatic resources inventory (Trihydro 2018a). Wetland and riparian conditions are as follows:

- Medicine Lodge Creek from diversion to Paint Rock Creek: NWI data show three small PSS areas along the creek and one small PEM wetland in an oxbow totaling approximately 1.6 acres. Riparian woodland is common along the lower half of this creek segment.
- Paint Rock Creek from diversion to Medicine Lodge Creek: NWI data show four areas of PEM near the creek, comprising three oxbows or secondary channels and one floodplain depression totaling approximately 1.8 acres. Riparian woodland and shrubland vegetation occurs along most of the creek segment.
- Paint Rock Creek from Medicine Lodge to Alkali Creek: NWI data show 18 wetlands totaling 56 acres. PEM wetlands in floodplain depressions are more than half of the total; PSS and PFO occur mostly along the creek edge. Riparian woodland and shrub vegetation is relatively common.
- Alkali Creek: Trihydro's aquatic resource inventory (Trihydro 2018a) indicates that wetlands are present along this entire length of creek and total approximately 4.1 acres. Most of the wetlands are PEM; PSS was delineated in two areas. Riparian shrub and isolated trees are present in some areas.
- Paint Rock Creek below Alkali Creek: NWI data show 35 wetlands totaling approximately 53 acres. About half of the wetlands are PSS along the creek and the rest are largely PEM in oxbows, wetland depressions, or along the creek. Wetlands and riparian vegetation are mostly located in the upper half of this creek segment.
- Nowood River: NWI data show approximately 120 wetlands totaling hundreds of acres. The Nowood River is highly meandered, and many of the wetlands are in large oxbows that extend up to 0.25 miles away from the main channel. Approximately half of the wetlands are PSS and half are PEM. Riparian vegetation is present along some portions of the river segment.

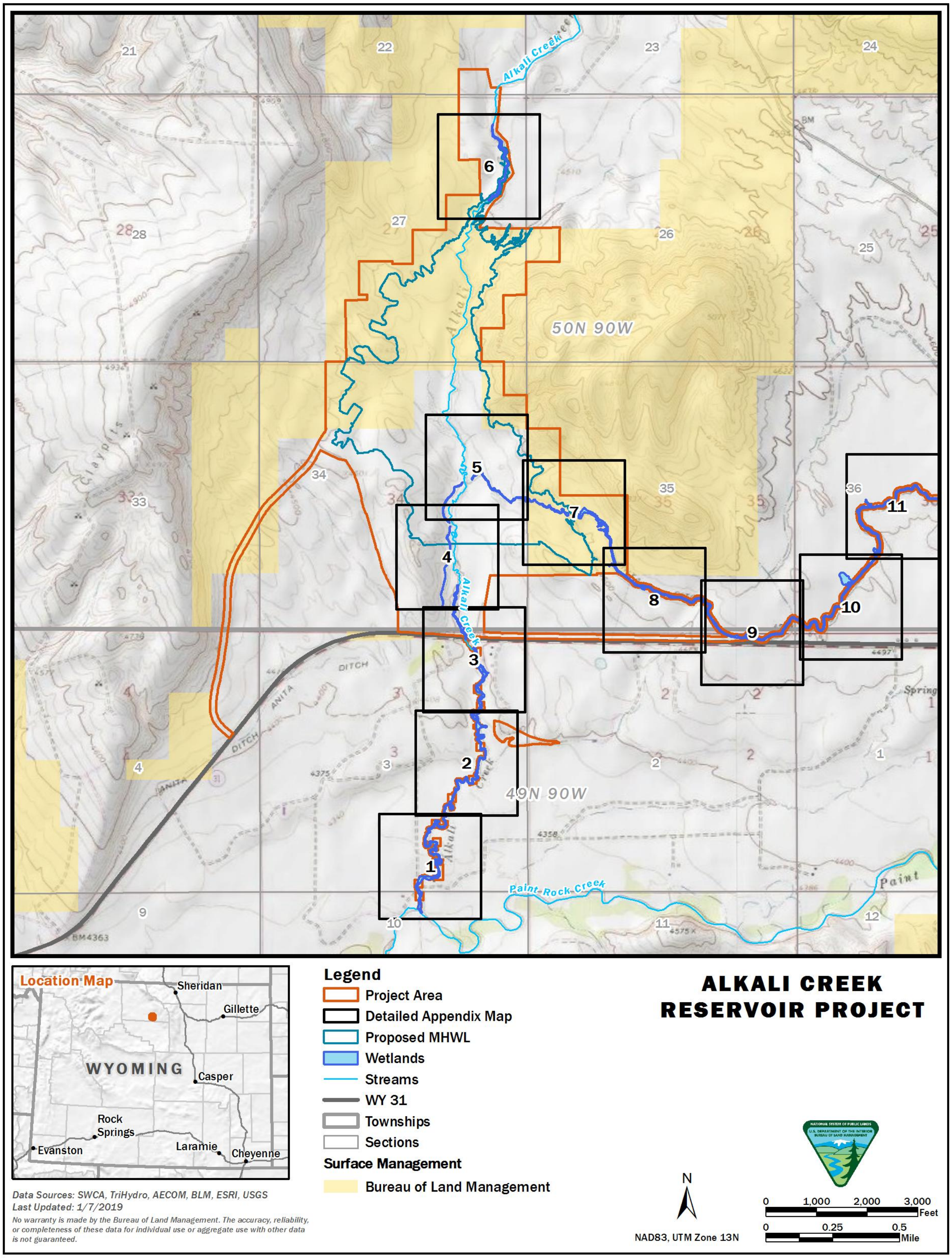

Figure 3.17-1. Wetlands and surface waters in the project area (direct effects analysis area), west side.

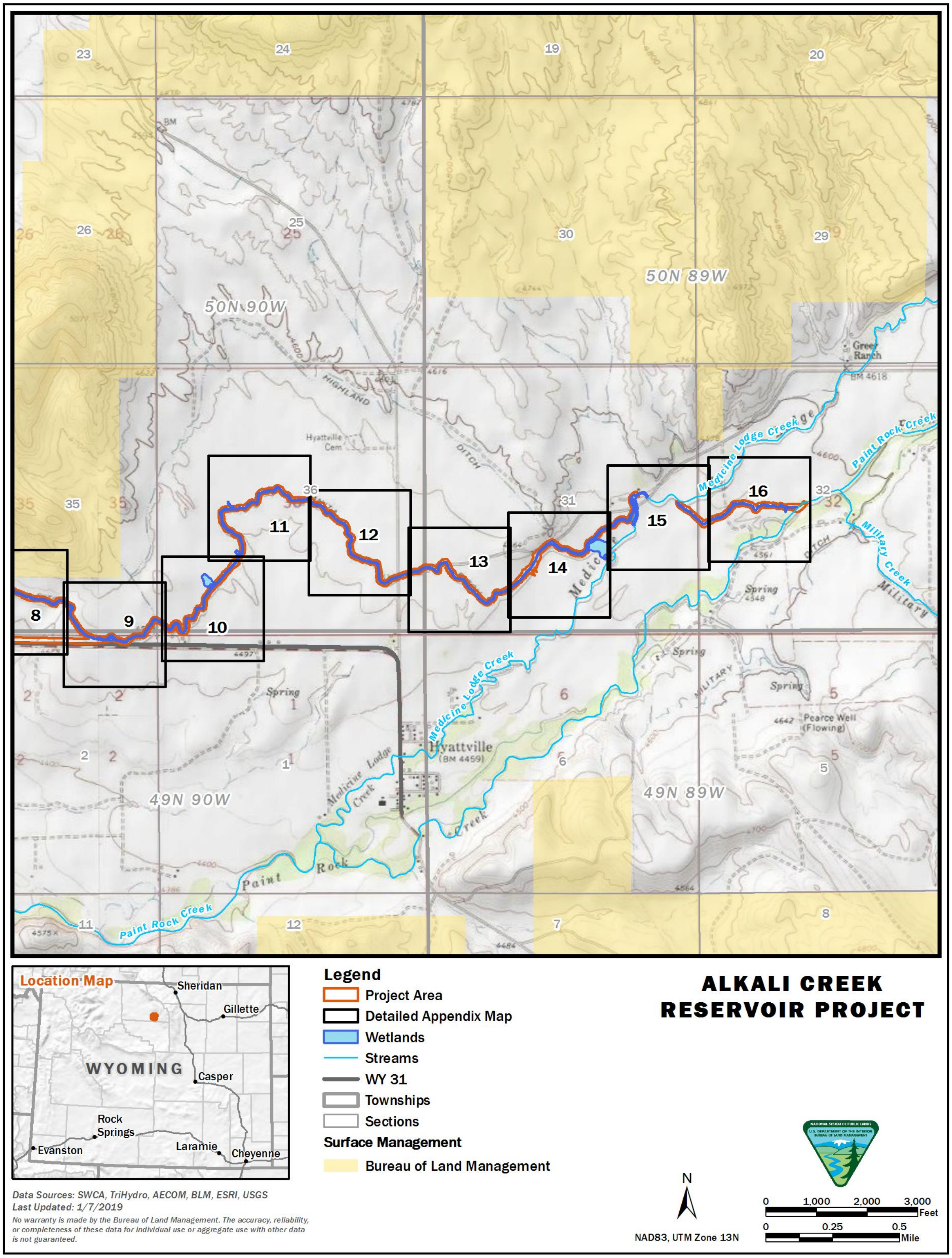

Figure 3.17-2. Wetlands and surface waters in the project area (direct effects analysis area), east side.

3.17.3 Methods of Analysis

Direct effects to wetlands were evaluated quantitatively by overlaying the results of the aquatic resource inventory with the project elements using GIS. Indirect effects to wetlands and riparian areas potentially affected by changes in flow volume or timing were evaluated qualitatively using the results of hydrologic modeling, especially changes in flow during the growing season.

3.17.4 Environmental Effects

3.17.4.1 ALTERNATIVE A: NO FEDERAL ACTION

There would be no permanent effects to wetlands from the No Federal Action unless potentially irrigable permitted acreage goes into production independent of the Proposed Action. If none of the potentially irrigable acreage goes into production, temporary effects to wetlands along ditches may occur periodically from ditch maintenance, and indirect effects from operation of the existing irrigation system would continue. If all of the permitted irrigable acreage goes into production, wetland impacts would occur in some stream reaches as described below (see Table 3.15-4 for changes in stream flows).

- Medicine Lodge Creek from the diversion to Paint Rock Creek: Flows would be reduced in May, June, and September, and would be increased in late summer. Reductions in bankfull flows may result in a trend toward development of multiple channels and increased width-to-depth ratio. Longer term effects may include increased stream entrenchment resulting in reduced overbank flows and lowering of the alluvial groundwater table near the stream. These incremental changes could lead toward eventual establishment of an inset floodplain, a narrower band of riparian vegetation, and reduced areas of wetlands along the creek.
- Paint Rock Creek from the diversion to Medicine Lodge Creek: Reductions in flows would be relatively small and would be unlikely to affect wetlands or riparian vegetation.
- Paint Rock Creek from Medicine Lodge to Alkali Creek: Reductions of flow in September of all years and October of dry years would have minimal effects to wetlands because reflow reductions would occur at the end of the growing season.
- Alkali Creek: Late-summer increases in flows may be beneficial for support of existing wetlands but would unlikely result in an increase in wetland size.
- Paint Rock Creek below Alkali Creek: Flow changes would be relatively small and are unlikely to affect wetlands.
- Nowood River: Increased irrigation would result in some reductions in bankfull flows as well as decreased river flows throughout the growing season, with greater impacts downstream near the Bighorn River. Reductions in bankfull flows have the potential to result in incremental stream geomorphology changes. Increased stream entrenchment may adversely affect wetland and riparian areas along the channel by reducing overbank flow and depth of saturation. Most of the wetlands in the Nowood Valley are away from the river and are probably supported by alluvial groundwater or irrigation practices. Reductions in stream flows would not likely significantly change groundwater depths across the floodplain

3.17.4.2 ALTERNATIVE B: PROPOSED ACTION

Effects to existing wetlands and surface waters from the Proposed Action are summarized in Table 3.17-2.

Table 3.17-2. Direct Effects to Wetlands and Surface Waters by Project Element under the Proposed Action

Project Element	Wetlands (acres)				Surface Water (acres)		
	PEM	PSS	PFO	Total	Creeks	Ditches	Total
Dam and reservoir	2.11	0.00	0.00	2.11	1.13	0.63	1.76
Ditch and diversion improvements*	4.58	0.00	0.03	4.61	1.79	7.54	9.33
Alkali Creek stabilization*	3.72	0.40	0.00	4.12	1.52	0.00	1.52
Total	**10.41**	**0.40**	**0.03**	**10.84**	**4.44**	**8.17**	**12.61**

*Based on comments by the USACE on the draft EIS, impacts to wetlands along the ditch and diversion improvements are considered temporary, and impacts from the Alkali Creek stabilization are considered to be relocated wetlands.

The dam and reservoir would include direct effects from construction of the dam and spillway and from inundation by the reservoir. Effects would occur both to Alkali Creek and to the portion of Anita Ditch that is within the dam and reservoir footprint. Approximately 0.41 acres of Alkali Creek wetlands and approximately 0.88 acres of Anita Ditch wetlands are within the footprint of the dam and the reservoir NHWL and would be permanently filled or inundated. Approximately 0.26 acres of wetlands along Alkali Creek is between the NHWL and the MHWL, and this area is likely to remain wetlands but with modified hydrology and vegetation. Approximately 0.45 acres of wetlands along Alkali Creek and 0.10 acres of Anita Ditch wetlands are between the dam and WY 31 (near the proposed spillway). Impacts to wetlands within the reservoir footprint would be permanent.

The enlargement of supply ditches would include the widening of ditches and modifications to existing diversions, including placement of cross vanes or similar structures in Medicine Lodge and Paint Rock Creeks. Wetland effects would occur along Anita Ditch (3.84 acres), Anita Supplemental Ditch (0.49 acres), and Medicine Lodge Creek (0.28 acres). It is likely that similar wetlands would re-establish along the ditches and at Medicine Lodge Creek after construction, and these impacts would be temporary.

Alkali Creek stabilization measures would include rock grade control structures to serve as control points and to maintain channel grade. The stabilization structures would be installed at intervals along Alkali Creek south of WY 31. Additional activities in this area would include bank revetment and enlargement or replacement of culverts. These stabilization measures would maintain or increase the area of wetlands along Alkali Creek.

Other project activities, including construction and use of access roads and development of a public recreation area, are expected to have no direct effects to wetlands.

The USACE would require compensatory mitigation for permanent wetland losses including the 2.1 acres of existing wetlands within the footprint of the proposed dam and reservoir. The WWDO has identified seven potential mitigation areas totaling 8.2 acres for creation of new wetlands at the reservoir (Trihydro 2016a). The wetland mitigation areas would be located on flat areas near the upper edge of the reservoir and would be created by constructing berms and placing salvaged hydric soils. Variations in water depth would result in creation of shallow open water, marshes, and wet meadows. The required acres of compensatory mitigation would be identified during Section 404 permitting. Additional wetlands may establish naturally on the periphery of the reservoir; these are not included in compensatory mitigation.

Indirect effects to wetlands could result from project-induced flow changes in ditches and streams in the analysis area. Changes in flows could affect wetlands by lowering of alluvial groundwater tables, or by changing the width of bank area that is regularly inundated. Lowering alluvial groundwater could affect wetlands across the valley floor. Changes in inundation patterns primarily concern changes in peak flows, which may result in channel encroachment and changes in composition of streamside wetland vegetation. Riparian vegetation would most likely be affected from changes in overbank flow onto the active floodplain during floods. A summary of flow changes and effects for each stream reach is provided below for each surface water modeling scenario.

3.17.4.2.1 Modeling Scenario 1

Modeling Scenario 1 addresses impacts of the new reservoir combined with the new irrigable acreage going into production. Changes in stream flows are presented in Table 3.15-5.

- Medicine Lodge Creek from the diversion to Paint Rock Creek: Bankfull flows would decrease, and stream flows would be reduced throughout the growing season. Initial effects from reductions in bankfull flows may include a trend toward development of multiple channels and increased width-to-depth ratio. Longer term effects may include increased stream entrenchment resulting in reduced overbank flows and lowering of the alluvial groundwater table near the stream. These incremental changes could eventually lead toward eventual establishment of an inset floodplain, a narrower band of riparian vegetation, and reduced areas of wetlands along the creek. Reductions in stream flows throughout the growing season may result in changes in plant species composition or cover in fringe wetlands along the edge of the creek.
- Paint Rock Creek from the diversion to Medicine Lodge Creek: Reductions in flows would be relatively small and would be unlikely to affect wetlands or riparian vegetation.
- Paint Rock Creek from Medicine Lodge to Alkali Creek: Bankfull flows would be reduced by a small amount and could result in incremental changes similar to those described for Medicine Lodge Creek. Potential effects would be greatest in scrub-shrub wetlands and riparian vegetation adjacent to and near the creek channel. Emergent wetlands are mostly located further from the channel and are likely supported by irrigation.
- Alkali Creek: The Proposed Action would decrease flows to low levels during most of the year, including the current April through May spring runoff season, and would greatly increase flows in July and August. Increased high flows in late summer combined with channel stabilization measures would result in decreased stream entrenchment, which may raise the alluvial water table and increase overbank flooding. The area of wetlands and riparian is likely to increase, especially in the lower section near the valley floor. The late-season development of wetland hydrology is likely to have an effect on species composition.
- Paint Rock Creek below Alkali Creek: Flow changes are not expected to result in changes in geomorphology. Wetlands and riparian vegetation are not likely to be affected except for isolated areas of bank erosion.
- Nowood River: Reductions in bankfull flows have the potential to result in incremental stream geomorphology changes. Increased stream entrenchment may adversely affect wetland and riparian areas along the channel by reducing overbank flow and depth of saturation. Most of the wetlands in the Nowood Valley are away from the river and are probably supported by alluvial groundwater or irrigation practices. Reductions in stream flows are not likely to significantly change groundwater depths across the floodplain.

3.17.4.2.2 Modelling Scenario 2

Modeling Scenario 2 shows impacts if the amount of irrigated acreage does not change as a result of the new reservoir (Table 3.15-7). There would be little or no changes to flows in Medicine Lodge Creek and to Paint Rock Creek from the diversion to Alkali Creek. Flows in Alkali Creek would be reduced in the spring, but to a smaller extent than the previous scenario, and there would be only small increases in late summer. The combination of reduced spring flows and limited increases in late-summer flows would likely result in decreases in wetland area or quality along lower Alkali Creek. There would be limited changes in stream flows in lower Paint Rock Creek and the Nowood River that are unlikely to adversely affect wetlands.

3.17.4.2.3 Modelling Scenario 3

Modelling Scenario 3 addresses changes in stream flows that would result from the reservoir if all of the idle acreage goes into production independent of the Proposed Action (Table 3.15-9). Impacts would be generally the same as described above under Modelling Scenario 1 except there would be little or no impacts to Medicine Lodge Creek and the Nowood River because bankfull flows would not change. Late-summer increases in flows in the Nowood River may have minor, beneficial impacts to streamside wetlands.

3.17.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

Direct and indirect effects would be mostly similar to the Proposed Action. Reductions in bankfull flow would be 2% to 27% in Medicine Lodge Creek and 1% to 26% in Paint Rock Creek between Medicine Lodge Creek and Alkali Creek. Changes to wetlands and riparian vegetation would be the same as described for the Proposed Action, but the incremental changes may be greater. Spillway modification is not likely to change wetland effects. Modified filling might result in less modification to the existing ditches, which may result in less effects to wetlands located along the ditches.

3.17.5 Summary of Effects

Table 3.17-3 presents a summary of the effects to wetlands under all alternatives.

Table 3.17-3. Wetlands Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would changes to, or fluctuations in, water flow (diversions, water releases) affect the quality and quantity of wetlands along Paint Rock Creek and Medicine Lodge Creek downstream of the reservoir?	Under Modelling Scenario 2 (without potentially irrigable permitted acreage in production), temporary effects to wetlands along ditches may occur periodically from ditch maintenance, and indirect effects may occur from operation of the existing irrigation system. Under Modelling Scenario 1 (with potentially irrigable permitted acreage in production), reductions of bankfull flows in Medicine Lodge Creek may lead to reduced areas of wetlands along creek. Increased irrigation would lead to decreased flows in Nowood River. Increased stream entrenchment may adversely affect wetland and riparian areas along the channel by reducing overbank flow and depth of saturation.	Under Modelling Scenario 1 (with potentially irrigable permitted acreage in production), reductions in bankfull flows in Medicine Lodge Creek would lead to reduced areas of wetlands along creek. For Alkali Creek, increased high flows in late summer combined with channel stabilization measures would increase area of wetlands and riparian vegetation. Increased irrigation would lead to decreased flows in Nowood River. Increased stream entrenchment may adversely affect wetland and riparian areas along the channel by reducing overbank flow and depth of saturation. Under Modelling Scenario 2 (without potentially irrigable permitted acreage in production), there would be little or no changes to flows in Medicine Lodge Creek and to Paint Rock Creek from the diversion to Alkali Creek. Flows in Alkali Creek would be reduced in the spring, but to a lesser extent, and there would be only small increases in late summer. This would likely result in decreases in wetland area or quality along lower Alkali Creek. Wetlands along lower Paint Rock Creek and Nowood River are unlikely to be adversely affected. Under Modelling Scenario 3, effects would be the same as above except there would be little or no impacts to Medicine Lodge Creek and the Nowood River because bankfull flows would not change. Late-summer increases in flows in the Nowood River may have minor beneficial impacts to streamside wetlands.	Same as the Proposed Action
How would reservoir inundation affect existing wetlands?	No effect	Construction of the dam and reservoir would result in 2.11 acres of permanent wetland effects.	Same as the Proposed Action
What would be the effects of surface disturbance, including altering ditches and streams, on the hydrology of existing wetlands?	No effect	Construction of the ditch improvements and Alkali Creek stabilization would result in 8.73 acres of wetland effects. These impacts would be temporary; hydrology and wetlands would re-establish after construction.	Same as the Proposed Action

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would the downstream improvements change the vegetation community along Paint Rock Creek and Medicine Lodge Creek?	No effect for most reaches. Under Modelling Scenario 1 (with potentially irrigable permitted acreage in production), Medicine Lodge Creek could eventually move toward eventual establishment of an inset floodplain, a narrower band of riparian vegetation, and reduced areas of wetlands along the creek.	Under Modelling Scenario 1 (with potentially irrigable permitted acreage in production), increased high flows in Alkali Creek in late summer combined with channel stabilization measures would increase area of wetlands and riparian vegetation. In Paint Rock Creek, reductions in stream flows throughout the growing season may result in changes in plant species composition or cover in fringe wetlands along the edge of the creek. Under Modelling Scenario 2 (without potentially irrigable permitted acreage in production), flows in Alkali Creek would be reduced in the spring, but to a lesser extent, and there would be only small increases in late summer. This would likely result in decreases in wetland area and eventual reductions in riparian vegetation.	Same as the Proposed Action
What would be the effects to vegetation from converting Alkali Creek to a perennial stream?	No effect	Flows in Alkali Creek would be reduced during most of the year, but would be greatly increased during late summer. Increased high flows and channel stabilization measures are likely to increase the area of wetlands and riparian, especially in the lower section near the valley floor.	Same as the Proposed Action

3.17.6 Mitigation Measures

Pursuant to 40 CFR 230.94 (Compensatory Mitigation for Losses of Aquatic Resources), a compensatory mitigation plan must be submitted and approved by the USACE before the District Engineer can issue an individual CWA Section 404 permit. The plan would need to address each of the 12 elements required for a mitigation plan. A description of conceptual mitigation is provided in Section 7.3.3.1 of the *Nowood River Phase II Summary Report* (Trihydro 2016a). The amount of required compensatory mitigation and the detailed plan would be developed after the determination of the least environmentally damaging practicable alternative. No public notice would be required for the mitigation plan as part of the 404 process.

3.17.7 Unavoidable, Adverse Effects

Unavoidable, adverse effects to wetlands would include disturbance and loss of riparian vegetation and 2.11 acres of existing wetlands areas in the analysis area.

3.18 Terrestrial and Aquatic Wildlife

This section describes the effects of the project on terrestrial and aquatic wildlife.

3.18.1 Issues and Indicators

3.18.1.1 TERRESTRIAL WILDLIFE

As part of the project's internal and external scoping process, the following wildlife-related issues were identified:

- What would be the effects of habitat alteration or habitat loss associated with surface disturbance on bird species, big-game species, and other BLM sensitive species?
- What would be the effects of converting terrestrial habitat to aquatic habitat on bird species, big-game species, and other BLM sensitive species?
- Would proposed fencing affect big-game species?
- How would proposed surface disturbance affect occupied or suitable habitat and local populations of greater sage-grouse (*Centrocercus urophasianus*)?
- How would light, noise, dust, and visual intrusions during construction activities affect bird species, big-game species, and other BLM sensitive species?
- How would an increase in traffic and human activity during construction and operations affect bird species, small mammal species, and big-game species?
- What would be the effects of recreational activities on bird and wildlife species?

In coordination with BLM resource specialists, the following terrestrial wildlife resources indicators were developed to address these issues:

- Acres of wildlife habitat lost to project elements
- Acres of terrestrial habitat converted to aquatic habitat
- Risk of wildlife injury or mortality
- Risk of altering wildlife behavior and habitat use

3.18.1.2 AQUATIC WILDLIFE

As part of the project's internal and external scoping process, the following aquatic wildlife–related issues were identified:

- How would stream disturbance from construction of diversion structures in Paint Rock and Medicine Lodge Creeks and culverts and rock grade control structures in Alkali Creek affect aquatic habitat?
- How would reservoir construction and the subsequent conversion of lotic habitat to lentic habitat affect fish and other aquatic species?
- How would changing the water flow regimes in Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek affect fish species and their habitats? In addition, how would these changes affect fish and aquatic species downstream in the Nowood River?
- Would the project introduce or increase the spread of aquatic invasive species?
- What would be the effects of recreational activities on aquatic species?

Issues identified for surface water and water quality as well as for wetlands are in Sections 3.15 and 3.17, respectively, and also have linkage to aquatic biological resources.

In coordination with BLM resource specialists, the following aquatic wildlife indicators were developed to address these issues:

- Area of disturbance related to fish and macroinvertebrate habitat
- Loss of stream miles and reservoir surface area, volume, estimated depths, and area of nearshore habitat in acres
- Percentage flow change that exceeds 10% compared to base flows in a given month during normal, dry, and wet years and qualitative evaluation of effects of flow changes on fish and macroinvertebrates
- Relative risk based on known or potential presence of aquatic invasive species in the analysis area
- Qualitative evaluation of changes in fishing pressure

3.18.2 Affected Environment

3.18.2.1 TERRESTRIAL WILDLIFE

The analysis area for terrestrial wildlife species is the project area with a 1-mile buffer. The analysis area extends beyond the project area because wildlife migration and the ability of construction activities to extend to a habitat-level effect. The general line-of-sight and/or audible distance where wildlife species can be affected by the project is 1 mile. The temporal analysis period includes recent past and present conditions as well as the anticipated 75-year life of the project.

The wildlife analysis area has several vegetation types, as detailed in Section 3.13 Vegetation, which provide habitat for a variety of terrestrial wildlife species. The mammals in the analysis area tend to be generalist species that can be found in other regions of the state. No mammal species' ranges are restricted to the analysis area or the immediate vicinity. Big-game species that could occur in the analysis area include pronghorn (*Antilocapra americana*), elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), moose (*Alces alces*), American black bear (*Ursus americanus*), wolf (*Canis lupus*), mountain lion (*Puma concolor*), and white-tailed deer (*Odocoileus virginianus*). Big sagebrush shrubland and steppe, nonnative grassland and steppe, native grassland, and aspen forest and woodland are important habitats for big-game species in the winter and during seasonal migrations. Pronghorn are more common than deer in saltbush and greasewood, big sagebrush shrubland and steppe, and grassland habitats. The only crucial big-game range in the analysis area is for the mule deer. The mule deer crucial range consists of a corridor along the south portion of the analysis area that is between larger areas of crucial range to the northeast and southwest. The analysis area supports a diverse range of bird species, including many year-round residents, summer residents and migratory birds, and winter residents and migratory birds. The rolling hills, shrublands, riparian areas, and agriculture areas in the analysis area provide a variety of habitats (nesting and brooding, foraging, resting, and wintering) that support bird species.

Habitat needs for raptors include nesting sites, foraging areas, and roosting or resting sites. Roosting generally occurs in riparian areas and on cliff faces. Potential nesting and roosting sites in the analysis area occur primarily in riparian habitats along Alkali Creek and Paint Rock Creek and in cliff and canyon habitats along the north portion of Alkali Creek. SWCA conducted raptor and raptor nest surveys in the analysis area in 2017 and 2018. Two raptor nests (one *Buteo* sp. and one bald eagle [*Haliaeetus leucocephalus*]) were observed in the analysis area during the 2018 surveys. Additionally, many raptor species were observed using the analysis area, including northern harrier (*Circus hudsonius*), red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*), turkey vulture (*Cathartes aura*), and bald eagle (SWCA 2017a and 2018).

The analysis area contains both greater sage-grouse general habitat management areas (GHMA) and priority habitat management areas (PHMA) as defined by the BLM (BLM 2015a). The PHMA acreage in the analysis area and project area is shown in Table 3.18-1. All areas in the project area and analysis area that are not PHMA are categorized as GHMA (3,694 acres in the analysis area). The PHMA intersected by the project area corresponds to the boundaries of the State of Wyoming Sage Grouse Executive Order 2015-4 Hyattville Core Area. In addition to the analysis area, which is a 1-mile buffer around the project area, greater sage-grouse leks were assessed within 2 miles and 4 miles of the project area based on the BLM PHMA and State of Wyoming Sage Grouse Executive Order regulatory guidelines. There are no known greater sage-grouse leks within 2 miles of the project area, but there are five leks within 4 miles of the project area, with the closest lek being 2.9 miles away from the project area. Additionally, a telemetry study of greater sage-grouse in the project area occurred from 2011 to 2014. Only 10 individuals, approximately 2.8% of birds monitored, were documented using habitats within 2 miles of the project area. The nearest recorded occurrence of a sage-grouse was 0.78 miles from the project area (West Inc. 2015).

Table 3.18-1. Greater Sage-Grouse Priority Habitat Management Areas in the Analysis and Project areas by Surface Ownership, Proposed Action and Modified Proposed Action

Alternative	Analysis Area (acres)		Project Area (acres)	
	BLM	Private	BLM	Private
Proposed Action and Modified Proposed Action	1,830.5	7,142.5	3.0	102.0

BLM sensitive species are species designated internally as BLM sensitive in accordance with BLM Manual 6840 (BLM 2008c). There are 28 terrestrial BLM sensitive species listed for the WFO. These species, their suitable habitat, and their potential to occur in the analysis area are listed in Table 3.18-2. Although not generally considered a terrestrial species, the plains spadefoot toad is also included in this table because of its occasional use of terrestrial habitats.

Table 3.18-2. Terrestrial Bureau of Land Management Sensitive Species in the Worland Field Office

Common Name	Scientific Name	Habitat	Potential to occur in the Analysis Area
Mammals			
Gray wolf	*Canis lupus*	Generalists: tundra, woodlands, forests, grasslands, deserts	Yes
Townsend's big-eared bat	*Corynorhinus townsendii*	Forests, basin-prairie shrub, caves and mines	Yes
White-tailed prairie dog	*Cynomys leucurus*	Basin-prairie shrub, grasslands	Yes
Spotted bat	*Euderma maculatum*	Cliffs over perennial water, basin-prairie shrub	Yes
North American wolverine	*Gulo gulo*	Continuous, dense stands of subalpine and alpine coniferous forests	No
Water vole	*Microtus richardsoni*	Moist subalpine and alpine meadows	No
Grizzly bear	*Ursus arctos horribilis*	Forests, forest openings	No
Swift fox	*Vulpes velox*	Grasslands	Yes
Birds			
Northern goshawk	*Accepter gentilis*	Conifer and deciduous forests	No
Baird's sparrow	*Ammodramus bairdii*	Grasslands, weedy fields	Yes
Sagebrush sparrow	*Amphispiza nevadensis*	Basin-prairie shrub, mountain-foothill shrub	Yes
Western scrub-jay	*Aphelocoma californica*	Breeds in Utah juniper	No
Burrowing owl	*Athene cunicularia*	Grasslands, basin-prairie shrub	Yes
Ferruginous hawk	*Buteo regalis*	Basin-prairie shrub, grassland, rock outcrops	Yes
Greater sage-grouse	*Centrocercus urophasianus*	Basin-prairie shrub, mountain-foothill shrub	Yes
Mountain plover	*Charadrius montanus*	Short-grass and mixed-grass prairie, openings in shrub ecosystems, prairie dog towns	Yes
Yellow-billed cuckoo	*Coccyzus americanus*	Open woodlands, streamside willow and alder groves	No
Trumpeter swan	*Cygnus buccinator*	Lakes, ponds, rivers	Yes
Merlin	*Falco columbarius*	Open woodlands, savannah, grasslands, and shrub-steppe below 8,500 feet	Yes
Prairie falcon	*Falco mexicanus*	Open grasslands; nests in rock cliffs	Yes
Peregrine falcon	*Falco peregrinus*	Tall cliffs	Yes
Bald eagle	*Haliaeetus leucocephalus*	Primarily along rivers, streams, lakes, and waterways	Yes
Loggerhead shrike	*Lanius ludovicianus*	Basin-prairie shrub, mountain-foothill shrub	Yes
Long-billed curlew	*Numenius americanus*	Grasslands, plains, foothills, wet meadows	Yes
Sage thrasher	*Oreoscoptes montanus*	Basin-prairie shrub, mountain-foothill shrub	Yes
White-faced ibis	*Plegadis chihi*	Marshes, wet meadows	Yes
Black-throated gray warbler	*Setophaga nigrescens*	Breeds in pinyon-juniper woodlands	No
Brewer's sparrow	*Spizella breweri*	Basin-prairie shrub	Yes

Common Name	Scientific Name	Habitat	Potential to occur in the Analysis Area
Amphibians			
Plains spadefoot	*Spea bombifrons*	Loose, well-drained soils in floodplains, prairies, loess hills	Yes

Source: BLM (2018c)

There are no terrestrial Endangered Species Act–listed threatened or endangered species that have the potential to occur in the analysis area (USFWS 2018).

SWCA conducted bird point counts throughout the analysis area in 2017 and 2018. The full list of bird species observed during these surveys can be found in technical memoranda (SWCA 2017a, 2018). Three BLM sensitive species, loggerhead shrike (*Lanius ludovicianus*), sage thrasher (*Oreoscoptes montanus*), and Brewer's sparrow (*Spizella breweri*), were observed in the analysis area during these surveys.

3.18.2.2 AQUATIC WILDLIFE

3.18.2.2.1 Aquatic Habitat

The analysis area for aquatic wildlife includes linear miles of stream habitat in Alkali Creek (4.4 miles), Paint Rock Creek (13.7 miles), Medicine Lodge Creek (2.7 miles), and the Nowood River (25.2 miles). Aquatic habitat in the analysis area also includes wetlands, which are discussed in Section 3.17. In total, approximately 10.8 acres of wetlands were identified in Alkali Creek and the Anita and Supplemental Anita Diversion ditches along with approximately 12.2 acres of surface waters. Most wetlands were identified as palustrine emergent, with smaller areas of palustrine scrub-shrub and palustrine forested. Numerous and often large wetlands are located downstream along Paint Rock Creek and the Nowood River, as described in Section 3.17.2.

The analysis area also contains crucial priority and enhancement priority habitat and conservation areas as defined by WGFD (WGFD 2015, 2010). In total, the analysis area contains 25.2 miles of crucial priority and enhancement priority stream habitat in the Nowood River. The habitat includes an approximate 0.6-mile buffer on each side of the Nowood River. The aquatic ecological value of the Nowood River habitat is attributed to the protection of species of greatest conservation (SGCN), as discussed below in the Special-Status Aquatic Species section. Enhancement priority habitat areas represent those habitats with a realistic potential to address wildlife habitat issues and to improve, enhance, or restore wildlife habitats. The analysis area also contains two conservation areas, Nowood River and Paint Rock Creek, which overlap the analysis area (WGFD 2018d). Conservation areas were defined by WGFD to protect riparian corridors and habitat for native fish, amphibians, turtles, and mollusks (WGFD 2010).

Water quality in Medicine Lodge and Paint Rock Creeks and the Nowood River is discussed in Section 3.15.4.2.3. Portions of Paint Rock Creek and the Nowood River are impaired for *E. coli*. However, it is important to note that the standard for *E. coli* is for human health. There is no Wyoming *E. coli* standard for aquatic life.

Aquatic invasive species are nonnative aquatic species such as zebra and quagga mussels (*Dreissena polymorha* and *D. bugensis)* and New Zealand mudsnail *(Potamo pyrgus antipodarum)* that can adversely affect aquatic species and their habitat. Although no invasive species have been detected in the analysis area, they could be present (Hochhalter 2018).

3.18.2.2.2 Fish

The BLM's focus of fish resources is on game (sports) and special-status fish species because of their importance to the WGFD and federal agencies as they relate to their management of public lands. Paint Rock and Medicine Lodge Creeks support a coldwater game fishery at higher elevations; this fishery transitions to a coolwater-warmwater fishery at lower elevations in the Nowood River. The WDEQ classification for stream reaches in the analysis area is Class 2AB, which is designated for the protection of game and non-game fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture, and scenic values (WDEQ 2013). The WGFD categorizes stream segments according to the number of pounds of trout per mile. These categories are Blue Ribbon (> 600 pounds per mile), Red Ribbon (300–600 pounds per mile), Green Ribbon (50–300 pounds per mile), and Orange Ribbon (unknown pounds) (WGFD 2018d). The analysis area contains 16.4 miles of Red Ribbon coldwater game fish habitat in Paint Rock Creek (13.7 miles) and Medicine Lodge Creek (2.7 miles) and 25.2 miles of Orange Ribbon coolwater-warmwater fish habitat in the Nowood River (WGFD 2018d). Current populations of game fish species include brown trout, channel catfish (*Ictalurus punctatus*), mountain whitefish (*Prosopium williamsoni*), and rainbow trout in Paint Rock and Medicine Lodge Creeks, and channel catfish and sauger (*Sander canadense*) in the Nowood River (Bear 2009; Hochhalter 2017).

No current or core "conservation population" (i.e., genetically pure) of Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) occurs in the analysis area. The closest current and core conservation populations are located in the upper portion of Paint Rock Creek approximately 18 miles upstream of the analysis area (Yellowstone Cutthroat Trout Assessment Group 2018). Because there is historic Yellowstone cutthroat trout habitat in Paint Rock (13.7 miles) and Medicine Lodge (2.7 miles) Creeks, this species is considered a species of management priority in the analysis area.

Streams in the analysis area contain native and nonnative fish species. Native fish species are important as part of WGFD's protection of streams. Some of the native fish species in the analysis area are also special-status species and are discussed in the Special-Status Aquatic Species section. Studies conducted by Bear (2009) within and adjacent to the analysis area indicated that the fish populations mainly comprise minnow and sucker species. Fish collected during Bear's studies as well as by the WGFD were dominated by native species such as fathead minnow (*Pimephales promelas*), longnose dace (*Rhinichthys cataractae*), longnose sucker (*Catostomus catostomus*), mountain sucker (*Catostomus platyrhynchus*), and shorthead redhorse (*Moxostoma macrolepidotum*) in the Nowood River, and lake chub (*Couesius plumbeus*), longnose dace, mountain sucker, and white sucker (*Catostomus commersoni*) in Alkali and Paint Rock Creeks (Bear 2009; WGFD 1994, 2016). Native fish species were more abundant than nonnative species, which include carp (*Cyprinus carpio*), brown trout, and rainbow trout (Bear 2009).

3.18.2.2.3 Amphibians

SWCA conducted an amphibian survey throughout the analysis area in 2017, and no amphibians were observed (SWCA 2017b). However, stream and wetland habitat provides potential habitat for amphibians.

3.18.2.2.4 Macroinvertebrates

Information on macroinvertebrates was based on WDEQ data from surveys conducted at the following locations and dates: Paint Rock Creek at the Lumen Draw confluence (September 2016), Medicine Lodge Creek near Hyattville (September 2000), and Nowood River near Manderson (October 2010). Macroinvertebrate communities were diverse and abundant, with 38 to 46 total taxa and densities ranging from 4,100 to 17,700 individuals per square meter (WDEQ 2017). The most abundant taxa consisted of mayfly, caddisfly, stonefly, beetle, and blackfly species. Three macroinvertebrate groups that are considered indicators of high water quality conditions (i.e., mayflies, stoneflies, and caddisflies) were represented by moderate to high number of taxa (15 to 24).

3.18.2.2.5 Special-Status Aquatic Species

No federally listed aquatic species or aquatic species proposed for listing occur in the analysis area (USFWS 2018). Other special-status aquatic species in the analysis area include Wyoming SGCN and BLM sensitive species. Following U.S. Congressional guidelines for state wildlife action plans, each state must identify species with low or declining populations that are indicative of the diversity and health of the state's wildlife. In Wyoming, these species are termed SGCN (WGFD 2017). In total, four fish SGCN were evaluated in terms of potential occurrence in the analysis area (Table 3.18-3). Based on the recent species evaluations in the Wyoming Action Plan (WGFD 2017g), the identification of SGCN in the analysis area includes Tier II (moderate priority) and III (lowest priority) ratings. A summary of habitat and spawning and breeding periods is also provided in Table 3.18-3.

Table 3.18-3. Special-Status Aquatic Species in the Analysis Area

Common Name	Species Name	Status*	Occurrence and Habitat
Fish			
Flathead chub	*Platygobio gracilis*	SGCN Tier III	Known occurrence in the Nowood River Habitat: Use smallest dominant substrates, deepest water, greatest amount of woody debris, and least amount of undercut banks Spawning: July–September
Sauger	*Sander canadensis*	SGCN Tier II	Lower Nowood River during spring runoff for spawning and remain in the river until late October Habitat: Relatively deep, low velocity pools and runs in large, turbid rivers Spawning: May
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	SGCN Tier II	Lower Nowood River during spring runoff for spawning and then returns to the Bighorn River Habitat: Near the bottom of large, unregulated, turbid rivers over sand or fine gravel substrates Spawning: June and July
Yellowstone cutthroat trout	*Oncorhynchus clarkii bouvieri*	BLM; SGCN Tier II	Historic habitat in Paint Rock and Medicine Lodge Creeks
Amphibians			
Northern leopard frog	*Lithobates pipiens*	BLM; SGCN Tier II	Species not observed in Alkali Creek and ditches; dismissed from additional analysis

Sources: Bear (2009); Hochhalter (2017); Smith and Keinath (2007); SWCA (2017); WGFD (2017g, 2010); Yellowstone Cutthroat Trout Assessment Group (2018).

* Status: SGCN = Species of Greatest Conservation Need, BLM = BLM sensitive species.

3.18.3 Methods of Analysis

3.18.3.1 TERRESTRIAL WILDLIFE

Effects to terrestrial wildlife were analyzed using a GIS analysis of acres of terrestrial habitat lost to project construction or converted to aquatic habitat and a qualitative assessment of the risk for increased wildlife displacement, changes in habitat use or avoidance, and injury or mortality from the project. The qualitative assessment included examining the effects of increased traffic volume on wildlife injury and mortality; the effects of construction noise, dust, and visual intrusions on wildlife species; and the effects of recreation on wildlife species. Wildlife data used in the analysis included existing information from the WGFD, USFWS, Wyoming Natural Diversity Database, and BLM, along with 2017 and 2018 SWCA survey data.

3.18.3.2 AQUATIC WILDLIFE

Based on the flow analysis provided in Appendix E, flow change that exceeded 10% in a given month during normal, dry, and wet years was the impact indicator. This percentage was used because it is a level that exceeds the difference that could occur as a result of flow measurement error or uncertainty. Percentage flow changes exceeding 20 % particularly in consecutive months represent a more substantial effect on aquatic habitat and fish species. The flow analysis for aquatic biological resources used median flow data, because they show a wider range of months under normal, dry, and wet years when flow changes exceeded 10% compared to average flow data. Percentage flow changes were provided by model analyses for the following three scenarios: Modeling Scenario 1 (with potentially irrigable permitted acreage in production), Modeling Scenario 2 (without potentially irrigable permitted acreage in production), and Modeling Scenario 3 (with potentially irrigable permitted acreage in production independent of the Proposed Action).

3.18.4 Environmental Effects

3.18.4.1 ALTERNATIVE A: NO FEDERAL ACTION

3.18.4.1.1 Terrestrial Wildlife

Under the No Federal Action, terrestrial wildlife would not be affected. Existing terrestrial wildlife habitats would not be removed, replaced, or converted in the analysis area. Any effects on wildlife would result from any possible or ongoing agricultural, residential, or other development in the area.

3.18.4.1.2 Aquatic Wildlife

Under the No Federal Action, the Alkali Creek Reservoir would not be constructed. There would be no instream disturbances in Paint Rock, Medicine Lodge, and Alkali Creeks from project construction activities. Fish passage would continue to be restricted in Paint Rock Creek. Sediment input from current activities in the analysis area would continue under the No Federal Action, but there would be no effect from the project disturbance activities.

Effects to aquatic habitat and species in Paint Rock and Medicine Lodge Creeks and in the Nowood River would continue at present levels as a result of current water uses, stream flows, and existing development in drainages in the analysis area. Aquatic habitat in Paint Rock and Medicine Lodge Creeks would continue to coincide with current flow patterns. Flows also could be affected by the potential future irrigation of 3,150 acres of land, which consists of 2,400 acres in the lower Nowood River and 750 acres in areas adjacent to Medicine Lodge and Paint Rock Creeks. Although these lands are not currently irrigated, the full use of water rights would result in flow changes in these streams. The full use of water rights for irrigation of idle lands would result in flow increases exceeding 10% in 1 to 3 months and flow reductions exceeding 10% in 1 to 5 months in the analysis area streams depending on the location and type of year. For example, the lower Nowood River at the Bighorn confluence would have flow reductions exceeding 10% in 4 months in a normal year (June–September), 3 months in a dry year (June, July, and August), and 2 months in a wet year (July and August). The magnitude of these additional flow reductions would range from 15 to 153 cfs in a normal year and from 14 to 94 cfs in a dry year in comparison to stream flows under current irrigation. There would be no flow increases exceeding 10% in the lower Nowood River with the irrigation of idle lands.

The current level of recreational fishing in the analysis area would continue under the No Federal Action.

3.18.4.2 ALTERNATIVE B: PROPOSED ACTION

3.18.4.2.1 Terrestrial Wildlife

Terrestrial wildlife would be affected by the loss of habitat, conversion of terrestrial habitat to aquatic habitat, increased traffic and human use in the project area, and disturbances during construction. Direct, long-term loss of terrestrial habitat would occur from the surface disturbance associated with the dam and reservoir construction, along with associated infrastructure, including the access roads, enlargement of supply ditches, public access areas, Alkali Creek stream structures, and borrow area. The construction phase would have short-term, localized, adverse effects on wildlife from noise, light pollution, dust, and general disturbance. Surface-disturbing activities that remove vegetation and disturb soils can affect habitat quality. Permanent and temporary effects to wildlife would include alteration or loss to existing habitat and disturbance and use associated with the Proposed Action (e.g., construction noise, recreational use). Project surface disturbances are identified in Table 2.4-2 in Chapter 2.

Habitat alteration or loss associated with both temporary and permanent surface disturbance would result in directly changing local bird, big-game, and BLM sensitive species assemblages and use in the area. Reptiles, amphibians, and small mammals would have the greatest short-term and long-term adverse effects (from mortality and habitat loss) because these groups have smaller home ranges that could be eliminated through actions occurring under the Proposed Action. Noxious weeds that often colonize along the edges of surface disturbance could spread to non-disturbed adjacent habitats, degrading habitat quality and decreasing the amount of native forage. During construction, wildlife would avoid otherwise suitable habitat in and around the surface disturbance. Small mammals or birds may avoid adjacent habitat due to increased exposure to predators, noise, and human presence during construction, maintenance, and recreational activities. Erosion or runoff from surface disturbance (e.g., access roads, dam embankment) could enter adjacent habitats and cause additional soil erosion or reduce the quality of vegetation in the adjacent habitat. Potential direct effects to big-game species would include reduction of potential forage and the potential increase of noxious weeds and habitat fragmentation caused by vegetation removal. The proposed fencing may deter big-game species from moving across the analysis area or accessing the project area itself, though big-game species can sometimes cross fencing. The fencing may act as a deterrent to big-game movement, though this would likely be a minor effect because of the large size of big-game home ranges. Construction of the Proposed Action could remove potential raptor nesting substrate and habitat (e.g., trees and grasslands) and negatively affect tree nesters (e.g., golden eagle [*Aquila chrysaetos*], merlin [*Falco columbarius*], red-tailed hawk, and American kestrel [*Falco sparverius*]) and ground nesters (e.g., ferruginous hawk [*Buteo regalis*], burrowing owl [*Athene cunicularia*], and short-eared owl [*Asio flammeus*]). The Proposed Action would remove suitable foraging habitat for golden eagles, owls, and hawks.

Habitat fragmentation from the larger dam footprint, pipelines, access roads, ditches, and fences could reduce habitat connectivity and restrict animal movement for smaller, less mobile species. Fragmentation causes a reduction in usable ranges and potential isolation of smaller wildlife species. Pronghorn can be impeded by fences, which could result in restricting access to water located in reservoir for this species. Mule deer crucial range is the only known corridor to overlap the analysis area. Given the large size of the mule deer crucial range compared to relatively small size of the Proposed Action, habitat fragmentation from the Proposed Action would likely have a minor effect on mule deer movement. The only project elements that are located within the mule deer crucial range are the Anita Supplemental Ditch, Anita bypass pipeline, Alkali Creek stream structures, borrow area, and portions of the Anita Ditch. Big-game may temporarily avoid traveling near these areas during construction.

Greater sage-grouse could be affected by loss of habitat within the PHMAs and GHMAs. Approximately 105 acres of PHMA area would be lost to greater sage-grouse in the project area. There should be minimal visual and noise disturbance during construction and operation during the breeding season because of the distance of the project from known leks and the existence of visual and noise obstructions (e.g., trees, ridges, existing buildings, traffic on existing roads). However, because greater sage-grouse could use the project area year-round, the increased noise and human activity during construction (see Sections 3.6 Noise and Section 3.12 Transportation) could reduce the use of the project area during this time. Additionally, the potential long-term increase in recreational use and new viewshed (Sections 3.9 Recreation and Section 3.14 Visual Resources) in the project area could also result in a reduction of greater sage-grouse use. However, greater sage-grouse use of the project area is low, and effects to greater sage-grouse use of surrounding habitats are expected to be minimal. The riparian development that may occur along the inundation area boundary within PHMAs could result in increased forb and insect populations that are beneficial to young greater sage-grouse.

To further analyze the effects of the Proposed Action to greater sage-grouse, a Density and Disturbance Calculation Tool analysis was conducted. Of the 105 acres of project area that is within the Hyattville Core Area, 94.67 acres has already been counted as existing disturbance in the Density and Disturbance Calculation Tool. Therefore, the project would disturb approximately 10.33 new acres of the Hyattville Core Area and contribute approximately 0.02% additional disturbance. The total disturbance for this area would be approximately 3.31%, which falls below the development thresholds for the greater sage-grouse core area. The project would be compliant with SGEO Executive Order 2015-4 (WGFD 2018e).

In addition to those effects from habitat alteration or loss, conversion from terrestrial to aquatic habitat would further result in these areas being unavailable to terrestrial wildlife species, such as small mammals, sagebrush or grassland obligate birds, big game, and reptiles, except as a water source. Flooding of the reservoir area would convert approximately 333.3 acres of terrestrial habitat at maximum water levels. However, the Proposed Action would create more wetland and riparian habitats along the edges of the reservoir area. The diversity and abundance of migratory game birds, waterfowl, shorebirds, fish feeding raptors (e.g., bald eagle, osprey [*Pandion haliaetus*]), and wading birds (e.g., western grebe [*Aechmophorus occidentalis*], common loon [*Gavia immer*]) would increase because of the increased availability of such aquatic, wetland, and riparian habitats. Conversion to open water habitat could negatively affect burrowing owls, which rely on prairie dog colonies in grasslands for shelter and nesting sites. Creation of additional aquatic habitat could result in the increase in mosquito populations, which would increase the chance of West Nile Virus outbreaks in the surrounding areas. West Nile Virus outbreaks are known to be detrimental to greater sage-grouse populations.

The increase in local traffic volumes and human activity during construction and recreational activities could lead to a rise in wildlife mortality or injury. Mortalities and injuries could result from wildlife collisions with vehicles, facilities, or construction equipment. Nests, dens, or burrows could be destroyed by construction equipment.

Human activity, including recreation, during construction and operation could cause raptors to avoid otherwise suitable habitat. For example, noise and disturbance associated with the recreational facilities could make potential nesting habitat unsuitable for raptors. The human disturbance may cause nest abandonment, make a nest site less productive, or prevent a suitable nest site from being used. Indirect negative effects on raptors may result from decreasing the prey base (which generally consists of small mammals, reptiles, and songbirds) in the analysis area because of habitat loss.

Noise pollution can harm the health, reproduction, survivorship, habitat use, physical distribution, and abundance of wildlife species. Noise can also lead to changes in behavior, including avoidance behavior. Short-term construction effects would mainly involve displacement of individuals from disturbed areas and adjacent habitats (wildlife avoidance). Displaced individuals would be forced into neighboring territories where they would compete with already established individuals for limited food supplies and other resources. Potential temporary effects from construction could also include nest or burrow abandonment or loss of eggs or young, which would result in a decrease in reproductive success for certain species.

3.18.4.2.2 Aquatic Wildlife

Habitat Disturbance/Alteration and Water Quality

There would be instream disturbances in Paint Rock, Medicine Lodge, and Alkali Creeks from project construction activities. Construction of the diversion structures would alter approximately 20,400 square feet in Paint Rock Creek and 7,100 square feet in Medicine Lodge Creek. Habitat quality would improve in terms of stream stability, erosion control, and the addition of rock substrates in a 1.5-mile segment of Alkali Creek after temporary disturbance of approximately 206,820 square feet for rock grade control structures.

The channel grade controls in Alkali Creek would be constructed using natural channel design techniques with consideration for fish habitat and geomorphic processes. As discussed in Section 3.15, there would be change in channel form in Alkali Creek due to stabilization structures to convey delivery flows. Channel form would change from a Rosgen F-type to Bc-type, which consists of a riffle-dominated channel with limited pools. These habitat conditions would favor species such as longnose dace rather than lake chub, channel catfish, and sucker species that use pool habitats. Potential widening and lateral migration also could occur upstream of the reservoir because of sedimentation and backwater effects. Culverts would also be enlarged or replaced in Alkali Creek at two locations as shown in Figure 2.4-1. The culverts also would be constructed and placed following natural channel design techniques. In addition, habitat improvements involving stream stability and the addition of rock substrates in Paint Rock Creek would disturb approximately 19,600 square feet in a 300-foot segment. The habitat improvements would be beneficial to fish and macroinvertebrates and a portion of the conservation area designated for the Paint Rock Creek drainage. These construction activities would result in potential temporary displacement of fish and macroinvertebrate mortalities. However, fish would move back to the area and macroinvertebrates would recolonize the disturbed areas after construction is completed within several months (Waters 1995).

The creation of the Alkali Creek Reservoir would remove approximately 2.1 miles of stream (lotic) habitat, which would be converted to 294 acres of reservoir habitat at the NHWL. The loss of stream habitat would eliminate fish and macroinvertebrate species that are associated with stream morphology and flowing conditions. In general terms, creation of the Alkali Creek Reservoir would provide standing water (lentic) habitat with deep water and bays (reservoir inlets) and nearshore areas. All fish species known to occur in Alkali Creek such as channel catfish, lake chub, longnose dace, longnose sucker, mountain sucker, and white sucker are adaptable to lentic conditions and could colonize the reservoir, though they prefer lotic habitats. Game fish could be stocked in the reservoir, if the decision is made to develop a game fishery. The conservation pool would be maintained for the reservoir following guidance from the WGFD. Simulated end-of-month storage data for the proposed reservoir are discussed in Section 3.15.4.2.1 and are useful in determining the potential for fishery development. The maximum depth of the reservoir would be 57 feet from the bottom of Alkali Creek and 37 feet from the toe of the dam. Approximately 25 % of the conservation pool would have depths of 12 to 15 feet. Bay and nearshore habitat would be beneficial to fish species because fish use these areas as feeding areas and the development of young fish.

As discussed in Section 2.4.2.7.2, if the reservoir is abandoned and removed, grade control structures in Alkali Creek would be removed or left in place, depending on WGFD evaluation and recommendation at the time of reservoir removal. Because the channel associated with the proposed reservoir would be located on private lands, the BLM would not have the authority to require reclamation. Channel reclamation would be discussed at the time of dam removal and coordination with landowners to determine if reclamation is acceptable. If reclamation is approved by the landowner, channel dimensions would be restored to allow for sediment transport, floodplain connectivity, and fish habitat.

There would be no adverse effects to special-status fish species (flathead chub [*Platygobio gracilis*], sauger, and shovelnose sturgeon [*Scaphirhynchus platorynchus*]) and to the crucial priority and enhancement priority habitat in the Nowood River because habitat disturbance would not affect downstream areas such as the Nowood River.

As discussed in Section 3.15, construction disturbance would also increase sediment input in Alkali, Paint Rock, and Medicine Lodge Creeks. Changes in water quality from surface disturbance within or near waterbodies would include short-term increases in suspended sediment concentrations and turbidity. Sediment that is suspended from direct disturbance would be re-deposited in downstream areas. The extent of the sedimentation effect would depend on the flow conditions, substrate composition, stream configuration, and types of aquatic communities located within the affected areas. The duration of sediment effects would be short term and would coincide with the construction period. Fish and macroinvertebrate species could be affected by sedimentation from covering substrates or physiological processes of species in portions of the perennial streams in the analysis area (Waters 1995). To avoid or minimize this effect, the project would implement erosion control measures, as detailed Section 2.4.2.3.

As discussed in Section 3.15.4.2.3, there would be minor changes in stream temperatures, dissolved oxygen, and *E. coli* concentrations because of releases from the reservoir. A multilevel outlet described in Section 2.4.2.2.1 would allow for control of the temperature of released water. However, inflows in the winter may contribute higher temperatures because of the artesian well water source. The outflow temperatures would be monitored and modified if needed, as part of the AMP (see Section 3.15.6). Potential water quality changes in the reservoir would also be addressed through the AMP.

The attainment of beneficial uses in Medicine Lodge and Paint Rock Creeks and the Nowood River related to 1) non-game and game fish species and other aquatic life such as macroinvertebrates and 2) fish consumption would not be changed as a result of the Proposed Action, as discussed in Section 3.15.4.2.3.

Vehicle and equipment use within or near waterbodies would pose a risk to aquatic biota from fuel or lubricant spills. If fuel reached a waterbody, aquatic species could be exposed to toxic conditions. Spills could result in chemical residues within or on substrate in waterbodies, resulting in direct mortalities or reduced health of aquatic organisms. A mitigation measure would be implemented to restrict fueling within 100 feet of streams and wetlands. The construction contractor would be required to implement spill prevention, control, and countermeasures in the event that a spill occurs during construction.

One special-status aquatic species, Yellowstone cutthroat trout (historic habitat), would be adversely affected by short-term sediment increases in disturbance areas in Paint Rock and Medicine Lodge Creeks. The affected areas would be localized near the disturbance, with conditions returning to pre-construction levels after the instream work is completed. There would be no adverse or beneficial effects on special-status species in the Nowood River. Sediment-related effects would not extend downstream into the Nowood River. The fuel restriction mitigation measure and spill prevention and control would also prevent adverse effects on species in the Nowood River. Northern leopard frog was considered but eliminated from further analysis, because it was not observed in field surveys.

Aquatic Invasive Species

If recreational boating is allowed in the Alkali Creek Reservoir, there would be a long-term risk of introducing aquatic invasive species. Wyoming law requires any watercraft entering the state from March 1 through November 30 each year to have a mandatory inspection by an authorized inspector before launching in Wyoming waters. In addition, construction activities associated with diversion structures in Paint Rock and Medicine Lodge Creeks and rock grade control structures in Alkali Creek would represent a short-term risk to transfer and spread of aquatic invasive species. It is assumed that aquatic invasive species could be present in these streams. No best management practices or design features have been defined to require equipment or vehicle washings prior to working in multiple streams with the same equipment.

Flow Conditions and Aquatic Habitat

The changes in flow and aquatic habitat and species would be a long-term effect during the operation of the reservoir. The effects of flow changes on stream morphology are discussed in Section 3.15. Potential effects to stream morphology include reduced sediment transport capacity leading to channel aggradation and lateral stability issues, which exacerbates lateral migration and bank erosion. Eventually the channel may narrow through the process of vegetation encroachment, reduced habitat complexity, and reduced overbanking flows that recharge alluvial aquifers and support floodplain habitats and channel planform adjustment. The channel would eventually support a narrower band of riparian vegetation.

The importance of a stream's flow regime for sustaining the biodiversity and ecological integrity of aquatic environment is well established (Poff and Zimmerman 2010). Flow regime is considered the primary determinant regarding the structure and function of aquatic and riparian ecosystems for streams and rivers. When evaluating the effects of flow reductions on aquatic species, it is important to consider the magnitude of flow change in relation to the base flow and the time of year. The effects of flow reductions on fish include potential decrease in habitat, restriction in fish movements, change in fish cover, and shift in species composition. Percentage flow changes exceeding 20% particularly in consecutive months represent a more substantial effect on aquatic habitat and fish species. It is assumed that all of the fish species in the analysis area would be sensitive to flow changes exceeding 20% in consecutive months. Flow increases would have both beneficial and adverse effects on fish species and their habitat. Flow increases would provide additional wetted area and increased depths in the stream. For example, increased flow especially in the winter months would increase overwintering habitat. Adverse effects could include habitat changes from channel instability and increased bank erosion, loss of riparian vegetation, and alteration of spawning cues and fish recruitment. The response of macroinvertebrate communities to flow changes has been the subject of reviews by Poff and Zimmerman (2010) and Dewson et al. (2007). Studies that involved relatively large flow reductions (approximately 60% to 100%) indicated that macroinvertebrate abundance and diversity declined. However, results varied for smaller flow changes in terms of effects on macroinvertebrate communities.

Based on the flow analysis summary and background information regarding flow change effects on aquatic species, the following summary is provided for the analysis area streams. Three modelling scenarios were analyzed for the evaluation of project flow effects on aquatic species habitat and species. Modelling Scenario 1 consists of the Proposed Action with potentially irrigable permitted acreage in production and represents the highest level of effects to aquatic species. Modeling Scenario 2 consists of the Proposed Action without potentially irrigable permitted acreage in production. Modeling Scenario 3 compares the Proposed Action with idle land irrigation to the No Federal Action without the reservoir and irrigation of idle lands, identifying flow changes associated solely with the reservoir. Impacts resulting from the three scenarios are discussed below for the project area streams.

It is important to note that most of the flow changes are related to irrigating an additional 2,000 acres of land in the lower Nowood River, based on the assumption that the full water rights would be exercised for these currently idle lands. For example, the full use of water rights in the lower Nowood River would account for 75% to 100% of the flow reductions under the Proposed Action. Full water rights also would apply to 1,000 acres of irrigated land adjacent to Medicine Lodge and Paint Rock Creeks.

Medicine Lodge Creek: Flow changes in Medicine Lodge Creek would vary depending on the location. Under Modelling Scenario 1, the stream segment upstream of Anita Ditch would have flow increases exceeding 10% in 1 month (August) in a wet year to 4 months (April, July–September) in a dry year, with percentages ranging from 12% to 96%. These flow increases would be beneficial by providing additional habitat for aquatic species. However, relatively high flow increases could result in adverse effects in terms of bank instability and erosion. There would be no flow reductions exceeding 10% in all types of years under this scenario. There also would be no flow changes exceeding 10% in this stream segment under the other two scenarios. Flow changes exceeding 10% in Medicine Lodge Creek downstream of Anita Ditch would occur in 4 to 5 months. The highest level of flow effects would occur under Modelling Scenario 1 when there would be reductions exceeding 10% in 3 of 4 months (May, June, July, or September) during all types of years. The percentage reductions would range from 11 to 52 from base flows of 8 to 99 cfs. The flow reductions would result in a substantial loss of aquatic habitat particularly when the percentage reductions exceed 20% in consecutive months. Flow increases exceeding 10% also would occur in 1 month (July) during a wet year and 2 months (July and August) during normal and dry years. Flow increases in these months would range from 57% to 248%. There would be no flow changes exceeding 10% in this stream segment under Modelling Scenario 2 and just 1 month with a flow change exceeding 10% under Modelling Scenario 3 (i.e., 12% in May during a normal year).

Paint Rock Creek: In the upper portion of Paint Rock Creek upstream and downstream of the Anita Supplement Ditch, flow reductions under Modelling Scenario 1 would slightly exceed 10% in 1 or 2 months (May and August) during wet and dry years, with percentages ranging from 12% to 14%. There would be no flow increases exceeding 10% under Modelling Scenario 1. By excluding irrigation of idle lands, flow changes exceeding 10% under Modelling Scenario 2 would only occur in 1 month (August) during a dry year with a reduction of 16%. When evaluating the reservoir by itself (Modelling Scenario 3), flow reductions would occur in 1 to 3 months (May, July, or August), with percentages ranging from 11% to 15%. The effects of these flow changes on aquatic habitat (e.g., Yellowstone cutthroat trout historic habitat) and macroinvertebrates and fish would be minor in the segments upstream and downstream of the Anita Supplemental Ditch because of the low magnitude of flow change. The downstream segments of Paint Rock Creek from the confluence with Alkali Creek to the confluence with the Nowood River would result in flow changes exceeding 10% in 3 to 4 months. Flow reductions exceeding 10% would occur in 1 or 2 months (April and May) during all types of years. These flow reductions would range from 13% to 42%. Flow increases exceeding 10% also would occur in 1 or 2 months (July and August), with increases ranging from 26% to 93%. Based on the occurrence of flow changes exceeding 10% in 2 consecutive months during normal and dry years, there would be substantial adverse effects on aquatic species under Modelling Scenario 1. When excluding the irrigation of idle lands (Modelling Scenario 2), flow reductions exceeding 10% would occur in just 1 month (April) in each type of year. These flow reductions could still result in adverse effects, but the relative magnitude would be lower than Modelling Scenario 1. The analysis of the reservoir by itself under Modelling Scenario 3 showed that flow reductions would exceed 10% in 1 or 2 months (April and May) and increases in 1 or 2 months (July and August). The flow reductions ranged from 11% to 33%, with flow increases from 14% to 73%. The effect of these flow changes would be substantial in a dry year, as indicated by the percentage magnitude and occurrence in consecutive months.

Alkali Creek: Flow changes in Alkali Creek would include both reductions and increases that exceed 10%, although flow would be maintained throughout the year because of the project-committed measure involving a bypass flow of 0.4 cfs. Modelling Scenario 1 would result in flow reductions in 2 or 3 months (April, May, or June) depending on the type of year. Flow reductions would range from 13% to 98% from base flows of 2 to 17 cfs, which would be a substantial reduction in aquatic habitat. Flow increases exceeding 10% also would occur under Modelling Scenario 1 in 2 months (July and August) during all types of years. These flow increases would range from 27% to more than 400% from base flows of 3 to 7 cfs. Under Modelling Scenario 2, flow reductions exceeding 10% would occur in 1 or 2 months in normal and dry years (April and May), with percentages ranging from 59% to 77%. There would be a flow increase exceeding 10% in only 1 month (July) during a wet year. Under Modelling Scenario 3, there would be flow reductions exceeding 10% in 2 months (April and May), with percentages ranging from 45% to 98%. Flow increases would occur in 1 or 2 months (July and August), with percentages of 49% to more than 400%. The magnitude of the flow changes in consecutive months would result in moderate level adverse effects due to habitat loss. It is important to note that Alkali Creek is not classified as a game fishery. The adverse effects of flow changes would limit the development of a game fishery and native fish species in Alkali Creek.

Nowood River: Flow changes exceeding 10% in the Nowood River would mainly be attributed to the inclusion of idle land irrigation (Modelling Scenario 1). Of the two analysis locations for the Nowood River, the highest number of flow changes exceeding 10% would occur at the Big Horn confluence. Flow reductions exceeding 10% would occur in 2 months (July and August) during a wet year and 3 of 4 months (May, June, July, or August) during normal and dry years. The percentage reductions would range from 12% to 71%, with the highest change in a dry year. The base flow during these months is relatively high (200 cfs to 1,000 cfs) except for August (51 cfs and 88 cfs). Flow increases exceeding 10% also would occur in 1 month (October) during a wet year and 2 months (August and October) during a dry year, with percentages ranging from 11% to 18%. The relatively high magnitude of flow changes in consecutive months indicates that there would be adverse effects to aquatic species and special-status species including flathead chub, sauger, and shovelnose sturgeon under Modelling Scenario 1.

Under Modelling Scenario 2, there would be no flow changes exceeding 10%, which would result in minor effects on aquatic species. When evaluating the reservoir by itself under Modelling Scenario 3, there would be flow increases exceeding 10% in 1 month (August) during wet and normal years (13% to 28%) and 2 or 3 months (July, August, or September) during a dry year (13% to 59%). These flow increases would result in beneficial effects by providing additional habitat and adverse effects associated with bank instability and erosion particularly in 3 consecutive months during a dry year.

Recreational Fishing

If the decision is made to develop a game fishery in the Alkali Creek Reservoir, there would be beneficial effects to recreational fishing in the area.

3.18.4.3 ALTERNATIVE C: MODIFIED PROPOSED ACTION

3.18.4.3.1 Terrestrial Wildlife

The effects to terrestrial wildlife from the Modified Proposed Action would be the same as those described for the Proposed Action. Surface disturbances are identified in Table 2.4-2 in Chapter 2. Effects to greater sage-grouse leks would remain the same between the two action alternatives because the Modified Proposed Action is not any closer to a lek than the Proposed Action.

3.18.4.3.2 Aquatic Wildlife

The effects of the Modified Proposed Action on aquatic habitat and species would be the same as discussed for the Proposed Action regarding habitat changes from creating the new reservoir, risk of aquatic invasive species, flow changes, and recreational fishing.

The modification of the spillway would reduce sediment input to Alkali Creek on a short-term basis by avoiding a large cut along Alkali Creek. This reduction of sediment input would be beneficial to aquatic habitat and species by eliminating this source of sediment and potential adverse effects on deposition on stream substrates.

3.18.5 Summary of Effects

Table 3.18-4 presents a summary of the effects to terrestrial and aquatic wildlife under all alternatives.

Table 3.18-4. Terrestrial and Aquatic Wildlife Effects under all Alternatives

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
What would be the effects of habitat alteration or habitat loss associated with surface disturbance on bird species, big-game species, and other BLM sensitive species?	No effect	Habitats would no longer be available for forage, cover, reproduction, or migration for those species. Habitat alteration may degrade the quality of habitat for those species.	Same as the Proposed Action
What would be the effects of converting terrestrial habitat to aquatic habitat on bird species, big-game species, and other BLM sensitive species?	No effect	Habitat would no longer be available for use by most terrestrial wildlife species. However, game birds, waterfowl, shorebirds, fish feeding raptors, and wading birds may increase because of the increased availability of aquatic habitat.	Same as the Proposed Action
Would proposed fencing affect big-game species?	No effect	Big-game species may be deterred from using project area or their movements across the project area may be impeded.	Same as the Proposed Action
How would proposed surface disturbance affect occupied or suitable habitat and local populations of greater sage-grouse?	No effect	Greater sage-grouse use of the project area may be reduced. Minimal visual and noise disturbance could occur during construction and operation due to large distance between project and known leks.	Same as the Proposed Action
How would light, noise, dust, and visual intrusions during construction activities affect bird species, big-game species, and other BLM sensitive species?	No effect	The health, reproduction, survivorship, habitat use, distribution, and abundance of those species could be temporarily harmed during project construction. Individuals may be temporarily displaced from disturbed areas and adjacent habitats.	Same as the Proposed Action
How would an increase in traffic and human activity during construction and operations affect bird species, small mammal species, and big-game species?	No effect	Wildlife mortality or injury may increase due to collisions with vehicles, facilities, or construction equipment. Nests, dens, or burrows could be destroyed. Raptors may avoid the area because of the increased human activity.	Same as the Proposed Action
What would be the effects of recreational activities on bird and wildlife species?	No effect	Wildlife mortality or injury may increase from collisions with vehicles. Habitat avoidance by bird and other wildlife species may increase.	Same as the Proposed Action
How would stream disturbance from construction of diversion structures in Paint Rock and Medicine Lodge Creeks and culverts and rock grade control and habitat structures in Alkali Creek affect aquatic habitat?	No effect	There would be a short-term disturbance in Paint Rock and Medicine Lodge Creeks for diversion structures and Alkali Creek at two culvert sites. There would be short-term increases in sediment in Alkali, Paint Rock, and Medicine Lodge Creeks in localized areas below project instream disturbances. Habitat quality would improve in the 1.5-mile segment of Alkali Creek and the 300-foot segment in Paint Rock Creek.	Same as the Proposed Action

Issue	Alternative A: No Federal Action	Alternative B: Proposed Action	Alternative C: Modified Proposed Action
How would reservoir construction and the subsequent conversion of lotic habitat to lentic habitat affect fish and other aquatic species?	No effect	There would be a loss of 2.1 miles of stream habitat in Alkali Creek and creation of reservoir habitat. Species that require stream habitat would be eliminated. Fish species in Alkali Creek would adapt to lentic conditions and colonize the reservoir. The establishment of a conservation pool in the reservoir would result in beneficial effects by providing consistent habitat for the development of a fishery.	Same as the Proposed Action
How would changing the water flow regimes in Alkali Creek, Paint Rock Creek, and Medicine Lodge Creek affect fish species and their habitats? In addition, how would these changes affect fish and aquatic species downstream in the Nowood River?	Under Modelling Scenario 1, there would be substantial effects to fish and aquatic species related to flow increases in Medicine Lodge and Alkali Creeks and flow reductions in portions of Medicine Lodge, Paint Rock, and Alkali Creeks and the Nowood River. There would be no effect under Modelling Scenario 2.	There would be substantial effects from flow changes on aquatic habitat and species in Medicine Lodge Creek in segments located above and below the Anita and Anita Supplemental Ditches under Modelling Scenario 1. There would be minor effects to these segments under Modelling Scenario 2. There would be minor effects on aquatic habitat and species in the upper portion of Paint Rock Creel located upstream and downstream of the Anita Supplement Ditch under both Modelling Scenarios 1 and 2. There would be substantial effects on habitat and species in Paint Rock Creek segments located upstream and downstream of the Alkali Creek confluence under both Scenarios 1 and 2. There would be a substantial habitat reduction in Alkali Creek downstream of the reservoir (2.3-mile segment) from flow reductions under Modelling Scenario 1. Effects would be reduced to moderate levels under Scenario 2. Flow would be maintained throughout the year because of a bypass flow of 0.4 cfs. There would be substantial effects to fish, macroinvertebrates, and special-status species flathead chub, sauger, and shovelnose sturgeon in the Nowood River under Scenario 1. Effects would be reduced to minor levels under Scenario 2. Mitigation measures include an AMP for flow, which will be implemented to minimize effects in analysis area streams.	Same as the Proposed Action
Would the project introduce or increase the spread of aquatic invasive species?	No effect	There would be a risk of introducing or spreading aquatic invasive species avoided by watercraft regulations and mitigation measure requiring washing equipment.	Same as the Proposed Action
What would be the effects of recreational activities on aquatic species?	No effect	There would be a potential long-term increase in fishing levels in the Alkali Creek Reservoir and temporary increase in fishing pressure in local streams from project workforce.	Same as the Proposed Action

3.18.6 Mitigation Measures

The following mitigation measures are proposed for terrestrial and aquatic wildlife:

- Proposed fencing would be wildlife friendly and constructed to best suit the needs of big-game species in the area.
- Collision markers would be added to the proposed fencing in areas with a high potential for greater sage-grouse collisions.
- A mosquito abatement plan would be developed in conformance with the WFO RMP (BLM 2015a) and sage-grouse Executive Order 2015-4 to help reduce the risk of West Nile Virus outbreaks.
- Construction within the greater sage-grouse core area would be suspended from March 15 to June 30.
- No project activity would occur between the hours of 6 p.m. and 8 a.m. from March 1 to May 15.
- A noxious and invasive weed control program would be implemented, and monitoring would be done to ensure that no noxious or invasive weeds occur within the project area. If noxious or invasive weeds are identified, control measures would be taken to keep them from spreading.
- If vehicles and equipment are moved across multiple streams, equipment would be cleaned with a spraying device that uses an uncontaminated water source (i.e., a water source with no aquatic invasive species being present).
- If a culvert is required during construction, flow would be maintained in a portion of the stream to allow unrestricted fish passage. Culverts should be designed using natural channel design techniques where feasible and effective.
- Fueling of equipment and vehicles would be restricted within 100 feet of streams and wetlands.
- An AMP to address water quality issues and potential impacts to aquatic species will be developed before the publication of the ROD (see Section 3.15.6).
- A conservation pool would be established through BLM coordination with the WWDO and WGFD for the purpose of modifying reservoir operations to minimize adverse effects on fish species in the Nowood River.

3.18.7 Unavoidable, Adverse Effects

The unavoidable, adverse effects to terrestrial wildlife from the action alternatives would include direct wildlife habitat loss from the construction of the project elements (e.g., dam embankment, recreation area, and upgrades to access roads), habitat alteration though conversion of terrestrial wildlife habitat to aquatic habitat in the proposed inundation area, habitat fragmentation by constructing new features and infrastructure and reducing connectivity for smaller wildlife species, and direct mortality of wildlife from collisions with vehicles and equipment.

The unavoidable, adverse effects to aquatic wildlife from the action alternatives would include the loss of approximately 2.1 miles of stream habitat in Alkali Creek from the conversion to reservoir habitat and the permanent loss of aquatic habitat from the footprint of diversion structures in Alkali, Medicine Lodge, and Paint Rock Creeks, and culverts in Alkali Creek.

3.19 Other Disclosures

3.19.1 Irreversible and Irretrievable Commitments of Resources

The *irreversible* commitment of a resource means that, once committed, the resource is permanently lost to other potential uses. An irreversible commitment generally applies to nonrenewable resources such as mineral resources, cultural resources, or geologic features, or to resources that are renewable over a very long period, such as soils and old-growth forests.

The *irretrievable* commitment of a resource means that, although committed, the resource can be renewed or restored following the action. For the Proposed Action, irretrievable commitments of a resource would consist of resource commitments that would be lost to other potential uses during the life of the project, but whose commitments could be restored after decommissioning the dam and restoring and reclaiming the affected area.

The Proposed Action would not result in irreversible or irretrievable commitments of resources related to air quality, public health and safety, transportation, socioeconomics, or vegetation. The Proposed Action would result in net benefits to water rights, water supply and irrigation, sedimentation, and water quality downstream of the dam, and to groundwater supply and quality.

Dispersed recreationists could be irretrievably displaced from approximately 174.6 acres of BLM-administered lands for approximately 75 years because the area would be inundated, thus precluding dispersed recreation like hiking and hunting. Nonetheless, there would always be alternate sites available in the area to pursue a recreation activity in multiple recreation settings.

The Proposed Action would result in irretrievable effects to the visual landscape due to construction of the dam embankments, reservoir, and new roads. The Proposed Action would also increase the use of motorized recreation at the reservoir, resulting in minor but irretrievable increases in ambient noise levels during the life of the project.

Implementation of the Proposed Action would result in some irretrievable loss of access to mineral resources during the life of the reservoir. Other irretrievable land use commitments include agriculture, hunting, camping, ORV use, mining, oil and gas exploration and development, power and transmission lines, and other ROWs. The Proposed Action would also involve irreversible-use resources such as land, labor, and materials used in the construction of the proposed reservoir.

Inundation of the reservoir and ground disturbance related to the construction of reservoir infrastructure would result in irreversible damage and destruction to known cultural resources that are not eligible for the NRHP and potentially eligible or yet-to-be discovered sites. Although there are no known paleontological resources in the area, reservoir inundation and construction of project infrastructure would result in irreversible loss of possible paleontological resources through disturbance to geologic units with high and moderate potential to yield fossils.

An irretrievable commitment of soil resources would result from temporary effects that cannot be mitigated. Through the construction of the permanent infrastructure, there would be a commitment of approximately 433 acres of permanent disturbance from the Proposed Action. This number would be reduced under the Modified Proposed Action, which would reduce irretrievable effects by 34.9 acres because of the shorter spillway.

The Proposed Action would irretrievably alter the flow regime physical characteristics of Alkali Creek. The reservoir would inundate 2.1 miles of the creek. Alkali Creek would experience peak flows much higher than the current peak flows during irrigation season, and its flow would be reduced to zero when the reservoir is filling. These changes in stream flow would irretrievably alter stream morphology. The Alkali Creek stream channel would be stabilized as part of the project, resulting in irretrievable changes to channel type. The Proposed Action would also result in more modest but irretrievable changes to stream flow, morphology, transport capacity, erosion, and sedimentation in Paint Rock Creek and Medicine Lodge Creek.

The loss of stream habitat in Alkali Creek and the associated aquatic species would be irreversible and irretrievable. The small amount of habitat loss from the construction of culverts and rock grade control structures also would be irretrievable; however, the habitat loss would be reversible if the structures are removed at a later time. Approximately 2.11 acres of jurisdictional wetlands would be irreversibly affected by construction of the dam and reservoir. Approximately 8.2 acres of new wetlands would be created at the reservoir to satisfy compensatory wetland mitigation requirements for these wetland effects.

3.19.2 Short-Term Uses Versus Long-Term Productivity

The short-term use of air resources during construction would result in slightly increased, but negligible, effects. The long-term productivity of the air resource would not be affected.

Short-term uses that involve excavation or other surface disturbance may have the combined effect of destroying previously unknown cultural and paleontological resource sites as well as increasing threats (such as looting) to sites outside of the actual disturbance areas through increased traffic and public access. Cultural and paleontological resources that are eliminated from short-term uses such as scientific data recovery efforts and data recovery supporting surface-disturbing activities would no longer be available for further study.

The short-term use of geologic and mineral resources to create a new reservoir would affect the long-term accessibility of minerals and surface occupancy of mineral leases.

The short-term use of the area for a reservoir is not anticipated to adversely affect the long-term productivity of existing land uses. The long-term access to or surface occupancy of mineral leases would be affected during the life of the dam and reservoir. The long-term effects to existing land uses (i.e., agriculture, grazing, rural development) would be minimal.

Short-term construction activities, and to a lesser extent later operations, would affect natural ambient sound levels and produce minor, long-term negative effects from increased traffic and recreational use.

Short-term construction activities and the long-term increased risk from dam failure would increase the potential for downstream flooding and releases of small amounts of hazardous materials that could affect both short- and long-term public health and safety.

Short-term land-based recreation uses (e.g., OHVs) would change as the project is converted from dispersed to developed, and from a land-based to flat-water recreation setting. The long-term productivity of recreation resources would likely increase from the development of a unique recreation setting that may draw more local use. The longer-term use of dispersed recreation would be lost for the reservoir area.

Short-term socioeconomic uses during construction would include the creation of construction jobs. Resources used in the short term would include land, labor, materials, and housing. The long-term effects of the Proposed Action would be the creation of a larger supply of late-season irrigation water, which would enhance agricultural productivity, household income, and employment. The additional economic activity would increase economic output and create the potential for state and local governments to collect additional tax revenues.

Long-term soil productivity would decrease because of the inundation by the reservoir and effects from permanent infrastructure. Short-term soil productivity would be reduced from construction disturbances. Long-term soil health would recover though implementation of mitigation measures intended to reclaim affected areas following construction disturbance and project decommissioning.

Construction of the project would create short-term increases in traffic, but would provide long-term transportation benefits by enhancing access to the reservoir and recreation facilities.

Long-term vegetation productivity would decrease because the reservoir area would be converted to an aquatic environment. Ground disturbances would increase the potential spread of noxious weeds in the short term and long term and would require long-term implementation of weed management practices. Longer-term vegetation productivity would be mitigated following the successful revegetation of areas.

Short-term effects to the viewshed would be mitigated and would decrease with time. Long-term visual resource quality would be reduced from some viewpoints near the project.

The long-term use of water resources would increase as a result of water storage during low-demand periods. The capture, storage, and release of water resources in the reservoir would result in long-term changes to seasonal stream flow timing and volume related changes to stream morphology, as well as changes in sediment transport and water quality.

Construction of the proposed reservoir and associated infrastructure may result in minor, short-term effects from widening ditches, reconstructing diversion structures, or building other instream structures. The Proposed Action is anticipated to reduce seasonal irrigation shortages by an average of 39%, increasing irrigation use and supporting additional water demands in the long term.

The project would result in long-term effects to wetlands from direct effects and from changes in stream flow and groundwater availability along Alkali Creek, though these effects would be mitigated as part of the CWA 404 permitting process.

The short-term use of Alkali Creek for wildlife and aquatic habitat would change because of the conversion of 2.1 miles of stream habitat to reservoir habitat. There would be a long-term gain in aquatic and wildlife productivity at Alkali Creek Reservoir from the addition of new lentic habitat. Habitat improvements in Alkali Creek downstream of the reservoir would result in long-term beneficial uses to aquatic habitats; however, flow reductions would limit habitat quality in October through March.

4 CUMULATIVE EFFECTS

4.1 Introduction

As defined in 40 CFR 1508.7 (CEQ regulations for implementing NEPA), a cumulative effect is an effect on the environment that results from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions, regardless of which agency (federal or non-federal) or person undertakes such actions. Cumulative effects may result from individually minor but collectively significant actions occurring over a period of time.

4.1.1 Cumulative Impact Analysis Areas

The geographic extent of cumulative effects may vary by the type of resource and resource issues and by the type of potential effect. Different cumulative impact analysis areas (CIAAs) and temporal boundaries have been developed for each resource and are listed in Table 4.1-1.

Table 4.1-1. Cumulative Impact Analysis Areas by Resource

Resource	CIAA	Rationale	Temporal Boundary
Air quality	Big Horn and Washakie Counties	This area was chosen because it is a typical spatial boundary used to determine compliance with NAAQS.	Life of the project
Cultural resources	Visual horizon up to 3 miles from the reservoir, dam, and primary access road	This area was chosen because effects to cultural resources in the visual horizon can permanently alter the cultural landscape.	Permanent (beyond the life of the project)
Geology and minerals	Project area with a 0.25-mile buffer	This area was chosen because it incorporates project disturbance and a buffer area to incorporate Federal Mineral Estate.	Permanent (beyond the life of the project)
Land use	Project area with a 0.25-mile buffer	This area was chosen because it incorporates peripheral land uses and any potential conflicts and edge effects.	Life of the project
Noise	During construction: project area with a 2-mile buffer	This area was chosen because a 2-mile buffer provides a sufficient attenuation distance to mask construction noise.	Construction: 2 years
	During operation/maintenance: project area with a 0.5-mile buffer	This analysis area is reduced because operations and maintenance equipment is lighter weight and produces lower noise levels than construction equipment.	Operation/ maintenance: Life of the project
Paleontological resources	Project area with a 1-mile buffer	This area was chosen because it incorporates project disturbance and a buffer area to incorporate potential disturbance in the same geological formations by other projects.	Permanent (beyond the life of the project)
Public health and safety	Alkali Creek watershed above and below the proposed Alkali Creek Reservoir through Paint Rock Creek	This area was chosen because the proposed Alkali Creek Reservoir site would be most susceptible to contamination during reservoir construction. Areas downstream of the reservoir, including both Alkali and Paint Rock Creeks, are included because they would be affected if the dam should fail.	Life of the project
Recreation	Project area with a 5-mile buffer	This area was chosen to better capture dispersed recreation use in the area.	Life of the project
Socioeconomics	Big Horn and Washakie Counties	This area was chosen because the economic and demographic effects of the project would be experienced by the surrounding communities in Big Horn and Washakie Counties.	Life of the project
Soils	Project area with a 0.25-mile buffer	This area was chosen because it contains the locations where the project's potential effects could affect soil stability.	Permanent (beyond the life of the project)
Transportation	Regional, local, and on-site roadway networks within approximately 25 miles that may be affected by construction and post-construction trip generation	These roadway networks were chosen because it is reasonably foreseeable that project activities could affect their traffic or condition.	Life of the project

Resource	CIAA	Rationale	Temporal Boundary
Vegetation	Project area with a 1-mile buffer	This area was chosen because it includes the species most likely to present a potential noxious weed and invasive plant problem during and following construction.	Permanent (beyond the life of the project)
Visual resources	Project area with a 5-mile buffer including viewing locations and KOPs that may occur outside the 5-mile buffer	This area was chosen because it contains the locations where the project could affect scenic quality.	Life of the project
Water resources	Project area and stream reaches from the point where water is diverted from Paint Rock Creek, Medicine Lodge Creek, and Alkali Creek downstream to the confluence with the Bighorn River	This area was chosen because it contains the locations where the project's potential hydrologic effects could affect surface water, groundwater, fluvial geomorphology, and water quality.	Permanent (beyond the life of the project)
Water rights and irrigation	Water right holders and irrigated acreage in the Paint Rock Creek watershed and the Nowood River below the confluence with Paint Rock Creek	This area was chosen because it includes those areas that the reservoir is supposed to serve.	Life of the project
Wetlands	Project area and stream reaches from the point where water is diverted from Paint Rock Creek, Medicine Lodge Creek, and Alkali Creek downstream to the confluence with the Bighorn River.	This area was chosen because it contains the locations where the project's potential hydrologic effects could affect wetlands and riparian vegetation.	Permanent (beyond the life of the project)
Terrestrial and aquatic wildlife	Project area with a 1-mile buffer as well as habitats within hydrological unit code (HUC) 12 watersheds, with adjustments for individual species	These areas were chosen because they include the species and their habitat most likely to be affected by the project.	Permanent (beyond the life of the project)

4.1.2 Cumulative Actions Summary

4.1.2.1 PAST AND PRESENT ACTIONS

Past and present development within the CIAAs include agricultural uses such as farming and ranching (e.g., water withdrawals), grazing (e.g., three allotments overlap the project area: West Alkali, North of Ditch, and Black Hills), recreational facilities (e.g., Medicine Lodge Archaeological site, trails and trailheads, the Red Gulch/Alkali National Backcountry Byway, Paint Rock Canyon Trail, and Bighorn Canyon National Recreation Area), irrigation projects (e.g., Greybull Valley Irrigation District Dam/Reservoir, Wardell/Harrington Reservoirs, and Renner Reservoir), stream restoration projects, road and highway development, power and transmission line development, and the development of small towns and associated support systems and infrastructure (e.g., Hyattville, Greybull).

4.1.2.2 REASONABLY FORESEEABLE FUTURE ACTIONS

Reasonably foreseeable future actions are decisions, funding, or formal proposals that are either existing or are highly probable based on known opportunities or trends. In general, specific acreages and locations of reasonably foreseeable future actions are not known at this time. Anticipated reasonably foreseeable future actions for the CIAAs are identified below:

- Deferred mineral lease parcels: Deferred mineral lease parcels overlap the project area that are awaiting the state's leasing decision.
- Mining claims: No development has occurred in the claim areas to date and the BLM has not received any proposals for mining development activities on federal mineral estate.
- Meadowlark Lake enlargement: An enlargement to Meadowlark Lake has been identified and is being evaluated as an option to address water shortages along Tensleep Creek and portions of the Nowood River.

- Leavitt Reservoir expansion: This project would create a supplemental irrigation supply and leave a 1,500-acre-foot minimum pool for habitat, fishing, and recreational use. Additionally, the reservoir would provide some flood control.
- Medicine Lodge Creek restoration project: This project would repair channel degradation across 0.73 miles of Medicine Lodge Creek. A new bridge would be constructed, year-round fish passage would be available at the Anthony and Betty Irrigation Diversions, and a stable stream channel would be constructed allowing for sediment transport, floodplain connectivity, and fisheries habitat. The project would also provide a fishing access area for the public.

4.1.2.3 NO FEDERAL ACTION

The No Federal Action would not contribute incrementally to the effects of past, present, and reasonably foreseeable future actions because continued operation of the NWID under current management conditions would occur. As a result, a No Federal Action cumulative effects analysis is not included below.

4.2 Air Quality

4.2.1 Contributing Cumulative Actions

The CIAA for air quality is Big Horn and Washakie Counties. Most emissions from past and present actions have likely come from agricultural uses such as farming (e.g., furrowing, agricultural burning) and mobile sources such as vehicles on roads. Some emissions also occur from small towns, the development of power and transmission lines, and the development of irrigation projects. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined), mining claims (if mined), the Meadowlark Lake enlargement, the Leavitt Reservoir expansion, and the Medicine Lodge Creek restoration project.

4.2.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, the project would add cumulatively to air pollutant emissions in the air quality CIAA. However, criteria pollutant and HAP emissions from construction activities (exhaust emissions from heavy-duty construction equipment, exhaust from construction worker and delivery vehicles, and fugitive dust emissions) would be temporary and localized near the project area. The highest effects are predicted to occur during peak construction periods; none of these effects are expected to exceed the NAAQS or WAAQS when added to other air quality–contributing cumulative actions. There would be no long-term effects from construction-related emissions after project completion.

Long-term, cumulative air quality effects would occur from recreational activities and increased vehicle traffic to and from the reservoir as well as from increased windblown dust from exposed surfaces along the expanded reservoir shoreline during periods of low water levels. These effects from the Proposed Action or Modified Proposed Action would add to effects from past and present actions and from the reasonably foreseeable future actions. Fugitive dust emissions would be largely unavoidable because they depend in part on the extent of bare soil exposed by reservoir water level fluctuation. This incremental increase in emissions would be relatively small and would not result in NAAQS or WAAQS exceedances in the CIAA when added to other air quality–contributing cumulative actions, based on the analysis in Section 3.2.4.

4.3 Cultural Resources

4.3.1 Contributing Cumulative Actions

Cultural resources tend to degrade over time from natural forces; however, many survive for hundreds or thousands of years. Past, present, and reasonably foreseeable activities causing surface and subsurface disturbance in the CIAA can disturb or damage cultural resources. Effects would depend on the amount, placement, and type of surface disturbance, and could be beneficial (if the identification of new cultural resources during surface disturbance contributes cumulatively to an increase in the knowledge of cultural properties in the area) or adverse (if widespread disturbance activities cover a large portion of the landscape when viewed as a whole and lead to an increase in the potential for destruction or damage of cultural resources).

The CIAA for cultural resources is the visual horizon up to 3 miles from the reservoir, dam, and primary access road. Past and present actions that may contribute to cumulative effects in the CIAA are agricultural uses such as farming and ranching, grazing, any irrigation projects located in the CIAA, road development, power and transmission line development, and the development of Hyattville. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined).

4.3.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, reservoir creation and inundation would create long-term visual effects to three known sites of Native American concern as well as to a rural historic district. All project surface-disturbing activities have the potential to affect previously undiscovered sites. Inundation and wave action from the reservoir may also expose and damage previously undiscovered subsurface sites. The Modified Proposed Action would involve less ground disturbance and therefore may have a reduced likelihood of affecting previously undiscovered sites. Adverse effects from the Proposed Action or Modified Proposed Action would be mitigated based on Tribal, BLM, and SHPO consultation. Tribal consultation is ongoing, and specific concerns and project effects would be addressed in a memorandum of understanding.

The Proposed Action or Modified Proposed Action would add cumulatively to effects from past and present actions and from the reasonably foreseeable future actions. However, cumulative effects from the Proposed Action and Modified Proposed Action would be avoided, minimized, or mitigated following guidelines in the WFO RMP (BLM 2015a). A memorandum of understanding would also be developed to address effects to sites of Native American concern and to the historic district, which would also minimize the project's cumulative effects. In addition, unanticipated finds would be reported, and measures to avoid adverse effects outlined in Appendix K of the Wyoming State Protocol between the BLM and SHPO (2014) would be followed.

4.4 Geology and Minerals

4.4.1 Contributing Cumulative Actions

The CIAA for geology and minerals is the project area with a 0.25-mile buffer. A 0.25-mile buffer around the project area would limit Federal Mineral Estate that incorporates oil and gas activities. The CIAA for locatable minerals identifies no cumulative effects, and direct and indirect effects are limited to existing mining claims boundaries. The CIAA for salable minerals identifies no cumulative effects, and direct and indirect effects are limited to Federal Mineral Estate within the footprint of the reservoir area and constructed features that will persist on the landscape. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined), and mining claims (if mined).

4.4.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, new construction disturbance would result in low effects to mineral claims and oil and gas interests as described in Table 3.4-1. The loss of existing and potential future mineral leasing opportunities would be a minor effect because of the low potential for the use of these resources during the life of the project. Therefore, the Proposed Action and Modified Proposed Action would unlikely have a noticeable incremental cumulative effect on minerals in the CIAA. Direct effects to geological resources for temporary purposes would be mitigated; however, long-term geological effects related to project infrastructure, inundation, and wave erosion would be a contributing factor to cumulative geological effects.

4.5 Land Use

4.5.1 Contributing Cumulative Actions

The CIAA for land use is the project area with a 0.25-mile buffer. No special designations are identified in the project area. Past and present land use is largely agricultural and includes irrigated crops and livestock grazing. Project-related effects that would impact future land use include preventing future mineral leases, ROWs on BLM-administered land, future mining, and other recreational activities that are discussed in Section 4.9. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined).

4.5.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, surface disturbance and associated infrastructure may prevent or affect certain land uses. Section 3.5.2 describes the acreage of existing oil and gas leases and existing mining claims that would be affected. Additive long-term cumulative effects that would occur for the lifetime of the project are limitations on land use for approximately 0.04% of the land in Big Horn County, Wyoming. Beneficial effects are expected to include increased visitation for other land use activities such as recreation.

4.6 Noise

4.6.1 Contributing Cumulative Actions

The CIAA for noise during construction is the project area with a 2-mile buffer. The CIAA for noise during operation and maintenance is the project area with a 0.5-mile buffer. Past and present actions that may have resulted, or may result, in ambient and existing noise levels in the characteristic soundscape of the larger CIAA include agricultural uses such as farming and ranching, grazing, vehicle traffic on roads and WY 31, residential noise, and noise from the town of Hyattville. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined).

4.6.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, equipment operating at the project area may affect sensitive receptors within 0.75 miles of the project area with noise from construction activities. In addition, sensitive receptors within 0.5 miles of the project area may be affected by noise from operation and maintenance activities.

The Proposed Action or Modified Proposed Action would add cumulatively to effects from past and present actions and from the reasonably foreseeable future actions. No long-term cumulative effects would occur from project construction activities because construction noise would end at the completion of the project. A long-term cumulative effect would occur during project operation and maintenance from recreational noise (traffic and watercraft); maintenance activity noise from vehicle use, inspections, and general housekeeping; and spillway noise during times of high water volume. This noise would add to other sounds in the noise CIAA, such as vehicle traffic and farming operations.

As described in Section 3.6.4, predicted project noise levels are conservatively estimated. The predicted levels do not take into account the attenuation provided by topography, vegetation, and atmospheric absorption. This attenuation would provide considerable dampening of project noise and would reduce the incremental cumulative effect of the project on noise levels in the CIAA by decreasing the distance from the project area at which effects would be observed and by decreasing the number of potentially affected receptors.

4.7 Paleontological Resources

4.7.1 Contributing Cumulative Actions

Any land-disturbing activity can cause surface and subsurface physical disturbance that could result in the destruction or discovery/recovery of paleontological resources. Cumulative effects from such disturbance would depend on the amount, placement, and type of surface disturbance. If previously unrecorded paleontological resources are identified during projects in the CIAA, such activities may contribute cumulatively to an increase in the knowledge of paleontological data in the area, and new specimens may be collected. However, projects can also contribute cumulatively to widespread disturbance activities that cover a large portion of the landscape when viewed as a whole. Such disturbances could lead to an increase in the potential for destruction or damage to fossil resources in the CIAA, and could irreversibly damage the paleontological information base and preclude future analysis of destroyed fossils.

The CIAA for paleontological resources is the project area with a 1-mile buffer. Past and present actions that may have contributed or may contribute cumulative effects to paleontological resources in the CIAA include agricultural development; development of any irrigation projects in the CIAA; construction of roads, highways, and power and transmission lines; and development of small towns and associated infrastructure (e.g., Hyattville). Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined).

4.7.2 Cumulative Effects

Under the Proposed Action or Modified Proposed Action, reservoir creation would disturb geologic units with the potential to contain important paleontological resources, and inundation would make some of these areas inaccessible to research for the life of the project. In addition, erosion from wave action around the reservoir could also affect paleontological resources. The Modified Proposed Action would create less ground disturbance and may have a reduced likelihood of affecting previously undiscovered paleontological resources. Based on this analysis (see Section 3.7.4), the Proposed Action or Modified Proposed Action could add cumulatively to effects on paleontological resources from past and present actions and the reasonably foreseeable future actions. However, these effects would be avoided, minimized, and/or mitigated under existing stipulations in the WFO RMP (BLM 2015a) and other applicable guidance (e.g., Handbook H-8270-1 [BLM 1998], IM 2009 011 [BLM 2008b]). Mitigation measures proposed in Section 3.7.6 (e.g., monitoring during construction, development of a Paleontological Discovery Plan) would also limit the project's incremental cumulative effect on paleontological resources.

4.8 Public Health and Safety

4.8.1 Contributing Cumulative Actions

The CIAA for public health and safety is the Alkali Creek watershed above and below the proposed Alkali Creek Reservoir through Paint Rock Creek. Past and present actions that may have contributed or may contribute to public health and safety risks include agricultural uses such as farming and ranching (e.g., herbicide and pesticide use); grazing (e.g., effects to water quality); development of any irrigation projects in the watershed; construction of roads, highways, and power and transmission lines in the CIAA; and development of small towns and associated infrastructure (e.g., Hyattville). Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined). The reasonably foreseeable future actions could affect public health and safety in the CIAA through chemical or petroleum product spills and contamination.

4.8.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, hazardous materials would be brought on-site during project construction and implementation. These materials would include fuels, lubricants, coolants, and solvents with hazardous constituents. Herbicides, paints, and explosives may also be brought on-site for project construction and operation. If any hazardous materials are spilled or released into the environment, vegetation, aquatic life, wildlife, cattle, and human life could be adversely affected. The extent and magnitude of the effects would depend on the type and amount of hazardous material released, the location and substance into which it is released, and the timing of the release. If any release occurs during construction, the contractor would be required to clean up the spill and notify the State of Wyoming in accordance with Chapter 4 (Releases of Oil & Hazardous Substances into Waters) of the Wyoming water quality rules and regulations.

Although the risk of dam failure is low, failure of the dam and release of reservoir water would have immediate adverse effects on downstream landowners in the Alkali and Paint Rock Creeks area. The release of water to downstream creeks could result in a discharge of hazardous materials from the homes and businesses of those affected by the flooding.

The Proposed Action or Modified Proposed Action would add cumulatively to effects from past and present actions and the reasonably foreseeable future actions if releases or spills of hazardous materials or dam failure occur. However, this incremental increase in the risk of releases or spills of hazardous materials would be mitigated by the design feature in Section 2.4.2.3 that requires the development of site-specific health and safety plans as part of pre-construction submittals. The construction contractor would also be required to construct and maintain lined, secondary containment facilities for storing petroleum products. Mitigation measures are outlined in Section 3.8.6 and would limit the project's incremental cumulative effect on public health and safety. The risk of dam failure would be limited by preventative measures and emergency action procedures discussed in the draft *Proposed Emergency Action Plan* (Trihydro 2017d), as well as regular monitoring and inspections.

4.9 Recreation

4.9.1 Contributing Cumulative Actions

The CIAA for recreation is the project area with a 5-mile buffer. This area was chosen because it accounts for the wide area where recreation conditions could decrease or intensify. Potential cumulative effects from past and present actions include developed recreation sites at Paint Rock Creek Trail, Medicine Lodge Archaeological Site, the Red Gulch/Alkali National Backcountry Byway, and activities on BLM-administered land such as camping, hiking, and OHV use. Big-game and trophy hunting are popular on adjacent public lands year-round. Contributing reasonably foreseeable future actions could include the Medicine Lodge Creek restoration project.

4.9.2 Cumulative Effects

As discussed in Section 3.9.4, the Proposed Action and Modified Proposed Action would increase recreational activities by introducing more open water, shorelines, access roads, a parking lot, a comfort station, and a boat ramp. The action alternatives would shift recreation from terrestrial (e.g., hiking, hunting, horseback riding) to water-based.

The Proposed Action or Modified Proposed Action would add cumulatively to effects from past and present actions and from contributing reasonably foreseeable future actions. Most of these incremental effects are expected to be beneficial from increasing the developed recreation setting and providing additional recreation opportunities. There is a potential for a limited, adverse effect on dispersed recreation during project construction and a small, incremental reduction in hunting opportunities and wildlife presence because of the presence of the proposed reservoir.

4.10 Socioeconomics

4.10.1 Contributing Cumulative Actions

The CIAA for socioeconomics consists of Big Horn and Washakie Counties. Potential cumulative effects from past and present actions include agricultural uses such as farming and ranching; grazing; recreational opportunities at areas such as the Medicine Lodge Archaeological site, trails and trailheads, the Red Gulch/Alkali National Backcountry Byway, Bighorn Canyon National Recreation Area; irrigation projects (e.g., Greybull Valley Irrigation District Dam/Reservoir, Wardell/Harrington Reservoirs, and Renner Reservoir; and the development of small towns and associated support systems and infrastructure (e.g., Hyattville, Greybull, Manderson). These past and present actions may have contributed to cumulative socioeconomic effects through changes to population, employment, income, poverty level, and housing; through the purchase and use of goods and services; and through demands on government services, school districts, and local infrastructure. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined), mining claims (if mined), the Meadowlark Lake enlargement, the Leavitt Reservoir expansion, and the Medicine Lodge Creek restoration project.

4.10.2 Cumulative Effects

As discussed in Section 3.10.4, the Proposed Action and Modified Proposed Action would primarily create beneficial effects through increased employment, income, and economic output through project construction, agricultural, and operational activities. Recreationists would also see beneficial effects under the action alternatives. There is small possibility that the action alternatives would create a limited, adverse effect on the local housing market by temporarily reducing availability and increasing prices if workers decide to locate in the same small area in the CIAA.

The Proposed Action or Modified Proposed Action would add cumulatively to socioeconomic effects from past and present actions and the reasonably foreseeable future actions. Most of the project's effects are expected to be beneficial. There is a small potential for an incremental, limited, adverse effect on the local housing market in the CIAA in combination with reasonably foreseeable future actions such as the Leavitt Reservoir expansion. The potential for adverse effects on the availability of temporary housing could be mitigated by encouraging construction firms to use local labor whenever feasible (see Section 3.10.5).

4.11 Soils

4.11.1 Contributing Cumulative Actions

The CIAA for soils is the project area with a 0.25-mile buffer. Past and present actions that may have contributed to cumulative soil effects include farming and ranching activities on adjacent private land. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined).

4.11.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, new construction disturbance would result in effects to soils, including soils with low restoration potential, soils with low resistance to compaction, soils with high degradation susceptibility, soils with high surface runoff potential, and soils with low to moderate wind erosion potential (see Table 3.11-3). Impervious surfaces would increase both wind and water runoff. Direct effects to soils for temporary purposes would be mitigated; however, long-term soil effects related to project infrastructure and inundation would contribute incrementally to cumulative soil effects in the CIAA. Reducing the length of the auxiliary spillway under the Modified Proposed Action would reduce permanent effects to some soils (see Table 3.11-3) and slightly reduce the incremental cumulative impact for this alternative. Implementation of the *Reclamation and Weed Management Plan* (Trihydro 2017b), which sets out reclamation performance standards for both interim and final reclamation, would reduce cumulative impacts to soils under both alternatives.

4.12 Transportation

4.12.1 Contributing Cumulative Actions

The CIAA for transportation consists of the regional, local, and on-site roadway networks within approximately 25 miles that may be affected by construction and post-construction trip generation. Potential cumulative effects from past and present actions include agricultural uses such as farming and ranching; recreational facility development; irrigation projects; development of roads and highways; and the development of small towns and associated support systems and infrastructure (e.g., Hyattville, Greybull, Manderson). Past and present actions in the transportation CIAA may have increased the number of vehicles on roads, created new roads, or affected the existing condition of roads. Contributing reasonably foreseeable future actions in the CIAA could include deferred mineral lease parcels (if leased and mined), mining claims (if mined), the Meadowlark Lake enlargement, Leavitt Reservoir expansion, and the Medicine Lodge Creek restoration project. Reasonably foreseeable future actions may also increase the number of vehicles on roads, create new roads, or affect the existing condition of roads.

4.12.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, there would be minor effects on WY 31 travel at access road intersections. There would be a potential increase in safety risks from left turns at WY 31 intersections, which would be addressed with temporary and/or permanent intersection controls. There would also be a potential for increased road surface degradation on roads that are not designed for heavy truck travel. Based on this analysis, the Proposed Action or Modified Proposed Action could add cumulatively to transportation effects from past and present actions and the reasonably foreseeable future actions. However, this incremental increase in traffic effects would be limited by the design feature in Section 2.4.2.3, which requires the development of a traffic management plan.

4.13 Vegetation

4.13.1 Contributing Cumulative Actions

As discussed in Section 3.13, the primary issue for vegetation analysis is the introduction or spread of noxious or invasive plant species resulting from project construction activities or operation and maintenance. No issues were identified for effects to general vegetation.

The CIAA for vegetation is the project area with a 1-mile buffer. Potential cumulative noxious or invasive plant effects may have occurred from past and present actions such as agricultural uses (farming and ranching), grazing, any irrigation projects in the CIAA, the development and use of roads and highways, and the development of power and transmission lines. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined).

4.13.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, new construction disturbance would result in an increased risk of the introduction or spread of noxious weeds. Operation of the reservoir may also provide favorable conditions for the establishment of species such as saltcedar and Russian olive. In addition, a number of noxious weeds are already established in the area (see Table 3.13-2). Based on this analysis, the Proposed Action or Modified Proposed Action could add cumulatively to noxious or invasive plant species effects from past and present actions and the reasonably foreseeable future actions. However, the implementation of the *Reclamation and Weed Management Plan* (Trihydro 2017b) would limit the potential for cumulative effects by using an integrated weed management approach, including planning, prevention and education, treatment, monitoring, and reporting. Proposed management activities would be consistent with BLM and Big Horn County Weed and Pest invasive and noxious weed management policies and procedures. With implementation of the *Reclamation and Weed Management Plan*, incremental effects from noxious weeds and invasive species would be limited.

4.14 Visual Resources

4.14.1 Contributing Cumulative Actions

The CIAA for visual resources is the project area with a 5-mile buffer. Potential cumulative effects to visual resources that may have affected the project area in the past and present include visual changes associated with farming and ranching activities on adjacent land. Contributing reasonably foreseeable future actions could include visual changes associated with the Medicine Lodge Creek restoration project.

4.14.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, changes would be made to the characteristic landscape. Construction activities would contribute to short-term visual effects with the presence of equipment, materials, and work crews at the project area. The Proposed Action would introduce a visual contrast with the addition of a reservoir, dam, facilities, access roads, and perimeter fence to the landscape. The degree of visual change would be similar under the Modified Proposed Action. Cumulatively, the Proposed Action and the Modified Proposed Action would add incrementally to a reduction in views of open and natural areas in the CIAA and would increase views of landscapes that have been developed.

4.15 Water Resources

4.15.1 Surface Water

4.15.1.1 CONTRIBUTING CUMULATIVE ACTIONS

The CIAA for surface water includes stream reaches from the point where water is diverted from Paint Rock Creek, Medicine Lodge Creek, and Alkali Creek downstream to the confluence with the Bighorn River. The CIAA comprises areas that would see changes hydrologically for the life of the project including the unnamed drainage used for the spillway. Past and present actions that may have contributed to hydrological effects in the CIAA include agricultural uses such as farming, ranching, grazing, irrigation and irrigation projects, and infrastructure associated with the development of small towns (e.g., Hyattville). Contributing reasonably foreseeable future actions could include farming and ranching activities on adjacent land, deferred mineral lease parcels (if leased and mined), and mining claims (if mined).

4.15.1.2 CUMULATIVE EFFECTS

Under the Proposed Action and Modified Proposed Action, direct effects to surface water would occur from inundation and changes to water flow associated with stream diversions. Reservoir construction would affect downstream flows by decreasing peak flows and increasing flows during later irrigation season, affecting seasonal flow patterns in downstream reaches. These effects are summarized in Table 3.15-3. Increased surface water evaporation would result in depletion of available water, which would minimally affect water resources in the CIAA. Consumptive use would increase, allowing more land to be irrigated, which would contribute to reduced stream flow in reaches within the CIAA such as the Nowood River. The reduced stream flows from the Proposed Action and Modified Proposed Action would add incrementally to water already withdrawn from affected streams for agricultural uses and irrigation projects in the CIAA. If potentially irrigable permitted acreage is put into production (Modelling Scenario 1), incremental cumulative effects would increase, most notably in the Nowood River reach of the CIAA.

4.15.2 Stream Morphology and Sedimentation

4.15.2.1 CONTRIBUTING CUMULATIVE ACTIONS

The CIAA for stream morphology and stream sedimentation includes tailwater streams 1,000 feet upstream on each tributary coming into the reservoir and downstream of the reservoir to Paint Rock Creek and 1.26 miles down Paint Rock Creek. Also included in the CIAA is the Diversion Channel from Paint Rock Creek, headwater streams 1,000 feet upstream on each tributary coming into the reservoir, and stream channels within the proposed high-water mark of the reservoir. Past, present, and future actions that may have contributed to effects within the watershed and stream reaches include farming and ranching activities on adjacent private lands. Contributing reasonably foreseeable future actions could include farming and ranching activities on adjacent land.

4.15.2.2 CUMULATIVE EFFECTS

Under the Proposed Action and Modified Proposed Action, direct effects would occur to Alkali Creek, Medicine Lodge Creek, and Paint Rock Creek. Alkali Creek would be affected through the 2.1-mile reach impoundment by the reservoir and by upstream effects resulting from backwater, which could cause the creek to widen and develop multiple channel braiding. Medicine Lodge Creek would have a reduced sediment transport capacity, which could lead to stability issues such as bank erosion and stream narrowing. Paint Rock Creek downstream of the confluence with Alkali Creek would have the potential for channel degradation associated with a decrease in sediment loading, as well as increased low-bank erosion at localized areas. Structures placed in the channel to enlarge the Anita Ditch and Anita Supplemental Ditch may contribute to stream morphology effects.

These impacts would add incrementally to past and present actions such as farming and ranching activities that may have increased stream sedimentation and affected stream morphology in CIAA streams. Implementation of the mitigation measure requiring Wyoming Stream Quantification Tool baseline assessments and repeated periodic surveys on appropriate reaches of Medicine Lodge Creek, Paint Rock Creek, Alkali Creek, and the Nowood River would determine whether there is a need for additional stream stabilization measures and would reduce the potential for cumulative stream morphology effects. Cumulative stream morphology effects would also be reduced by using natural channel design techniques for proposed stream structures in conjunction with specific WGFD biological recommendations.

4.15.3 Water Quality

4.15.3.1 CONTRIBUTING CUMULATIVE ACTIONS

The CIAA for water quality includes the Alkali Creek watershed above and slightly below the reservoir, and the surface underlying the reservoir that would chemically interact with the reservoir water. Past, present, and future actions that may have contributed to water quality effects in the CIAA include farming and ranching activities on adjacent private land. Any future actions associated with development of the alluvial aquifer resources within this area would contribute to cumulative water quality effects. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined).

4.15.3.2 CUMULATIVE EFFECTS

Under the Proposed Action and Modified Proposed Action, direct effects to water quality would occur during construction and during the life of the project. The magnitude of effects to water quality would depend on how long water is stored in the reservoir and the quantity and quality of stream water flow during different periods of the year. Most of these effects would be minor (see Table 3.15-3). Water quality effects occurring during construction would be negligible to minor and short term. Downstream water treatment providers for municipal waters (e.g., Hyattville, Manderson) would not be affected. Normal reservoir releases would likely improve downstream water quality in Paint Rock Creek, Alkali Creek, and the Nowood River. The water quality of the reservoir should be acceptable for the proposed recreational and other uses; however, there is some uncertainty with respect to *E. coli*. Potential negative effects to water quality from the Proposed Action and Modified Proposed Action would add to any already existing water quality impacts (e.g., potential *E. coli* impacts) from contributing actions such as farming and ranching. An AMP (Section 3.15.6) will be developed before the publication of the ROD to limit potential cumulative effects of *E. coli* and other water quality issues in the CIAA.

4.15.4 Groundwater

4.15.4.1 CONTRIBUTING CUMULATIVE ACTIONS

The CIAA for groundwater includes the Alkali Creek watershed above and slightly below the reservoir. Past, present, and future actions that may have contributed to groundwater effects in the CIAA include farming and ranching activities on adjacent private land. Any future actions associated with the development of the alluvial aquifer resources within this area would contribute to cumulative groundwater effects. Contributing reasonably foreseeable future actions could include farming and ranching activities on adjacent land.

4.15.4.2 CUMULATIVE EFFECTS

Under the Proposed Action and Modified Proposed Action, direct effects from reservoir construction would affect groundwater conditions such as volume, storage, and quality, but would not affect groundwater flow directions. Filling and maintenance of the reservoir would concentrate water over a progressively larger area that would result in infiltration and recharging of minor underlying aquifers. Groundwater quality of minor aquifers would be enhanced and downgradient groundwater from the reservoir would be improved and contain fewer dissolved solids. Effects under the Modified Proposed Action would be similar. These impacts would add to past, present, and future actions that may have contributed to groundwater changes in the CIAA.

4.16 Water Rights and Irrigation

4.16.1 Contributing Cumulative Actions

The CIAA for water rights and irrigation includes water right holders and irrigated acreage in the Paint Rock Creek watershed and the Nowood River below the confluence with Paint Rock Creek. Past and present conditions that may have contributed to effects on water rights and irrigation are current shortages that exist in the Alkali Creek Reservoir service area. Irrigation practices such as unlined ditch conveyance and flood irrigation used by farmers and ranchers also contribute to cumulative effects of water rights and irrigation in the CIAA.

The CIAA for surface water is the stream reaches from the point where water is diverted from Paint Rock Creek, Medicine Lodge Creek, and Alkali Creek downstream to the confluence with the Bighorn River and also the unnamed drainage used for the auxiliary spillway

4.16.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, direct effects would occur to irrigation from changes to late-season availability of surface water for irrigation as well as irrigation practices themselves. Surface water evaporation off the proposed reservoir surface would contribute to water loss but would not affect other water users in the watershed. Beneficial effects from the Proposed Action and Modified Proposed Action include a reduction in irrigation water shortages, an increase in potentially irrigable permitted acreage, and an increase in crop production. Cumulatively, the action alternatives would make additional water available to those affected by the current shortages that exist in the Alkali Creek Reservoir area. This would be a long-term, beneficial effect.

4.17 Wetlands

4.17.1 Contributing Cumulative Actions

The CIAA for wetlands is the project area as well as all areas of disturbance from construction and inundation and stream reaches from the point where water is diverted from Paint Rock Creek, Medicine Lodge Creek, and Alkali Creek downstream to the confluence with the Bighorn River. Past and present actions that may have contributed to wetland effects in the CIAA include agricultural uses such as farming and ranching, grazing, development of any irrigation projects, construction of roads, highways, and power and transmission lines that cross the CIAA, and the development of small towns and associated infrastructure (e.g., Hyattville). Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined). If past, present, and reasonably foreseeable actions cause fill or sedimentation in wetlands, or alter wetland hydrology, they would contribute to cumulative wetland effects.

4.17.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, direct effects would occur to wetlands from construction and inundation. Approximately 2.11 acres of permanent wetland effects would occur under both action alternatives from construction of the dam and reservoir. Under both action alternatives, changes in stream flows may increase wetlands along Alkali Creek but are unlikely to measurably affect wetlands along other stream segments. Based on this analysis, the Proposed Action or Modified Proposed Action would add cumulatively to effects from past and present actions and the reasonably foreseeable future actions on wetlands. However, evaluation of effects to wetlands and surface waters is necessary for USACE Section 404 permits, and the USACE require compensatory mitigation for the permanent wetlands losses. As part of the project, wetlands would be constructed as compensatory mitigation. This would limit incremental cumulative effects to wetlands from the project.

4.18 Terrestrial and Aquatic Wildlife

4.18.1 Contributing Cumulative Actions

The CIAA for terrestrial wildlife resources is the project area with a 1-mile buffer as well as habitats within hydrological unit code (HUC) 12 watersheds, with adjustments for individual species to be determined with further analysis. Past and present actions that may have contributed to terrestrial and aquatic wildlife effects in the CIAA include farming and ranching, grazing, road and highway development, power and transmission line development, and development in Hyattville. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined).

The CIAA for aquatic wildlife (fish, macroinvertebrates, amphibians, and reptiles) includes any HUC 12 watershed that includes a stream that could have flow alterations. The CIAA comprises the footprint of Alkali Creek Reservoir at the MHWL and segment of Alkali Creek to be inundated, as well as the stream segments from the diversion points on Paint Rock and Medicine Lodge Creek and the Nowood River downstream to the Bighorn River confluence. Past, present, and future actions that may contribute effects to aquatic wildlife include farming and ranching use on adjacent private lands, grazing, and development near streams. Contributing reasonably foreseeable future actions could include deferred mineral lease parcels (if leased and mined) and mining claims (if mined). If any actions cause fill or sedimentation in stream channels, they would contribute to cumulative aquatic wildlife effects.

4.18.2 Cumulative Effects

Under the Proposed Action and Modified Proposed Action, direct effects to terrestrial wildlife would include loss of habitat, conversion of terrestrial habitat to aquatic habitat, increased traffic and human use, and other disturbances associated with project construction. Habitat alterations or losses for the life of the project would change local bird, big-game, and BLM sensitive species use in the area. An increase in recreational use, noise effects, and human activity during construction and operation would contribute to cumulative effects to wildlife. These effects would add incrementally to past, present, and future actions that have impacted terrestrial wildlife and terrestrial wildlife habitat in the CIAA, such as past conversion of native habitats to agricultural lands and fragmentation of wildlife habitat through road development.

Under the Proposed Action and Modified Proposed Action, direct effects to aquatic wildlife would occur from habitat disturbance, introduction of aquatic invasive species, changes to flow conditions and aquatic habitat, changes to water quality, and an increase in recreational fishing (see Table 3.18-4). Construction activities would temporarily displace aquatic wildlife for several months, or until construction is complete and the fish and macroinvertebrates recolonize. Beneficial effects of the Proposed Action and Modified Proposed Action include the introduction of standing water with deep water and bays and of nearshore habitat areas. With mitigation implementation, the introduction of aquatic invasive species during construction and recreational activities would be limited. In addition, under both action alternatives, 2.1 miles of stream habitat in Alkali Creek would be lost for the life of the project. The loss of stream habitat in Alkali Creek, flow changes, and the remaining adverse effects to aquatic wildlife would add incrementally to other contributing actions that have negatively impacted aquatic wildlife and aquatic wildlife habitat in the CIAA, such as farming and grazing. However, the implementation of mitigation measures such as the AMP (Section 3.15.6) to address water quality issues would reduce incremental negative impacts on aquatic wildlife in the CIAA. The conservation pool design feature in the action alternatives would also help minimize cumulative effects to fish species.

APPENDIX A

Literature Cited

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APPENDIX B

Consultation and Coordination

CONSULTATION AND COORDINATION

Introduction

Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA) require that federal agencies provide meaningful opportunities to the public and stakeholders to provide input and identify their concerns during an environmental impact statement (EIS) process. Federal laws such as the Endangered Species Act, the Clean Water Act, and the National Historic Preservation Act of 1966, as amended (NHPA) mandate public involvement and consultation with agencies or federally recognized tribal governments. This appendix provides information on the consultation and coordination that occurred during the NEPA process for the Alkali Creek Dam and Reservoir EIS.

Agency Consultation

CEQ regulations implementing NEPA allow the lead agency to invite tribal, state, and local governments, as well as federal agencies, to serve as cooperating agencies during the NEPA process. To serve as a cooperating agency, the potential agency or government must have either jurisdiction by law or special expertise relevant to the environmental analysis. Entities that accepted the Bureau of Land Management's (BLM's) invitation and participated as cooperating agencies are listed in Table B-1.

The requirements for consultation under the NHPA are in addition to and independent of the opportunity for qualified entities to cooperate under the provisions of NEPA. Letters to initiate tribal consultation were sent to the Blackfeet Nation, Northern Cheyenne Tribe, Crow Tribe of Indians, Shoshone-Bannock Tribes, Eastern Shoshone Tribe, and Northern Arapaho Tribe on October 10, 2017. The letters notified the tribes of the proposed project and requested government-to-government consultation between the BLM and the tribes. Tribal contacts that are consulting with the BLM for this project are also listed in Table B-1.

Table B-1. Persons, Agencies, Tribes, and Organizations Consulted

Name	Entity and Position	Role
Alvin Not Afraid	Crow Tribal Council, Chairman	Cooperating agency
Blaine Edmo	Shoshone-Bannock Tribal Council, Chairman	Cooperating agency
Clint Wagon	Eastern Shoshone Business Council, Chairman	Cooperating agency
Harry Barnes	Blackfeet Tribal Business Council, Chairman	Cooperating agency
Kirstina Quaempts	Northern Cheyenne Tribe, Tribal Historic Preservation Office Section 106 Coordinator	Cooperating agency
Lawrence Jace Killsback	Northern Cheyenne Tribe, President	Cooperating agency
Roy Brown	Northern Arapaho Business Council, Chairman	Cooperating agency
Bradley Rogers	U.S. Fish and Wildlife Service (USFWS), Fish and Wildlife Biologist	Consulting agency
Nathan Darnall	USFWS, Deputy Field Supervisor	Consulting agency
William (Billy) Bunch	U.S. Environmental Protection Agency (EPA) Region 8, Aquatic Resource Protection and Accountability Unit	Cooperating agency
Melissa McCoy	EPA Region 8, NEPA Compliance and Review	Cooperating agency
Brian Lovett	Wyoming Department of Environmental Quality (WDEQ), Industrial Siting Administrator	Cooperating agency

Name	Entity and Position	Role
Landon Brown	WDEQ, Pollution Prevention	Cooperating agency
Mark Conrad	WDEQ, Water Quality Division NEPA Coordinator	Cooperating agency
Jason Mead	Wyoming Water Development Commission	Cooperating agency
Beth Callaway	Wyoming State Engineer’s Office, River Basin Coordinator	Cooperating agency
Philip Beamer	Wyoming State Engineer’s Office, Water Division III Hydrographer/ Commissioner	Cooperating agency
Chris Wichmann	Wyoming Department of Agriculture Natural Resources and Policy Manager	Cooperating agency
Larry Bentley	Wyoming Department of Agriculture, Eastern Wyoming Program Coordinator	Cooperating agency
Jerry Altermatt	Wyoming Game and Fish Department (WGFD), Terrestrial Habitat Biologist	Cooperating agency
Leslie Schreiber	WGFD, Wildlife Biologist	Cooperating agency
Rick Huber	WGFD, Staff Aquatic Biologist	Cooperating agency
Sam Hochhalter	WGFD, Regional Fisheries Supervisor	Cooperating agency
Judy Wolf	Wyoming State Historic Preservation Office (SHPO), Chief Planning and Historic Context	Cooperating agency
Mary Hopkins	Wyoming SHPO, Historic Preservation Officer	Cooperating agency
Richard Curritt	Wyoming SHPO, Senior Archaeologist Review and Federal Consultation, NEPA Coordinator	Cooperating agency
Susan Child	Wyoming Office of State Lands and Investments, Deputy Director	Cooperating agency
Thomas Dream	Wyoming State Geological Survey, Director and State Geologist	Cooperating agency
Jessica Crowder	Wyoming Office of the Governor, Policy Advisor	Cooperating agency
Deb Craft	Big Horn County Commission, County Commissioner	Cooperating agency
Felix Carrizales	Big Horn County Commission, County Commissioner	Cooperating agency
Lori Smallwod	Big Horn County Commission, County Clerk	Cooperating agency
George Kelso	South Big Horn Conservation District, Chairman of Conservation District	Cooperating agency

Public Involvement

The formal public scoping process for the project began on October 11, 2017, with the publication of the notice of intent (NOI) in the *Federal Register*. The NOI initiated the public scoping process and served to notify the public of the BLM’s intent to prepare an EIS. The BLM also issued a media release and sent a mail and email announcement of the scoping period to the project mailing list. The mailing list was developed from BLM’s mailing list, tribal contacts, and other cooperating agencies. The 30-day public comment period concluded on November 13, 2017.

A meeting of cooperating agency representatives was held in Hyattville, Wyoming, on October 24, 2017, at the Hyattville Community Center at 4:00 p.m., and a formal public scoping meeting followed at 6:00 p.m. The public scoping meeting provided information on the proposed project and gave members of the public and agency personnel the opportunity to ask questions or make comments. A presentation was given at each meeting by the BLM and representatives of the project proponent (Wyoming Water Development Office [WWDO]). Representatives from the BLM, the WWDO and their contractor, and the third-party NEPA contractor were also available during the meetings for questions. Meeting attendees were encouraged to ask questions during the presentations. The BLM developed several posters that were on display throughout the room; these showed an overview of the proposed project, a project map, an overview of the NEPA process, and methods for providing comments.

Members of the public and agencies had several methods for providing comments during the scoping period:

- Comments could be handwritten on comment forms at the scoping meeting. Comment forms were provided to all meeting attendees and were also available throughout the meeting room so attendees could write and submit comments during the meeting.
- Emailed comments could be sent to the following dedicated email address: blm_wy_alkalireservoireis@blm.gov
- Individual letters and comment forms could be mailed using U.S. Postal Service to the following:
- NEPA Coordinator
  BLM Worland Field Office (WFO)
  101 South 23rd Street
  Worland, Wyoming 82401

The BLM WFO received a total of 11 submissions from members of the public and the cooperating agencies during the scoping period. In all, 73 unique comments were identified from all 11 submissions. Issue statements were developed from similar comments. All comments were given equal consideration, regardless of method of submittal. For more information on the scoping comments and the scoping analysis process, refer to the December 2017 *Scoping Summary Report, Alkali Creek Dam and Reservoir Project, Draft Environmental Impact Statement*[1] available on the BLM's ePlanning website at: https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage&currentPageId=102200.

The notice of availability for the draft EIS was published in the *Federal Register* on August 31, 2018. The 45-day public review period extended through October 15, 2018. A public meeting was held on September 20, 2018, at the Hyattville Community Center from 5:30 to 8:00 p.m. There was no formal presentation at the meeting, but several posters and handouts with project information were provided, along with electronic copies of the draft EIS. Members of the public were encouraged to ask questions of BLM specialists in attendance. Methods established for providing comments were the same as for the initial public scoping meeting. The BLM WFO received a total of 12 submissions from members of the public and cooperating agencies. Responses to the comments are located in Appendix F of the final EIS.

List of Preparers and Reviewers

Tables B-2, B-3, and B-4 identify BLM, U.S. Army Corps of Engineers (USACE), and Wyoming Department of Transportation (WYDOT) staff and consultants used in the preparation of the EIS.

[1] Bureau of Land Management (BLM). 2017. *Scoping Summary Report. Alkali Creek Dam and Reservoir Project Draft Environmental Impact Statement.* Available at: https://eplanning.blm.gov/epl-front-office/projects/nepa/69700/130242/158390/Alkali_Scoping_Summary_Report_DRAFT_2017-12-19_508.pdf. Accessed May 23, 2018.

Table B-2. BLM Staff Used in the Preparation of this Environmental Impact Statement

Name	Office	Role
Adam Babcock	WFO	Recreation, visual resource management, special designations, travel management/off-highway vehicles
Connie Craft	WFO	Realty and land tenure
Darci Stafford	WFO	Fluid minerals
Dora Ridenour	WFO	Assistant field office manager, lands and realty
Hannah Fortney	WFO	Recreation and visual resources
Holly Elliott	WFO	BLM project manager, planning and environmental coordinator
Jeff Coyle	WFO	Hydrologist
Jennifer Dobb	Wyoming State Office, Cheyenne	Economics
Jessica Montag	Wyoming State Office, Cheyenne	Economics
Jim Wolf	WFO	Resource advisor
JoDee Cole	WFO	GIS
John Elliott	WFO	Assistant field office manager, resources
Joseph Scyphers	WFO	Solid materials
Karen Hepp	WFO	Threatened and endangered plant species
Leslie Coleman	WFO	Soils and invasive nonnative plants
Marit Bovee	WFO	Archaeology, paleontology
Michael J. Phillips	WFO	Field office manager
Monica Goepford	WFO	Public health and safety
Rita Allen	WFO	Resource advisor
Ryan McCammon	Wyoming State Office, Cheyenne	Air quality, noise
Sarah Beckwith	WFO	Public affairs web support
Stacey Whitman Moore	WFO	Archaeology
Ted Igleheart	WFO	Wildlife, fish, threatened and endangered and special status species
Teryl Shryack	WFO	Grazing administration, vegetation
Tim Stephens	WFO	Wildlife, fish, threatened and endangered and special status species
Tyson Finnicum	Wyoming State Office, Cheyenne	State office planning and NEPA compliance
Yvonne Warren	WFO	Fire/fuels

Table B-3. USACE and WYDOT Staff Used in the Preparation of this Environmental Impact Statement

Name	Office	Role
Kevin Little	USACE Wyoming Regulatory Office	USACE project lead
Michael Happold	USACE Wyoming Regulatory Office	Wyoming program manager
Randy Merritt	WYDOT	WYDOT project lead
Dave Haller	WYDOT	WYDOT district construction tech

Table B-4. Consultant Staff Used in the Preparation of this Environmental Impact Statement

Name	Education and Experience	Role
SWCA Environmental Consultants		
Bryan Swindell	M.S. Earth Sciences; 16 years of experience	GIS manager, geospatial analysis
Calah Worthen	M.S.T. Environmental Science; 7 years of experience	Water quality
Christi Haswell	B.A. American Studies; 16 years of experience	Public involvement, agency coordination
Crystal Young	B.S. Watershed Science and Geomorphology; 14 years of experience	Stream morphology
Dave Reinhart	B.A. Anthropology; GIS Certificate in Applied GIS; 17 years of experience	Information technology
David Fetter	B.S. Watershed Science; 12 years of experience	Resource coordinator
Georgia Knauss	M.S. Geoscience; 19 years of experience	Paleontology
Gretchen Semerad	M.S. Environmental Science; 15 years of experience	Cumulative effects, technical writing
Jake Powell	B.S. Range Science; 19 years of experience	Grazing, wildlife, special-status species
Jenny Addy	B.S. Conservation and Restoration Ecology; 6 years of experience	Cumulative effects, technical writing
Jeremy Eyre	J.D. Law (Environmental and Natural Resources); 15 years of experience	Land use
Kari Chalker	M.A. Liberal Education; 15 years of experience	Technical editor
Kayleigh Rust	B.S. Environmental Economics; 10 years of experience	Soils
Kimberly Ip	B.S. Ecology, Behavior, and Evolution; 13 years of experience	Assistant project manager
Linda Tucker Burfitt	B.A. Communications, 17 years of experience	Lead editor
Landon Bott	B.S. Environmental Science; 5 years of experience	Administrative record
Naomi Ollie	M.A. Anthropology; 15 years of experience	Cultural resources
Ryan Rausch	B.S. Biology, M.E.L.P. Environmental Law; 14 years of experience	Recreation
Tom Hale, PMP, CEP	M.S. Park and Natural Resources Management, M.L.A. Environmental Planning; 28 years of experience	EIS project manager
AECOM Technical Services, Inc.		
Brian Kennedy	B.A. Environmental Planning and Design; 33 years of experience	Transportation
Caitlin Shaw	M.S. Geosciences; 9 years of experience	Transportation, air quality
Jeff Dawson	M.S. Botany; 39 years of experience	Vegetation, wetlands, special-status species
Rollin Daggett	M.S. Freshwater and Marine Biology; 41 years of experience	Aquatics, fisheries
Tom Damiana	M.S. Aerospace Engineering; 18 years of experience	Noise
Carnevale Environmental Consulting		
Mike Carnevale	M.S. Zoology and Physiology; 38 years of experience	Alternatives development lead

Name	Education and Experience	Role
Wenck Associates Inc.		
Dylan Wade	B.S. Mechanical Engineering; 12 years of experience	Hydrology
Joe Bischoff	M.S. Ecology; 21 years of experience	Water quality: *E. coli*
Mark Stacy	M.S. Geology and Water Resources; 21 years of experience	Groundwater, water quality
Victor Anderson	M.S. Civil Engineering; 45 years of experience	Dam/engineering design review
BBC Research and Consulting		
Doug Jeavons	M.A. Economics; 32 years of experience	Socioeconomics
Michael Verdone	Ph.D. Natural Resource Economics; 10 years of experience	Socioeconomics

APPENDIX C

Alternatives Evaluated for the Alkali Creek Dam and Reservoir Final Environmental Impact Statement

This appendix has been revised from the version of Appendix C that was presented in the draft environmental impact statement (EIS) for the Alkali Creek Reservoir Project. This revised appendix clarifies and refines the screening analysis to better explain the steps and screening criteria used to select the alternatives included in the EIS for detailed analysis and those that were dropped from detailed analysis. The appendix is organized as follows:

- Section 1 presents the screening analysis process used to verify previous alternatives selection by the Wyoming Water Development Office (WWDO). Results are summarized in a tabular format.
- Section 2 presents the alternatives development and screening process to determine alternatives to be analyzed in the EIS. Results are summarized in a tabular format.

SCREENING OF INITIAL WYOMING WATER DEVELOPMENT OFFICE STORAGE ALTERNATIVES

The Bureau of Land Management (BLM) screened the initial 40 storage alternatives evaluated by the WWDO and presented in the Level II, Phase I and Phase II studies (Trihydro Corporation [Trihydro] 2013, 2016). Using the information presented in the Level II studies, the BLM used a different screening approach to conduct an apples-to-apples comparison to confirm whether the proposed Alkali Creek Reservoir was the best candidate to be included in the draft EIS for detailed analysis.

The screens were as follows:

1. Purpose and Need and Reliability/Yield
2. Technological Feasibility
3. Environmental Impacts
4. Project Cost
5. Unique Considerations

Reliability/Yield was originally listed as a separate screen in the draft EIS. Because it was largely looking at the same things as the purpose and need, it was combined with that screen for the final EIS.

The screens are described below along with a summary of the alternatives that fell out at each screen. Table C-1 presents more detail for each of the 40 screened storage alternatives. This screening used the Trihydro (2013) report as the basis to evaluate and compare the 40 reservoir alternatives with a similar database. Table C-2 presents the non-storage alternatives that were considered. Table C-3 provides some additional information on the Cottonwood Creek, Little Cottonwood Creek, and Alkali Creek storage alternatives. Finally, Table C-4 summarizes the screening process for all alternatives.

SCREEN 1. PURPOSE AND NEED & RELIABILITY/YIELD: Does the alternative meet the purpose and need for the project? Is the alternative capable of serving the water supply needs in the Paint Rock Creek watershed and the lower Nowood River? Is the reservoir storage site (singly or in combination) large enough to meet the project need? Is the water supply (yield) adequate to satisfy the purpose and need?

This screen uses information developed through analyses of hydrology, reservoir capacity, and conveyance losses. This screen considers the Wyoming State Engineer's guidelines that conveyance losses of 1% per mile will be assigned to each reservoir alternative from the outlet to the points of water use. If a reservoir is located 50 miles to the nearest point of use, the Wyoming State Engineer's Office assumes that 50% of the water released will be consumed by conveyance losses.

For this screen to be considered "practicable," the alternative needs to provide 5,638 acre-feet of late-season irrigation water 8 out of 10 years to lands in the lower portion of the Nowood River watershed, including the Paint Rock Creek watershed.

This screen dropped the most alternatives from detailed consideration. Considering the purpose and need provided by the U.S. Army Corps of Engineers (USACE), every alternative in the Nowood basin upstream from the confluence of the Paint Rock Creek watershed was eliminated based upon the inability of those alternatives to meet the project purpose of serving the irrigated lands in the entire Paint Rock Creek watershed and the lower Nowood River. For these alternatives to serve lands in the Paint Rock Creek watershed above the confluence with the Nowood River, a large diversion dam near the confluence with Paint Rock Creek on the Nowood River would be required. In addition, pumping facilities, canals, pipelines, and a tunnel would be needed to serve lands above the confluence. Further, the Wyoming State Engineer assumes that conveyance losses of 1% per mile will occur with late-season water released from storage in Wyoming.

Nearly all of the reservoir sites in the Nowood River basin above the confluence with Paint Rock Creek would realize conveyance losses exceeding 20%, and conveyance losses of some reservoir sites in the upper reaches of the basin above the Town of Ten Sleep would exceed 50%. Most of the reservoir sites in the Paint Rock Creek basin above the confluence with the Nowood River were also eliminated from detailed analysis in this screen. Of the 40 reservoir alternatives the WWDO initially investigated, 33 were eliminated in this screen. The reasons for these sites being eliminated are summarized in Table C-1. This data used in the Trihydro (2013) report were used as the basis to evaluate and compare the 40 reservoir alternatives with a similar database. Insufficient water supply and inadequate reservoir storage capacity issues were the primary reasons for elimination of the sites from further detailed analysis.

SCREEN 2. TECHNOLOGICAL FEASIBILITY: Can the alternative be constructed? Are there engineering fatal flaws such as foundation conditions, geologic hazards such as karst geology, earthquake hazards, landslides, or other geotechnical considerations that cannot be mitigated? This screen uses information based on engineering analyses. Like Screen 1, Technological Feasibility in this screen is a simple yes/no decision: Can an alternative be constructed that is safe, reliable, and will hold water without excessive seepage?

For this screen to be considered "practicable," the alternative needs to meet dam safety requirements, avoid geologic hazards such as landslides and erodible dam foundations, and be capable of impounding water without excessive seepage or losses to geological formations. Difficult foundation conditions that may require significant and costly design considerations, construction costs, and risks that cannot be reasonably mitigated were dropped from consideration.

Geological hazards and constructability issues were a principal consideration for dropping the following reservoir sites from detailed analysis:

- Cottonwood Creek Reservoir
- Little Cottonwood Creek Reservoir
- Nowood Mahogany Butte #2 Reservoir
- Paint Rock Creek Reservoir

SCREEN 3. ENVIRONMENTAL IMPACTS: Does the alternative resolve resource conflicts that other alternatives do not? For example, how do the remaining alternatives compare to each other considering impacts to aquatic resources?

To comply with the 404 (b)(1) Guidelines, more weight was given to the aquatic impacts associated with each alternative that was evaluated. However, it was recognized that any alternative that affected the habitat of an endangered species or resulted in a direct take (there were none), could be a fatal flaw forcing mitigation or even withdrawal of the alternative from further consideration. Subordinate to the impacts to the aquatic environment, impacts to sage-grouse habitat, crucial big game range, designated wilderness, and important recreational facilities were also considered.

Many of the alternatives had greater aquatic and other environmental effects than the applicant's preferred alternative. Aside from other considerations (Purpose and Need & Reliability/Yield; Technological Feasibility), impacts to the aquatic environment, fisheries, sensitive species, and crucial habitat were some of the considerations for dropping the following two reservoir sites from detailed analysis:

- Canyon Creek Reservoir
- Otter Creek Reservoir

SCREEN 4. PROJECT COST: Though cost alone is insufficient justification for dismissing an alternative from detailed analysis, cost (capital and operation and maintenance [O&M] costs) is an important consideration in determining the feasibility of an alternative for evaluation of a least environmentally damaging practicable alternative.

Although cost was a consideration in the alternative evaluation, it was not needed in order to eliminate any alternatives. All alternatives considered were eliminated in previous screens.

This screen assumed that any alternative that was less than 1.5 times the cost of the WWDO preferred alternative (construction plus operation and maintenance) was feasible. The WWDO determined any alternative that cost more than 1.5 times the Alkali Creek Reservoir Project was economically infeasible. The WWDO sets the norms for agricultural water development projects in the State of Wyoming. The WWDO funds agricultural water supply and storage projects if the benefit/cost ratio is 1.0 or greater. In some cases, the WWDO has funded projects with a 95% grant (5% loan) and the agency has also assumed responsibility for operation and maintenance of the reservoirs.

Although construction costs for each storage alternative were presented in the Level II, Phase I report, the costs presented in the document were reconnaissance level and did not include operation and maintenance costs. Further, reconnaissance costs for diverting water from the Nowood River to the Paint Rock Creek basin above the confluence with the Nowood River were not estimated and not included in the construction costs for the reservoirs in the Nowood basin above the confluence with Paint Rock Creek.

Because of comments on the draft EIS, additional cost information for the Cottonwood Creek Reservoir and the Little Cottonwood Creek Reservoir storage options is provided in Table C-3. The cost of constructing, operating, and maintaining the infrastructure needed for Cottonwood Creek Reservoir and Little Cottonwood Creek Reservoir to serve the project need was determined to be more expensive over the life of the project than the Alkali Creek Reservoir (see Table C-3).

SCREEN 5. UNIQUE CONSIDERATIONS: Screen 5 can be used as a tie-breaker if there are two or more alternatives that pass Screens 1-4. Are there alternatives that provide unique characteristics that can make it more attractive (such as recreation and fishery/wildlife enhancement benefits among others)? Conversely, are there unique characteristics that can make it less attractive such as landownership issues, impacts to buildings and other infrastructure, irrigated lands, recreation facilities, and impediments to access?

Although some alternatives had significant adverse impacts to buildings, roads, farm and ranch lands, and recreational facilities, no alternatives reached this screen.

ALTERNATIVES DEVELOPMENT AND SCREENING FOR THE EIS

In addition to the initial 40 storage alternatives (see Table C-1), 12 additional action alternatives were identified during an alternatives workshop held with cooperating agencies at the BLM office in Worland, Wyoming, on January 9, 2018. These included:

- Three groundwater alternatives
- Natural storage using beaver (*Castor canadensis*) management
- Conservation
- Water leasing
- Six modifications that the WWDO proposed to its preferred alternative (Alkali Creek Reservoir)

A No Federal Action alternative is also included as required by NEPA. In all, 53 alternatives were evaluated using this screening process, as follows:

- Forty initial storage alternatives evaluated by the WWDO and later validated by the BLM using the screening process as summarized in Table C-1
- No Federal Action
- Twelve additional action alternatives (Table C-2)

The No Federal Action, beaver management, water leasing, and conservation alternatives have been evaluated as actions that would not require BLM rights-of way (ROWs), 404 Permits, or U.S. Forest Service Special Use Permits. The three groundwater alternatives were evaluated as actions that may require ROWs, 404 Permits, or U.S. Forest Service Special Use Permits.

Because the 404 (b)(1) guidelines are very specific and place more constraints on the evaluation and selection of a preferred alternative, the purpose and need developed by the USACE was given greater deference in the alternatives screening process.

The additional 13 alternatives were screened using the same practicability criteria as the initial 40 storage alternatives. The results of this screening are found in Tables C-2 and C-4.

Because of comments received during the public comment period on the draft EIS, additional information for the Alkali Creek, Cottonwood Creek, and Little Cottonwood Creek Reservoir Alternatives are also included in Table C-3.

Combinations of Alternatives

To meet the purpose and need for the project, water storage in the upper Paint Rock Creek drainage is required. Therefore, at least one alternative in the upper Paint Rock Creek drainage is required to best serve the project need. The Alkali Creek Reservoir remains the best alternative to meet the needs in the upper Paint Rock Basin. As a result, any combination of alternatives would need to provide a water supply to be equivalent to the Alkali Creek Reservoir. Also, given that Alkali Creek Reservoir is best able to meet project needs, is technologically feasible, and has comparably fewer impacts than other Paint Rock Creek basin reservoir sites, a potential Alkali Creek Reservoir (with a reduced storage pool and minimal canal/diversion enlargement) was included as part of any combination that was considered. Reservoir combinations included the following:

1) Alkali Creek Reservoir (reduced storage capacity and disturbance) and Big Trails Reservoir. This alternative was eliminated because overall environmental impacts and project cost would exceed those associated with Alkali Creek alone and provide no additional benefits.

2) Alkali Creek Reservoir (reduced storage capacity and disturbance) and Little Canyon Creek Reservoir. This alternative was eliminated because overall project cost would exceed those associated with Alkali Creek and provide no additional benefits.

Because the combinations included considering logistics, geotechnical considerations, aquatic and terrestrial environmental constraints, and overall cost, the universe of combination alternatives was limited.

CONCLUSION

The alternatives that were eliminated either cannot provide the water supply needed (either by location, yield, or storage) to meet the stated purpose and need, have technological (geology) issues, or have greater environmental effects than the Alkali Creek Reservoir alternative. A summary of the screening of all alternatives is provided in Table C-4. It is recommended that the No Federal Action, the Alkali Creek Reservoir, and three potential modifications to the Alkali Creek Reservoir project be carried forward for detailed analysis in the EIS. Based upon this analysis, of the options that could meet the purpose and need of the project, the Alkali Creek Reservoir is the action alternative that on-balance would have the least environmental effects to aquatic and terrestrial resources. Conservation may also be considered to enhance (not replace) water available to meet the project need and stretch the water provided by the proposed Alkali Creek Reservoir. Two modifications to the proposed Alkali Creek Reservoir presented in Table C-2 of this appendix could be considered to improve the efficiency and yield of the proposed project and reduce overall environmental effects and project costs. The groundwater alternatives, conservation, beaver management, and water leasing were also eliminated because the reliability of these alternatives to meet the project need was a major concern (Table C-2).

Additionally, after reviewing comments provided on the preliminary draft EIS and draft EIS, two alternatives were evaluated in more detail. Additional cost information (design, construction, and operation and maintenance) on diversion dams, canals, piping, and pumping facilities was provided by the WWDO (Donner 2018) for the Cottonwood Creek and Little Cottonwood Creek alternatives. In addition, aquatic and terrestrial environmental impacts, conveyance losses, water quality, and other factors were further considered in the evaluation of these two alternatives. After further consideration, the rationale for dropping these two alternatives was confirmed. A more detailed summary of the reasons for not carrying Cottonwood Creek and Little Cottonwood Creek forward for detailed analysis is presented in Table C-3.

Finally, because the project needs to serve lands above the confluence of Paint Rock Creek with the Nowood River, there were no combinations of alternatives that passed the environmental or cost screens to justify more detailed evaluation in the EIS.

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Table C-1. Screening of the WWDO's Initial Storage Alternatives Evaluated for the Alkali Creek Dam and Reservoir Draft Environmental Impact Statement

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Rationale for Detailed Analysis or Elimination*	Carried Forward for Analysis (yes/no)
Alkali Creek Reservoir (applicant's preferred alternative) Lat: 44.263196 Long: -107.385275	Off-channel reservoir associated with Alkali Creek (intermittent stream), also receiving diversion from Medicine Lodge Creek and Paint Rock Creek via Anita Supplemental Ditch and Anita Ditch (existing ditches) Earthen dam: 2,384 feet long, 84 feet tall, 692,304 cubic yards of fill Storage capacity: 7,994 acre-feet Water availability normal year (acre-feet): Direct: 827, Indirect: 13,360 / 66,042 Estimated construction cost (2015): $15,741,569 Cost/acre-feet of storage: $2,127	Yes	This alternative will be included in the EIS analysis for the following reasons: 1) The project has the yield and storage capacity to meet the purpose and need. 2) The alternative is located off-channel on an intermittent drainage. 3) The reservoir would affect 1.8 acres of wetlands. 4) The reservoir would impound available flows on Alkali Creek but would largely be filled with available flow diverted from Medicine Lodge Creek and Paint Rock Creek during spring runoff via expansion of existing ditches. 5) The flows would be supplied to the reservoir via enlargements to the existing Anita Supplemental Ditch and Anita Ditch and their existing diversion structures. 6) No impacts to fisheries in Alkali Creek would occur as a result of the alternative. Existing diversions and impacts on Medicine Lodge Creek and Paint Rock Creek already exist. 7) Also see additional information in Table C-3.	Yes
Alkali Creek South Reservoir Lat: 43.994251 Long: -107.401154	On-channel reservoir associated with Alkali Creek South Earthen dam: 980 feet long, 70 feet tall, 607,509 cubic yards of fill Storage capacity: 1,461 acre-feet Water availability normal year (acre-feet): 1,883 Estimated construction cost: $10,148,834 Cost/acre-feet of storage: $6,946	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative has insufficient water supply and storage capacity and is incapable of meeting the project purpose and need.	No
Big Trails Reservoir Lat: 43.705095 Long: -107.330069	On-channel reservoir associated with Nowood River Earthen dam: 765 feet long, 80 feet tall, 650,000 cubic yards of fill Storage capacity: 16,850 acre-feet Water availability normal year (acre-feet): 29,860 Estimated construction cost: $13,800,000 Cost/acre-feet of storage: $819	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative is incapable of meeting the project purpose and need because the reservoir would be unable to supply lands in the Paint Rock Creek drainage above the confluence with the Nowood River without affecting aquatic resources further from 1) another diversion from the Nowood River, 2) pumping, 3) piping, and 4) a tunnel. Further, calculated conveyance losses exceeding 60% are possible.	No
Bruner Gulch Reservoir Lat: 43.818915 Long: -107.379319	Off-channel reservoir associated with Buffalo Creek, also receiving new diversion from the Nowood River Earthen dam: 650 feet long, 45 feet tall, 164,742 cubic yards of fill Storage capacity: 7,700 acre-feet Water availability normal year (acre-feet): Direct: 3,607, Indirect: 9,760 Estimated construction cost: $12,200,000 Cost/acre-feet of storage: $1,584	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative would result in insufficient water supply/yield (7,700 acre-feet storage, and conveyance losses are estimated >50%). Therefore, this alternative does not meet the project purpose and need. 2) Yield without Nowood River diversion is 3,707 acre-feet, with Nowood River diversion is >13,000 acre-feet. Fishery impacts and stream flow impacts are associated with the new Nowood Diversion. The reservoir would require constructing a canal and tunnel to divert water from the Nowood River to fill the reservoir. 3) The reservoir would be unable to directly supply lands in the Paint Rock Creek drainage above the confluence with the Nowood River without another diversion from the Nowood River. Additionally, pumping, piping, and a tunnel are needed to service lands in the Paint Rock Creek basin above the confluence with the Nowood River. Fishery impacts and stream flow impacts are associated with the new Nowood Diversion.	No
Canyon Creek Reservoir Lat: 44.030263 Long: -107.336053	On-channel reservoir associated with Canyon Creek Earthen dam: 315 feet long, 120 feet tall, 502,519 cubic yards of fill Storage capacity: 46,650 acre-feet Water availability normal year (acre-feet): 9,184 Estimated construction cost: $9,559,754 Cost/acre-feet of storage: $205	No	This alternative is not included in the EIS analysis for the following reason: 1) The reservoir meets the purpose and need for the project (Screen 1) and there are no technological issues (Screen 2). 2) Eliminated in Screen 3. The reservoir would directly impact 47.4 acres of wetlands and an important brown trout fishery, and for these reasons, it did not clear Screen 3 (Environmental Impacts) and was not carried further for detailed analysis.	No
Cherry Creek Reservoir Lat: 43.656409 Long: -107.313035	Off-channel reservoir associated with Cherry Creek, also receiving new diversion from Box Elder Creek Earthen dam: 989 feet long, 95 feet tall, 426,632 cubic yards of fill Storage capacity: 1,345 acre-feet Water availability normal year (acre-feet): N/A Estimated construction cost: N/A Cost/acre-feet of storage: N/A	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative has insufficient storage capacity and is therefore incapable of meeting the project purpose and need.	No

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Rationale for Detailed Analysis or Elimination*	Carried Forward for Analysis (yes/no)
Cornell Gulch Reservoir Lat: 43.59117702 Long: -107.4443058	Off-channel reservoir associated with Cornell Gulch, also receiving new diversion from the Nowood River Earthen dam: 1,400 feet long, 110 feet tall, 697,786 cubic yards of fill Storage capacity: 2,661 acre-feet Water availability normal year (acre-feet): Direct: 524, Indirect: 4,464 Estimated construction cost: $12,930,000 Cost/acre-feet of storage: $4,859	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has insufficient storage capacity with conveyance losses to the first point of delivery in the proposed service area would exceed 25%.and requires a diversion from the Upper Nowood River.	No
Cottonwood Creek Reservoir Lat: 44.151512 Long: -107.683274 Water Availability (Normal Year (acre-feet):	Off-channel reservoir associated with Cottonwood Creek, also receiving new diversion from the Nowood River Earthen dam: 1,300 feet long, 90 feet tall, 311,007 cubic yards of fill Storage capacity: 11,100 acre-feet Water availability normal year (acre-feet): Direct: 4,238, Indirect: 167,910 Estimated construction cost: $9,000,000 (did not include cost of diversion from the Nowood River, pumping, piping and a tunnel) Estimated construction cost: $9,000,000 Cost/acre-feet of storage: $811	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 2. Because of topography, soils, and geology, the reservoir would have significant constructability issues. Conveyance losses would also be a factor. 2) The reservoir would be unable to supply lands in the Paint Rock Creek drainage above the confluence with the Nowood River without another diversion from the Nowood River requiring pumping, piping, and a tunnel resulting in additional aquatic effects. 3) The cottonwood drainage at the dam and reservoir pool is sparsely vegetated at the site, and there is no wetland or riparian vegetation evident on aerial photographs. Based on measured sediment accumulation at a temporary stream gage in Cottonwood Creek, this reservoir could also result in excessive sedimentation resulting in a shortened effective life of the impoundment. 4) Cottonwood Reservoir could only serve lands in the Paint Rock Creek drainage through exchange that the Alkali Creek Reservoir would serve directly (meeting approximately 300 acre-feet less need). 5) Also see additional information in Table C-3.	No
County Line Reservoir Lat: 44.159997 Long: -107.630692	Off-channel reservoir associated with unnamed drainage, also receiving new diversion from the Nowood River Earthen dam: 1,000 feet long, 100 feet tall, 1,230,000 cubic yards of fill Storage capacity: 3,850 acre-feet Water availability normal year (acre-feet): 69 Estimated construction cost: N/A Cost/acre-feet of storage: N/A	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. The storage capacity and yield is insufficient to meet the purpose and need. Eliminated in Screen 1.	No
Deep Creek Reservoir Lat: 43.554334 Long: -107.343234	On-channel reservoir associated with Deep Creek Earthen dam or concrete arch: 1,085 feet long, 100 feet tall, 672,000 cubic yards of fill Storage capacity: 9,600 acre-feet Water availability normal year (acre-feet): 6,517 Estimated construction cost: $13,000,000 Cost/acre-feet of storage: $1,354	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. Conveyance losses to the first point of delivery in the proposed service area are expected to exceed 75%. 2) Further, this alternative has geology concerns/constraints for the dam embankment and reservoir pool and would have been eliminated in Screen 2.	No
Little Canyon Creek Reservoir Lat: 43.751925 Long: -107.336053	On-channel reservoir associated with Little Canyon Creek Earthen dam: 1,575 feet long, 160 feet tall, 1,201,146 cubic yards of fill Storage capacity: 2,500 acre-feet Water availability normal year (acre-feet): 6,001 Estimated construction cost: $16,007,339 Cost/acre-feet of storage: $6,403	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. Insufficient storage capacity. In addition, conveyance losses to the first point of delivery in the proposed service area would exceed 25%.	No
Little Cottonwood Creek Reservoir Lat: 44.076659 Long: -107.529189	Off-channel reservoir associated with Little Cottonwood Creek, also receiving new diversion from the Nowood River. Earthen dam: 1,775 feet long, 90 feet tall, 1,824,978 cubic yards. Fill. Storage capacity: 8,400 acre-feet Water availability normal year (acre-feet): Direct: 1,280, Indirect: 152,893 Estimated construction cost: $21,165,017 Cost/acre-feet of Storage: $2,520	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 2. Because of topography, soils, and geology, the reservoir would have significant constructability issues. Conveyance losses (30%) would be greater than Cottonwood Reservoir. 2) The reservoir would be unable to supply lands in the Paint Rock Creek drainage above the confluence with the Nowood River without another diversion from the Nowood River, pumping, piping, and a tunnel resulting in additional aquatic effects. 3) The Little Cottonwood Reservoir could only serve lands in the Paint Rock Creek drainage through exchange that the Alkali Creek Reservoir would serve directly (meeting approximately 300 acre-feet less need). 4) Also see additional information in Table C-3.	No

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Rationale for Detailed Analysis or Elimination*	Carried Forward for Analysis (yes/no)
Lone Tree Reservoir Lat: 43.568274 Long: -107.463131	On-channel reservoir associated with the Nowood River Earthen dam: 300 feet long, 80 feet tall, 220,543 cubic yards of fill Storage capacity: 5,700 acre-feet Water availability normal year (acre-feet): 4,464 Estimated construction cost: $6,148,110 Cost/acre-feet of storage: $1,079	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative has insufficient yield and storage issues. Conveyance losses to the first point of delivery in the proposed service area would exceed 50%. 2) Further, this alternative has geology concerns/constraints regarding the foundation for the dam embankment and reservoir pool and would have been eliminated in Screen 2.	No
Lower Brokenback Reservoir Lat: 44.085502 Long: -107.516432	On-channel reservoir associated with Brokenback Creek Earthen dam: 1,400 feet long, 65 feet tall, 695,640 cubic yards of fill Storage capacity: 4,200 acre-feet Water availability normal year (acre-feet): 9,054 Estimated construction cost: $11,274,437 Cost/acre-feet of storage: $2,684	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative has limited storage capacity. 2) Further, this alternative would present geology concerns/constraints regarding the foundation for the dam embankment and reservoir pool and would have been eliminated in Screen 2. 3) Finally, this alternative would affect 14.2 acres of wetlands and would have been eliminated in Screen 3.	No
Lower Luman Creek Reservoir Lat: 44.26011031 Long: -107.4920134	Off-channel reservoir associated with Luman Creek, also receiving new diversions from Laddie Creek/South Paint Rock Creek Earthen dam: 861 feet long, 150 feet tall, 627,816 cubic yards of fill Storage capacity: 2,421 acre-feet Water availability normal year (acre-feet): Direct: 288, Indirect: 16,345 Estimated construction cost: $14,976,690 Cost/acre-feet of storage: $6,186	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. Storage capacity is very limited.	No
Lower Nowood Reservoir Lat: 44.159079 Long: -107.667806	On-channel reservoir associated with the Nowood River Earthen dam: 3,000 feet long, 45 feet tall, 755,986 cubic yards of fill Storage capacity: 40,650 acre-feet Water availability normal year (acre-feet): 214,189 Estimated construction cost: $12,886,826 Cost/acre-feet of storage: $317	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. The reservoir would be unable to supply lands in the Paint Rock Creek drainage above the confluence with the Nowood River without another diversion from the Nowood River, pumping, piping, and a tunnel resulting in additional aquatic effects. 2) Further, if Screen 1 was not sufficient to eliminate this alternative, the reservoir would inundate 238.4 acres of wetlands and would have been eliminated in Screen 3.	No
Lower Trout Creek Reservoir Lat: 44.373927 Long: -107.385275	On-channel reservoir associated with tributary of Paint Rock Creek Earthen dam: 1,700 feet long, 80 feet tall, 593,185 cubic yards of fill Storage capacity: 750 acre-feet Water availability normal year (acre-feet): 5,544 Estimated construction cost: $9,890,556 Cost/acre-feet of storage: $13,187	No	This alternative is not included in the EIS analysis for the following reason: 3) Eliminated in Screen 1. This alternative has very limited storage capacity (750 acre-feet).	No
McDermott Draw Reservoir Lat: 44.274293 Long: -107.756957	Off-channel reservoir associated with McDermott Draw, also receiving new diversions from Medicine Lodge Creek/Paint Rock Creek Earthen dam: 1,170 feet long, 45 feet tall, 302,910 cubic yards of fill Storage capacity: 1,800 acre-feet Water availability normal year (acre-feet): Direct: 2,193, Indirect: 74,257 Estimated construction cost: $7,109,485 Cost/acre-feet of storage: $3,950	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. The reservoir pool is very small, has limited potential to meet need in in the focus area, and only limited acreage would be served.	No
Meadowlark Lake Reservoir Enlargement Lat: 44.165157 Long: -107.232061	On-channel reservoir associated with East Tensleep Creek RCC Dam enlargement: 400 feet long, 5-foot height increase, 9,758 cubic yards of fill Storage capacity: 1,168 acre-feet enlargement; 4,677 acre-feet total Water availability normal year (acre-feet): 11,527 Estimated construction cost: $2,796,692 Cost/acre-feet of storage: $2,394 Note: 10-foot and 15-foot height increases were also evaluated and had greater impacts.	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. The total storage capacity is insufficient to meet the project needs. Conveyance losses to the first point of delivery in the proposed service area would exceed 50%.	No

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Rationale for Detailed Analysis or Elimination*	Carried Forward for Analysis (yes/no)
Medicine Lodge Reservoir Lat: 44.391696 Long: -107.380505	On-channel reservoir associated with Medicine Lodge Creek Earthen dam: 2,200 feet long, 90 feet tall, 2,085,767 cubic yards of fill Storage capacity: 11,100 acre-feet Water availability normal year (acre-feet): 1,752 Estimated construction cost: $24,338,415 Cost/acre-feet of Storage: $2,193	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. The reservoir would provide an insufficient water supply (< 2,000 acre-feet). This is a large reservoir with insufficient yield. 2) This alternative would affect 51.9 acres of wetlands and would have been eliminated in Screen 3.	No
North Brokenback Reservoir Lat: 44.16755 Long: -107.373224	On-channel reservoir associated with North Fork Brokenback Creek Earthen dam: 750 feet long, 120 feet tall, 1,310,815 cubic yards of fill Storage capacity: 820 acre-feet Water availability normal year (acre-feet): 2,399 Estimated construction cost: $16,851,913 Cost/acre-feet of storage: $20,551	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has an insufficient water supply and very limited storage capacity.	No
Nowood-Crawford Reservoir Lat: 43.550728 Long: -107.513509	On-channel reservoir associated with the Nowood River Earthen dam: 1,100 feet long, 70 feet tall, 695,139 cubic yards of fill Storage capacity: 1,100 acre-feet Water availability normal year (acre-feet): 3,829 Estimated construction cost: $9,800,000 Cost/acre-feet of storage: $8,909	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative has an insufficient water supply and very limited storage capacity.	No
Nowood Mahogany Butte #1 Reservoir Lat: 43.64691 Long: -107.37835	On-channel reservoir associated with the Nowood River Concrete arch dam. 275 feet long, 80 feet tall, 238,795 cubic yards of fill Storage capacity: 4,300 acre-feet Water availability normal year (acre-feet): 9,760 Estimated construction cost: $6,409,725 Cost/acre-feet of storage: $1,491	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative has insufficient storage capacity and a marginal water supply because conveyance losses to the first point of delivery in the proposed service area would likely exceed 50%.	No
Nowood Mahogany Butte #2 Reservoir Lat: 43.64691 Long: -107.37835	On-channel reservoir associated with the Nowood River Concrete arch dam: 400 feet long, 130 feet tall, 885,926 cubic yards of fill Storage capacity: 28,000 acre-feet Water availability normal year (acre-feet): 9,760 Estimated construction cost: $12,996,017 Cost/acre-feet of storage: $464	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 2. There are geology concerns/constraints regarding the foundation for the dam embankment and reservoir pool. 2) Additionally, this alternative would impact 23.5 acres of wetlands and would have been eliminated in Screen 3.	No
Otter Creek Reservoir Lat: 43.875655 Long: -107.345908	On-channel reservoir associated with Otter Creek Earthen dam: 3,500 feet long, 85 feet tall, 1,779,113 cubic yards of fill Storage capacity: 15,300 acre-feet Water availability normal year (acre-feet): 9,505 Estimated construction cost: $22,119,394 Cost/acre-feet of storage: $1,446	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 3. This alternative would affect 6.4 acres of wetlands and would affect important "yellow ribbon" naturally reproducing brown/rainbow trout fishery and a stable mountain sucker population and mountain sucker habitat. The mountain sucker is a species of concern (Belica et al. 2006). 2) This alternative would impact crucial mule deer range that is difficult to mitigate for the following reasons: 1) herd fidelity to the specific location, 2) snow cover characteristics, 3) vegetation communities, 4) slope aspect, 5) meteorological conditions, and 6) soils. 3) This alternative is located entirely within the sage-grouse core area. Populations of greater sage-grouse throughout the west are declining and the USFWS classifies the species as near threatened.	No
Paint Rock Creek Reservoir Lat: 44.285345 Long: -107.489633	On-channel reservoir associated with Paint Rock Creek Earthen dam: 720 feet long, 170 feet tall, 1,443,854 cubic yards of fill Storage capacity: 5,850 acre-feet Water availability normal year (acre-feet): 65,291 Estimated construction cost: $27,017,244 Cost/acre-feet of storage: $4,618	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 2. The geology is rated poor for embankment and pool foundations.	No

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Rationale for Detailed Analysis or Elimination*	Carried Forward for Analysis (yes/no)
Pete Reservoir Lat: 44.312359 Long: -107.785882	On-channel reservoir associated with unnamed tributary of Nowood River Earthen dam: 1,350 feet long, 80 feet tall, 992,119 cubic yards of fill Storage capacity: 1,600 acre-feet Water availability normal year (acre-feet): 197 Estimated construction cost: N/A Cost/acre-feet of storage: N/A	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has a limited water supply and storage capacity. Unable to meet purpose and need.	No
Solitude Reservoir Lat: 44.355029 Long: -107.270791	On-channel reservoir associated with Paint Rock Creek Earthen dam: 615 feet long, 60 feet tall, cubic yards of fill: N/A Storage capacity: 4,570 acre-feet Water availability normal year (acre-feet): 15,271 Estimated construction cost: N/A Cost/acre-feet of storage: N/A	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. Storage capacity is insufficient to meet the water needs in the focus, area and there are estimated conveyance losses of > 20% to the first point of delivery. Unable to meet purpose and need.	No
South Fork Otter Reservoir (Lower) Lat: 43.808036 Long: -107.248039	On-channel reservoir associated with Otter Creek Earthen dam: 485 feet long, 120 feet tall, 1,594,311 cubic yards of fill Storage capacity: 1,579 acre-feet Water availability normal year (acre-feet): 8,988 Estimated construction cost: $12,531,344 Cost/acre-feet of storage: $7,936	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has insufficient storage capacity. Unable to meet purpose and need.	No
South Fork Otter Reservoir (Upper) Lat: 44.112333 Long: -107.448956	On-channel reservoir associated with Otter Creek Earthen dam: 890 feet long, 120 feet tall, 1,594,311 cubic yards of fill Storage capacity: 1,023 acre-feet Water availability normal year (acre-feet): 8,988 Estimated construction cost: $18,480,575 Cost/acre-feet of storage: $18,065	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has insufficient storage capacity. Unable to meet purpose and need.	No
Summit Reservoir Lat: 44.37207 Long: -107.242543	On-channel reservoir associated with an unnamed tributary of Paint Rock Creek Earthen dam: 220 feet long, 30 feet tall, cubic yards of fill: N/A Storage capacity: N/A Water availability normal year (acre-feet): 699 Estimated construction cost: N/A Cost/acre-feet of storage: N/A	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. The headwaters of Paint Rock Creek provide insufficient water yield. Unable to meet purpose and need.	No
Taylor Draw Reservoir Lat: 43.919142 Long: -107.379389	Off-channel reservoir associated with Taylor Draw, also receiving new diversion from Otter Creek Earthen dam: 1,193 feet long, 85 feet tall, 499,063 cubic yards of fill Storage capacity: 2,435 acre-feet Water availability normal year (acre-feet): Direct: 2,075, Indirect: 9,505 Estimated construction cost: $15,605,863 Cost/acre-feet of storage: $6,409	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative would need to divert water from Otter Creek. Storage capacity is insufficient. Conveyance losses to the first point of delivery in the proposed service area would exceed 25%. Unable to meet purpose and need.	No
Upper Brokenback Reservoir Lat: 44.112333 Long: -107.448956	On-channel reservoir associated with Brokenback Creek Earthen dam: 376 feet long, 65 feet tall, 205,031 cubic yards of fill Storage capacity: 225 acre-feet Water availability normal year (acre-feet): 8,024 Estimated construction cost: $5,887,914 Cost/acre-feet of storage: $26,169	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. Extremely limited storage capacity. Unable to meet purpose and need.	No

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Rationale for Detailed Analysis or Elimination*	Carried Forward for Analysis (yes/no)
Upper Luman Creek Reservoir Lat: 44.24180894 Long: -107.4516683	Off-channel reservoir associated with Luman Creek, also receiving new diversions from Laddie Creek/South Paint Rock Creek Earthen dam: 1,080 feet long, 160 feet tall, 1,350,000 cubic yards of fill Storage capacity: 3,240 acre-feet Water availability normal year (acre-feet): Direct: 220, Indirect: 16,345 Estimated construction cost: $22,600,000 Cost/acre-feet of storage: $6,975	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has insufficient storage capacity. Yield is insufficient unless a complex water supply from South Paint Rock Creek and Laddie Creek is constructed. Unable to meet purpose and need.	No
Upper Nowood Reservoir Lat: 43.73688 Long: -107.332899	On-channel reservoir associated with the Nowood River Earthen dam: 1,260 feet long, 80 feet tall, 927,585 cubic yards of fill Storage capacity: 5,250 acre-feet Water availability normal year (acre-feet): 9,760 Estimated construction cost: $15,900,000 Cost/acre-feet of storage: $3,029	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has insufficient water storage capacity and >50% conveyance loss issues. Unable to meet purpose and need.	No
Weintz Draw Reservoir Lat: 44.233049 Long: -107.690194	Off-channel reservoir associated with Weintz Draw, also receiving new diversion via Anita Ditch from Paint Rock Creek Earthen dam: 960 feet long, 45 feet tall, 272,729 cubic yards of fill Storage capacity: 1,120 acre-feet Water availability normal year (acre-feet): Direct: 19, Indirect: 68,020 Estimated construction cost: $6,653,617 Cost/acre-feet of storage: $5,941	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has extremely limited storage capacity and potential to meet water supply needs in the focus area. Unable to meet purpose and need.	No
West Fork Willow Creek Reservoir Lat: 43.790051 Long: -107.365292	Off-channel reservoir associated with West Fork Willow Creek, also receiving new diversion from the Nowood River Earthen dam: 1,325 feet long, 70 feet tall, 859,444 cubic yards of fill Storage capacity: 9,600 acre-feet Water availability normal year (acre-feet): Direct: 99 Estimated construction cost: $12,748,455 Cost/acre-feet of storage: $1,328	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has an extremely limited water supply (99 acre-feet per year). Unable to meet purpose and need.	No
West Tensleep Lake Reservoir Lat: 44.25546 Long: -107.218302	On-channel reservoir associated with Tensleep Creek Earthen dam enlargement: 1,175 feet long, 42 feet tall, 115,000 cubic yards of fill Storage capacity: 75 acre-feet enlargement; total 4,000 acre-feet Water availability normal year (acre-feet): 5,722 Estimated construction cost: $3,590,853 Cost/acre-feet of storage: $47,878	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This reservoir site has insufficient storage capacity and conveyance losses would likely reduce the water supply by >40%. Unable to meet purpose and need.	No
Willow Creek Reservoir Lat: 43.790051 Long: -107.365292	On-channel reservoir associated with West Fork Willow Creek, also receiving new diversion from the Nowood River Earthen dam: 1,372 feet long, 145 feet tall, 1,609,061 cubic yards of fill Storage capacity: 42,915 acre-feet Water availability normal year (acre-feet): Direct: 99, Indirect: 3,829 Estimated construction cost: $25,773,098 Cost/acre-feet of storage: $601	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. Requires a diversion from the Nowood River, 6.5 miles of canal, and a 1,961-foot tunnel. Insufficient water supply. Unable to meet purpose and need.	No
Woods Gulch Reservoir Lat: 43.970945 Long: -107.375975	On-channel reservoir associated with Woods Gulch Earthen dam: 825 feet long, 50 feet tall, 273,173 cubic yards of fill Storage capacity: 336 acre-feet Water availability normal year (acre-feet): 360 Estimated construction cost: $6,207,824 Cost/acre-feet of storage: $18,476	No	This alternative is not included in the EIS analysis for the following reason: 1) Eliminated in Screen 1. This alternative has very limited water supply and insufficient storage capacity. Unable to meet purpose and need.	No

* Screening of the initial 40 storage alternatives relies on the data and information presented in the WWDO's Level II, Phase I and Phase II studies (Trihydro 2013, 2016).

After the alternatives workshop conducted at the BLM office in Worland, Wyoming, on January 9, 2018, additional alternatives were evaluated and compared to the Alkali Creek Reservoir. The information presented in Table C-1 for the Alkali Creek Reservoir project was updated using the information presented in Trihydro 2016. The environmental effects and costs associated with the Alkali Creek Reservoir increased because the preliminary information presented in Trihydro 2013 was further analyzed and refined. If all 40 reservoir alternatives had been evaluated in a similar manner in the Trihydro 2016 report, the impacts and costs associated with each would likely have changed considerably. For instance, the Trihydro 2013 report did not evaluate or consider:

1) The environmental effects to aquatic and terrestrial environments of the diversions associated with the water supplies for off-channel reservoirs that would divert from adjacent streams and rivers.
2) The capital and operation and maintenance costs of the diversions associated with the water supplies for off-channel reservoirs that would divert from adjacent streams and rivers were not considered.
3) The capital and operation and maintenance costs of the diversion, pumping facilities, canals, pipelines, and tunnels associated with the delivery of water from the UPPER Nowood River basin to lands in the Paint Rock Creek watershed above the confluence with the Nowood River were not considered.
4) The need (and cost) to bring electric power to alternatives requiring pumping to fill reservoirs or deliver water to irrigated lands was not determined.
5) Geologic hazards associated with the facilities noted in 1), 2), and 3).

Table C-2. Screening of Non-Storage Alternatives

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Likely Impacts to Waters of the U.S./Other Significant Adverse Effects; Rationale for Detailed Analysis or Elimination	Carried Forward for Analysis (yes/no)
No Federal Action	The No Federal Action is based on the continued operations of the Nowood Watershed Improvement District (NWID) as it currently exists without additional storage or late-season water supplies.	No (does not achieve overall project purpose)	This alternative is included in the EIS analysis for the following reasons: 1) The No Federal Action is required by the National Environmental Policy Act (NEPA); however, this alternative would not address late-season irrigation shortages in the lower Nowood River and Paint Rock Creek drainages. 2) The No Federal Action would not affect any waters of the U.S.	Yes, as required by NEPA
Non-storage Alternatives Considered for Analysis				
Alluvial Groundwater Pumping	Seven hundred fifty-four (754) wells would be required to provide the same maximum shortage reduction as the proposed reservoir. Construction costs are estimated to be $23,000,000 based on 754 wells drilled to a depth of 50 feet and include pumps and piping. This does not include operation and maintenance costs associated with electrical power purchases for pumping and replacement of aging infrastructure.	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. The adequacy of the alluvial groundwater supplies to meet the project need is questionable. 2) Alluvial groundwater supplies are regulated as surface waters by the Wyoming State Engineer. Therefore, the current late-season supply deficiencies would continue. 3) Pumping alluvial groundwater in the volumes needed to satisfy the project need could have significant effects on stream flows, wetlands, aquatic habitats, and riparian habitats. 4) Storage development through the WWDO provides proponent-favorable grant/loan funding options, which are not available for irrigation well development. This would place a significant financial burden on the proponent.	No
Non-tributary Groundwater Pumping – Tensleep Sandstone Aquifer	The Tensleep Sandstone Aquifer is the upper-most major water-bearing unit of the Paleozoic aquifer system in the Bighorn Basin. In the proposed reservoir service area, the aquifer is generally less than 1,000 feet below ground surface. In general, well yields from the Tensleep Sandstone range from 50 to 200 gallons per minute (gpm) with some artesian flow. At 200 gpm per well, 57 wells would be needed to provide the water volume equivalent to the proposed reservoir operation pool, and 188 gpm is needed to provide the same maximum shortage reduction as the proposed reservoir. The cost associated with this alternative is estimated to be as high as $74,000,000 based on 188 wells drilled to a depth of 700 feet and including pumps and distribution piping. This does not include operation and maintenance costs associated with electrical power purchases for pumping and replacement of aging infrastructure. BLM ROW and USACE 404 permits may or may not be required to implement this alternative.	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. This alternative may not be able to provide the volume of water needed to meet long-term needs, and the volume needed could exceed the capacity of the aquifer to recharge the aquifer (i.e., groundwater would likely be “mined” and not replaced by natural recharge. 2) This alternative does not appear to be technically or financially practicable and would have been eliminated in Screen 2 or 4. 3) The groundwater alternative using wells drilled in the Tensleep Sandstone Aquifer is not technically viable because of the large number of wells required to address irrigation demands, required well spacing to avoid well interference, and potential aquifer drawdown and/or effects on surface waters. 4) Given the limitations of the Tensleep Sandstone Aquifer for producing sufficient yields where secondary permeability is not present, siting 57 to 188 productive wells would be challenging. An extensive drilling/testing effort would be required before determining the “reasonableness” of this alternative. Well spacing to prevent interference between wells would also need to be considered and evaluated during siting and could limit how many wells can be constructed in a geographic area. 5) One hundred eight-eight (188) wells could dewater the aquifer and cause impacts to existing groundwater rights that would need to be evaluated and monitored. 6) Many of the well components, including pumps and piping, would not last the 50 years used as the minimum reservoir lifespan. Replacing these components would add additional costs for this alternative. 7) Further, storage development through the WWDO provides proponent-favorable grant/loan funding options, which are not available for irrigation well development. This would place a significant financial burden on the proponent.	No

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Likely Impacts to Waters of the U.S./Other Significant Adverse Effects; Rationale for Detailed Analysis or Elimination	Carried Forward for Analysis (yes/no)
Non-tributary Groundwater Pumping – Madison-Bighorn Aquifer	Located below the Tensleep Sandstone Aquifer, the Madison-Bighorn Aquifer is another major water-bearing zone within the Paleozoic Aquifer System. The Madison-Bighorn Aquifer is a massive crystalline limestone and dolomite aquifer that relies on secondary porosity through solution along joints and fractures for increased yield. As with the Tensleep Sandstone, the Madison Limestone and Bighorn Formations outcrop along the eastern flanks of the Bighorn Mountains and dip toward the interior of the basin. In the Hyattville area, Madison-Bighorn well depths are typically 2,500 to 3,500 feet with artesian yields up to 3,000 gpm. However, the typical yield is 500 gpm to 1,500 gpm. At 1,000 gpm per well, 12 wells would be needed to provide the same irrigation benefits as the proposed reservoir, and 38 wells would be required to provide the same maximum shortage reduction as the proposed reservoir. Although the Madison-Bighorn Aquifer is typically artesian in the area, the increased production from the aquifer might cause a lowering of the hydraulic head and loss of artesian pressure, thus requiring pumping over the long term. Based on typical drilling costs for deep, large-diameter aquifer wells, the cost to complete Madison-Bighorn Aquifer wells and install associated distribution piping is estimated at between $35,000,000 (for 12 wells) and $110,000,000 (for 38 wells). The analysis estimates that each well would cost approximately $2,100,000 to drill and complete, with additional costs for design, plans and specifications, pumps (assuming pumps are needed because of loss of artesian pressure), distribution piping, construction management, and contingencies. Distribution piping costs would be significant and depend greatly on well locations vs. application areas. This alternative assumes 0.5 miles of piping associated with each well. The annual power costs associated with pumping are estimated at $111,000. BLM ROW and USACE 404 permits may or may not be required to implement this alternative.	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. See the Non-tributary Groundwater – Tensleep Sandstone Aquifer discussion above. This alternative does not appear to be technically or financially practicable. 2) The likelihood of finding and developing adequate Madison-Bighorn Aquifer groundwater supplies is unknown. 3) Potential sustainability of drawing needed water from the aquifer is unknown because groundwater has a much longer residence time than surface water and is not nearly as renewable and sustainable. 4) This alternative could result in long-term impacts (drawdown) of the aquifer and impacts to municipal water supply systems. The potential loss of artesian pressure may affect other groundwater rights in the area. 5) As with the Tensleep Sandstone Aquifer, locating sufficient areas with increased secondary porosity may be difficult. 6) Well water likely could not be conveyed to irrigation diversions via streams and rivers because of differences in water quality and would need to be piped or conveyed in ditches. As an example, water discharge temperature from the deep aquifer can be 60 to 88 degrees, significantly higher than surface waters (Wyoming State Geological Survey 2012). The higher temperatures associated with the well water would affect aquatic life in the streams and rivers of the area. 7) This alternative may be technologically feasible but with significant associated costs. Extensive aquifer drilling and testing would be required to determine long-term viability as an irrigation water supply. This analysis would be costly and time consuming. In addition to the capital costs, many of the well components, including pumps and piping, would not last the 50 years determined as the minimum reservoir lifespan. Replacing these components would add additional costs for this alternative. The operation and maintenance costs may exceed the NWID's financial ability to pay. Depending on the capacity of the existing electrical infrastructure in the basin, some infrastructure upgrades could be required to accommodate the additional load created by the large well pumps. Costs associated with these upgrades would likely be passed along to the project proponents. 8) Recreation and environmental enhancement benefits would not be met with a groundwater alternative. 9) As described for the Tensleep Sandstone Aquifer, storage development through the WWDO provides proponent-favorable grant/loan funding options, which are not available for irrigation well development. This would place a significant financial burden on the proponent.	No
Beaver Management	Beaver would be managed in the Nowood River and Paint Rock Creek drainages to maximize water storage in natural ponds. When properly managed, beavers provide valuable wetland, open water, and riparian habitat development and maintenance. Beaver ponds and their adjacent habitats provide ecosystems that benefit a variety of flora and fauna. In the right place and properly managed, beavers are useful in stabilizing stream channels and regenerating riparian zones. Proper management is needed to ensure balance between maintaining beaver food supply and dam construction materials. The cost of implementing this alternative has not been estimated.	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. Beaver ponds are ephemeral and subject to periodic breaching during floods and runoff events. Beaver ponds are generally small and shallow; assuming each pond would impound 1 acre-feet and evaporative losses could be excessive; thousands of ponds would be needed. 2) Discharge from beaver ponds cannot be controlled to reliably deliver water during the late irrigation season. 3) There may be insufficient forage and building materials in the watershed to maintain the population of beaver needed to satisfy the project need. 4) Water stored in beaver dams may affect water rights holders and may interfere with water delivery. 5) Beavers may cause undesirable localized and temporary flooding. Beavers may cause significant negative effects to woody vegetation in riparian areas.	No

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Likely Impacts to Waters of the U.S./Other Significant Adverse Effects; Rationale for Detailed Analysis or Elimination	Carried Forward for Analysis (yes/no)
Water Conservation	There are two approaches to agricultural water conservation: 1) on-farm improvements and operations and 2) WWDO conservation practices and operations. On-farm improvements can include: 1) Conversion of flood or furrow irrigation to sprinklers, 2) Cropping changes, 3) Tailwater recovery and re-use, and Monitoring crop usage requirements and timing application of water. Costs to convert flood irrigation to sprinkler irrigation within the proposed reservoir service area and maintain these systems over the minimum 50-year reservoir life are estimated at approximately $33,800,000. WWDO conservation practices may include: 1) Identifying and lining high-seepage areas in canals/laterals, 2) Properly maintaining canals and laterals by shaping and weed and phreatophyte control, 3) Converting open canals/laterals to pipes, 4) Improving and automating headgates and turnouts, 5) Installing and maintaining flow measuring devices on canals and laterals, and 6) Encouraging irrigators to implement on-farm conservation practices. Although not carried forward, on-farm and on-WWDO conservation practices should be encouraged with the potential of providing better crop yields, fewer labor costs, and more efficient water management.	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 1. Does not meet the purpose and need of the project. Without storage, conservation alone cannot provide sufficient late-season irrigation water supplies. However, conservation could extend the supplies of water stored in reservoirs, allowing for longer periods of use or additional reservoir carryover from one year to the next to provide greater reliability during a short-term drought. 2) Costs to implement WWDO conservation measures are estimated to be roughly $61,500,000 based on converting open ditches to pipe and maintaining these piped conveyances over the minimum 50-year reservoir life. This alternative would still require a storage option to address needs in the service area. 3) Further, storage development through the WWDO provides proponent-favorable grant/loan funding options, which are not available for development of on-farm conservation practices, and funding sources from other federal and state agencies are limited. This would place a significant financial burden on the irrigators. 4) The State of Wyoming has no regulatory authority to require irrigators to implement water conservation practices. Government funding for these activities is very limited.	No
Water Leasing	Trihydro was directed by the BLM to investigate water leasing alternatives and briefly discussed this option in a December 26, 2017, memorandum. An alternative to lease water in lieu of the proposed reservoir was not evaluated in detail. This alternative would entail owners of water rights leasing a portion or all of their adjudicated water to other irrigators.	No	This alternative is not included in the EIS analysis for the following reasons: 1) Eliminated in Screen 2. This alternative is not considered practicable because of the absence of sizeable reservoirs in the Nowood River watershed. 2) Most of water rights within the watershed are tied to agriculture. Therefore, leasing these water rights would not provide a net benefit. 3) Institutional water rights constraints under Wyoming law would likely limit or preclude the implementation of this practice and would likely result in short-term benefits at best.	No
Modifications to the Alkali Creek Alternative Considered for Analysis				
Alkali Creek Reservoir Alternative with Spillway Modification #1	The proposed design includes constructing a principal spillway along the right (west) abutment and an auxiliary spillway west of the right abutment. This alternative is described in the Phase II Study as Option 1 (Trihydro 2016). This alternative would involve siting the auxiliary spillway along the left (east) abutment. The principal spillway could potentially be included within the auxiliary spillway or could remain in its currently proposed location. This alternative would disturb irrigated fields on the east side of Alkali Creek. This modification would reduce disturbance to row crops west of Alkali Creek. Further, this alternative would avoid a large cut through the ridge along Alkali Creek's west bank. This modification would reduce the excavation by about 400,000 cubic yards. This alternative would avoid the auxiliary spillway cutting through the outlet from the reservoir to the downstream portion of the Anita Ditch.	No	Modification 1 is not included in the EIS analysis for the following reasons: 1) Eliminated at Screen 3. Relocating the auxiliary spillway to the east abutment would affect approximately the same acreage of irrigated lands, including row crops, as would the originally proposed alignment. This modification also would require excavation in hard sandstones that may be more difficult to excavate than the materials in the ridge west of Alkali Creek. 2) This modification would require relocating the proposed secondary site access road and temporary construction roads. 3) Further, this alignment may not direct flood flow far enough from the dam embankment to prevent flood flows from affecting the embankment's downstream toe. No benefit to modify the Proposed Action in this way because of the additional environmental impacts.	No

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Likely Impacts to Waters of the U.S./Other Significant Adverse Effects; Rationale for Detailed Analysis or Elimination	Carried Forward for Analysis (yes/no)
Alkali Creek Reservoir Alternative with Spillway Modification #2	The proposed design includes constructing a principal spillway along the right (west) abutment and an auxiliary spillway west of the right abutment. This alternative is described in the Phase II Study as Option 1 (Trihydro 2016). These spillway locations were proposed to reduce disturbance to irrigated fields on the east side of Alkali Creek, downstream of the proposed embankment. At the time, the land west of the proposed reservoir was not irrigated. However, since these spillway alignments were developed, the landowner has installed center pivot sprinklers and planted row crops within the proposed auxiliary spillway footprint. A proposed modification to the proposed spillway configurations includes reducing the length of the auxiliary spillway by constructing an armored control section to direct probable maximum flood (PMF) flows into an existing drainage flowing south across Wyoming Highway 31 (WY 31) and eventually back into Alkali Creek. This alternative would reduce direct disturbance to row crops on the west side of the dam and would not introduce additional effects to irrigated fields east of Alkali Creek. This alternative would also avoid the large cut through the ridge along Alkali Creek's west bank. This modification would reduce the excavation by approximately 400,000 cubic yards. This alternative would avoid the auxiliary spillway cutting through the outlet from the reservoir to the downstream portion of the Anita Ditch. Note: The WY 31 bridge is not capable of handling the PMF flood flows under any of the three reservoir options (original alignment, Modification 1 [not carried forward], and Modification 2). In each case, a PMF flood event would overtop the highway. This is also the case without the proposed reservoir; a PMF event in the absence of the reservoir would also overtop WY 31.	Yes	This modification is included in the EIS analysis for the following reasons: 1) This modification would reduce direct effects to row crops west of Alkali Creek. Although row crops would be damaged in the event of an extreme flood, direct disturbance would be less than that associated with the originally proposed alignment. This alternative would also reduce the need to excavate a large cut through the ridge west of Alkali Creek, reducing environmental effects and project costs. 2) Hydraulic modeling simulates associated flood flows, which would exit the auxiliary spillway and flow down the natural drainage toward WY 31. A portion of the flood flow would cross WY 31 and continue down the natural drainage to Alkali Creek. The rest of the flood flow would flow east between WY 31 and the nose of the ridge west of Alkali Creek and enter Alkali Creek upstream of the WY 31 bridge. This splitting of flows reduces the likelihood of extreme flood flows affecting the embankment's downstream toe. 3) This modification would still require a USACE 404 and BLM ROW permits.	Yes
Alkali Creek Reservoir Alternative with Modified Reservoir Filling Scenario	The proposed plan includes enlarging both the Anita Ditch and the Anita Supplemental Ditch to carry existing irrigation demands and sufficient flows to fill the reservoir (7,994 acre-feet) in 30 days. Under the proposed plan, both ditches would be enlarged to convey a total of 150 cubic feet per second (cfs). This modification would reduce ditch enlargements by extending the reservoir filling window and by reducing the target volume from the normal high-water volume (7,994 acre-feet), which includes the dead pool and conservation pool, to the irrigation or operation pool volume (5,996 acre-feet). Historical stream gage data for Medicine Lodge Creek and Paint Rock Creek and StateMod model simulations of reservoir operations were evaluated to delineate an appropriate reservoir filling period. This evaluation indicates that the Paint Rock Creek and Medicine Lodge Creek spring runoff hydrograph volumes and durations are sufficient to support filling the reservoir's operating pool (5,996 acre-feet) over a 50-day period without impacting the reservoir's firm yield. A 50-day fill would require an average flow of approximately 60 cfs. Increasing the flow to account for potential conveyance losses would add another approximately 10%. Further, simulations indicate that Medicine Lodge Creek provides sufficient flow to support at least half (30 cfs) of the required reservoir flow. Therefore, the Anita Supplemental Ditch, which conveys flow from Paint Rock Creek to Medicine Lodge Creek/the Anita Ditch, would need to convey only half of the required flow rather than the full 60 cfs. This modification would involve enlarging the Anita Supplemental Ditch to convey a total of 80 cfs and enlarging the Anita Ditch to convey a total of 115 cfs. These flows include the reservoir flow, conveyance losses, and the existing peak May-to-June irrigation demands.	Yes	This modification to the original plan is included in the EIS analysis for the following reasons: 1) This modification would reduce effects to landowners but would not reduce the reservoir's firm yield. Reducing the ditch enlargement size would reduce project costs and would reduce complexities associated with replacing irrigation infrastructure. Further reducing the ditch enlargements and the volume of water carried in the ditches would reduce total seepage and evaporation losses. 2) This modification would not significantly reduce environmental effects as the ditches would still be enlarged, which would affect fringe wetlands within/adjacent to the ditches. However, these wetlands are affected during existing, routine ditch maintenance activities. Enlarging the existing diversion structures in Paint Rock Creek and Medicine Lodge Creek would also still be required. However, reducing the size of these enlargements would reduce effects to the streams. 3) This modification would still require USACE 404 and BLM ROW permits.	Yes

Alternative	Alternative Description	Potentially Practicable Alternative (yes/no)	Likely Impacts to Waters of the U.S./Other Significant Adverse Effects; Rationale for Detailed Analysis or Elimination	Carried Forward for Analysis (yes/no)
Alkali Creek Reservoir Alternative with Relocated Anita Supplemental Ditch Headgate	During May 2015 project discussions, the Wyoming Game and Fish Department (WGFD) indicated that the location of the existing Anita Supplemental Ditch headgate diversion is a potential concern. The current diversion is on the inside of a bend, which is where sediment naturally deposits. A potential modification would relocate the diversion upstream 300 to 400 feet.	No	This modification to the original plan is not included in the EIS analysis for the following reasons: 1) Eliminated at Screen 3. Relocating the headgate to the proposed location would require constructing the new diversion location and constructing a new ditch reach to connect the new diversion to the existing Anita Supplemental Ditch. These features would affect two landowners; neither landowner is in favor of this work, which would create new or additional disturbance to their properties. 2) The Paint Rock Creek stream channel and banks have changed since the WGFD made its initial recommendation. This includes continued bank erosion in the area of the proposed relocated headgate location. 3) Upon closer inspection, the proposed location does not provide any benefits over the currently proposed location: o This area of Paint Rock Creek is wide with a large cobble bar separating the main channel that is typically located along the north bank (location of existing and proposed headgate) and a secondary channel along the south bank. High, spring flood flows can cause the main flow to shift from the north channel to the south channel and away from the headgate. This condition exists for the current headgate location and for the proposed location. o Installing cross vanes or similar structures preferred by the WGFD in either location as a means to back water/build head to fill the ditch, could lead to short-circuiting (flow moving to the south channel and away from the diversions) due to the channel conditions. Stream work would be required to address this condition regardless of whether the diversion remains in its current location or is moved to the proposed location. Further, the stream reach requiring work would be approximately the same for both locations. The proposed location increases disturbance outside of the Paint Rock Creek channel, while not reducing the disturbance required within the channel. No benefit to modify the proposed action in this way because of the additional environmental impacts.	No
Alkali Creek Reservoir Alternative with a New Diversion Upstream of the Anita Supplemental Ditch	Model simulations performed as part of the Phase II Study indicate that Alkali Creek Reservoir operations could reduce shortages on Alkali Creek, the main stem of Paint Rock Creek, and the lower Nowood River (approximately 79% annual average shortage reduction for the model period). However, the proposed reservoir operations are simulated to have minimal effect on shortages along Medicine Lodge Creek (approximately 2% shortage reduction). Overall shortages within the focus area would be reduced by more than half (approximately 58% annual average shortage reduction) when Medicine Lodge Creek is included. Because of the proposed reservoir's location, diversions to meet the shortages along Medicine Lodge Creek would occur by exchange with releases from the proposed reservoir. Based on model simulations and input from area irrigators, shortages on Medicine Lodge Creek occur predominantly during low-flow summer months. These low, late-season flows limit exchange potential for irrigators along Medicine Lodge Creek. Therefore, during the same months that the Medicine Lodge Creek demands are shorted, the model simulates limited exchange potential. Alternatives to divert water from Paint Rock Creek upstream of the Anita Supplemental Ditch to a location on Medicine Lodge Creek upstream of the Highland Ditch were identified late in the Phase II Study. These alternatives were reviewed to provide a means of allowing exchanges later in the irrigation season. Under this alternative, flows from Paint Rock Creek could be diverted to irrigators along Medicine Lodge Creek in exchange for water released from the proposed reservoir. This alternative could provide greater opportunities for the reservoir to reduce shortages along Medicine Lodge Creek.	No	This modification to the original plan is not included in the EIS analysis for the following reasons: 1) Eliminated at Screen 3. This modification is likely to have greater aquatic affects than the existing Alkali Creek diversion alternative. This alternative would allow additional water to be diverted from Paint Rock Creek late in the irrigation season, reducing later-season flows in Paint Rock Creek, an important fishery. This modification would also increase effects to private landowners along the proposed new diversion alignment. 2) Although model simulations indicate that the new diversion would allow greater opportunity for late-season exchanges, the magnitude of this benefit is uncertain. Discussions with the State Engineers Office and some operators in the area, as well as review of historical stream gage data, suggest there may be a greater opportunity for later season exchange under the original alternative. There may also be opportunity to improve water availability by altering current irrigation management practices. 3) This modification could be incorporated after the proposed reservoir is constructed and its ability to address late-season shortages on Medicine Lodge Creek is validated. 4) Unless a cogent argument that this proposed modification can significantly improve the water supply or delivery efficiency of the currently designed Alkali Creek Reservoir project, further analysis of this modification is not recommended. No benefit to modify the proposed action in this way because of the additional environmental impacts.	No
Alkali Creek Reservoir Alternative with Anita and Anita Supplemental Pipelines	To increase conveyance efficiency, a piping alternative for conveying water from Medicine Lodge Creek to the proposed reservoir was evaluated during the Phase II Study. This pipeline could replace the Anita Ditch and potentially the Anita Supplemental Ditch and either convey existing water rights and water for filling the reservoir or convey only water to supply the reservoir. Plans included burying the pipeline along the current ditch alignments. Based on quotes and pipe characteristics provided by pipe manufactures and vendors, HDPE with steel reinforced ribs was evaluated. Trihydro calculated pipe sizes to convey 135 cfs (70-inch), 98 cfs (dual 48-inch), and 89 cfs (60-inch) and calculated conceptual-level construction estimates. Estimated pipeline supply and installation costs ranged from $3.2 million to $4.7 million, with pipe supply costs comprising the largest share of the estimated costs. This modification would require enlargements to the Paint Rock Creek and Medicine Lodge Creek diversions.	No	This modification to the original plan is not included in the EIS analysis for the following reasons: 1) Eliminated at Screen 3. This potential modification would increase wetland effects (as a result of placing irrigation flows in pipe) and could increase stream habitat effects. No benefit to modify the proposed action in this way because of the additional environmental impacts. 2) The flat grade between the Anita Ditch diversion point and the proposed reservoir requires large pipes to convey the design flows. These large pipes would increase construction and operation and maintenance costs and would require more complex diversion structures.	No

Table C-3. Additional Information for the Alkali Creek, Cottonwood Creek, and Little Cottonwood Creek Storage Alternatives

Alternative	Alternative Description	Additional Information
Alkali Creek Reservoir (applicant's preferred alternative) Lat: 44.263196 Long: -107.385275	Off-channel reservoir associated with Alkali Creek (intermittent stream), also receiving diversion from Medicine Lodge Creek and Paint Rock Creek via Anita Supplemental Ditch and Anita Ditch (existing ditches) Earthen dam: 2,500 feet long, 98 feet tall, 1,400,000 cubic yards of fill Storage capacity: 7,994 acre-feet Water availability normal year (acre-feet): Direct: 827, Indirect: 13,360 / 66,042 Estimated construction cost (2015): $34,722,060 Cost/acre-feet of storage: $4,344 Note: The reservoir alternatives eliminated from further study were derived from the *Nowood River Storage, Level II Study. Phase I Summary Report. Wyoming Water Development Commission. Cheyenne, Wyoming* (Trihydro 2013), and the WWDO and Trihydro acknowledge that all the costs estimated in the Level II, Phase I report are low. The cost estimate for the Alkali Creek alternative was reviewed, refined, and revised in the *Nowood River Storage, Level II Study. Phase II Summary Report. Wyoming Water Development Commission. Cheyenne, Wyoming* (Trihydro 2016), resulting in a significant increase in the estimated project cost. However, in the alternatives screening process, cost was a minor factor in eliminating alternatives from further analysis in the EIS. Factors such as logistics, geological concerns, reservoir yield and storage capacity, and aquatic and terrestrial environmental effects were used to eliminate alternatives and develop a reasonable range of supplemental irrigation water supply options. No alternatives were eliminated for further consideration using cost alone as a reason for not carrying an alternative forward for detailed analysis in the EIS. In addition, the WWDO developed considerably more engineering and environmental data for the Alkali Creek alternative that was later considered in the screening analysis.	1) The Alkali Creek Reservoir is a practicable alternative and was carried forward for detailed analysis in the EIS (Table C-1). 2) The project has the yield and storage capacity to meet the purpose and need. 3) The alternative is located off-channel on an intermittent drainage. 4) The reservoir would impound available flows on Alkali Creek but would largely be filled with available flow diverted from Medicine Lodge Creek and Paint Rock Creek during spring runoff. 5) The flows would be supplied to the reservoir via enlargements to the existing Anita Supplemental Ditch and Anita Ditch and their existing diversion structures. 6) The Alkali Creek Reservoir would be able to reduce shortages on irrigated lands from Paint Rock Creek below the confluence with Alkali Creek as well as the Cottonwood and Little Cottonwood alternatives. 7) The ends of Anita Ditch and George Bayne Ditch after they cross Alkali Creek and the ditches that divert from Paint Rock Creek below the confluence with Alkali Creek could be served directly from the Alkali Creek Reservoir. 8) The Alkali Creek Reservoir would reduce shortages by 11% in the Medicine Lodge Creek drainage (by exchange) compared to 2% for the Cottonwood and Little Cottonwood alternatives. 9) The Alkali Creek Reservoir site has wetland and riparian vegetation and is a vegetated corridor. There are irrigated lands upstream of the reservoir to help filter sediments. 10) No effects to fisheries in Alkali Creek would occur as a result of the alternative. Existing diversions on Medicine Lodge Creek and Paint Rock Creek already exist. 11) Fisheries in Paint Rock Creek and Medicine Lodge Creek are presently affected by existing diversions. Improvements to the diversions could reduce fisheries effects. 12) Estimated, permanent loss of 2.11 acres of wetlands from impoundment or embankment. 13) Temporary impacts to wetlands downstream of Alkali Creek: 4.8 acres (if entire areas are disturbed for stream stabilization/enhancement). Temporary impacts would naturally be replaced and enhanced by wetland development adjacent to the Alkali Creek stream channel during project operation. 14) Temporary wetlands impacts of 8.73 acres from ditch enlargements (largely wetlands that are currently disturbed every few years during ditch maintenance/cleaning). This wetland effect would be temporary and would be offset by development of fringe wetlands during project operation. Most of the ditches are not and would not be lined enabling development of fringe wetlands. 15) The reservoir impounds water into the greater sage-grouse core area, and the proposed supply ditches pass through the core area, but largely within existing disturbance areas. Project-specific effects within the greater sage-grouse core area would be 0.02%, and the total effects, including existing impacts, would be 3.31%. 16) Only seasonal big game range would be affected by the project.
Cottonwood Creek Reservoir Lat: 44.151512 Long: -107.683274	Off-channel reservoir associated with Cottonwood Creek, also receiving new diversion from the Nowood River Earthen dam: 1,300 feet long, 90 feet tall, 311,007 cubic yards of fill Storage capacity: 11,100 acre-feet Water availability normal year (acre-feet): Direct: 4,238, Indirect: 167,910 Estimated construction cost: $55,000,000 (excluding bores under the Nowood River and Paint Rock Creek) Estimated total cost: $76,000,000 (>1.5 times the cost of Alkali Creek Reservoir) Cost/acre-feet of storage: $6,847 (>1.5 times the cost of Alkali Creek Reservoir)	1) The Cottonwood Reservoir would be able to reduce shortages on irrigated lands from Paint Rock Creek below the confluence with Alkali Creek as well as the Alkali Creek Reservoir. 2) The ends of Anita Ditch and George Bayne Ditch after they cross Alkali Creek and the ditches that divert from Paint Rock Creek below the confluence with Alkali Creek could be served by exchange. 3) The Cottonwood Reservoir would reduce shortages by 2% in the Medicine Lodge Creek drainage (by exchange) compared to 11% by Alkali Creek Reservoir. 4) On average, the Cottonwood Reservoir would reduce shortages in the Paint Rock Creek drainage 300 acre-feet less than Alkali Creek Reservoir. 5) The Cottonwood Creek Reservoir was eliminated at Screen 2 (Table C-1) because of significant constructability issues. 6) The Cottonwood drainage at the dam and reservoir pool is sparsely vegetated at the site, and there is no wetland or riparian vegetation evident on aerial photographs. Based on measured sediment accumulation at a temporary stream gage in Cottonwood Creek, this reservoir could also result in excessive sedimentation resulting in a shortened effective life of the impoundment. 7) Without a diversion from the Nowood River, this alternative would result in insufficient water supply. A 6-mile pipeline from the Nowood River would be needed to fill the reservoir. The diversion would likely have significant but unquantified aquatic (fisheries and wetlands) and terrestrial effects. 8) Canal construction costs are in the order of $425,000.00 per mile, and pipeline costs are in the order of $1,200,000.00 per mile. This does not include the cost of a pumping facility or O&M of the pumping facilities. With the canal and reservoir, (not accounting for a pumping system, a delivery system to Paint Rock Creek, and O&M), estimated costs are about $35.8 million in 2018 dollars. 9) Project costs with a dam, pump station to the Cottonwood Dam site, and delivery to Paint Rock Creek (pipes, pumps and pumping equipment are estimated at $55 million (excluding bores under the Nowood River and Paint Rock Creek). Also, not included is upgrading the electric power supply to bring electric service to the pumping stations. Trihydro estimates the power costs and O&M costs are about $21 million over the life of the project, bringing the total project to about $76 million. 10) To gravity feed water into the reservoir, a diversion and 20-mile long canal is needed. Twenty percent (20%) conveyance losses in the canal can be expected. A shorter canal/pipeline would require pumping to fill the reservoir. There would be wetland effects associated with construction of the canal. 11) The reservoir water supply diversion and diversion/delivery system to Paint Rock Creek would affect habitat for the following native (sensitive) species of fish: burbot and flathead chub. 12) The reservoir and supply canal are in crucial mule deer range.

Alternative	Alternative Description	Additional Information
Little Cottonwood Creek Reservoir Lat: 44.076659 Long: -107.529189	Off-channel reservoir associated with Little Cottonwood Creek, also receiving new diversion from the Nowood River Earthen dam: 1,775 feet long, 90 feet tall, 1,824,978 cubic yards of fill Storage capacity: 8,400 acre-feet Effective storage: (Reservoir storage – conveyance loss = 5,880 acre-feet) Water availability normal year (acre-feet): Direct: 1,280, Indirect: 152,893 Estimated construction cost: $21,165,017 Total project cost: $40 million Cost/acre-feet of storage: $4,762 Cost/acre-feet of effective storage: $6,803	1) The Little Cottonwood Reservoir would be able to reduce shortages on irrigated lands from Paint Rock Creek below the confluence with Alkali Creek as well as the Alkali Creek Reservoir. 2) The ends of Anita Ditch and George Bayne Ditch after they cross Alkali Creek and the ditches that divert from Paint Rock Creek below the confluence with Alkali Creek could be served by exchange. 3) Similar to the Cottonwood Reservoir, the Little Cottonwood Reservoir would reduce shortages by approximately 2% in the Medicine Lodge Creek drainage (by exchange) compared to 11% by the Alkali Creek Reservoir. 4) On average, the Little Cottonwood Reservoir would reduce shortages in the Paint Rock Creek drainage 300 acre-feet less than the Alkali Creek Reservoir. 5) The Little Cottonwood Creek Reservoir was eliminated at Screen 2 (Table C-1). 6) A new diversion from the Nowood River is needed involving 3.5 miles of pipeline/canal and a half-mile of tunnel. 7) Conveyance losses of 30% are likely. 8) Aquatic effects to stream channels and wetlands would occur but have not been quantified. Because new diversions and delivery infrastructure are needed, the associated effects would likely exceed the aquatic effects associated with Alkali Creek. 9) Compared to Alkali Creek Reservoir, the effective storage cost is more than 50% greater. 10) Construction costs for the diversion and conveyance system from the Nowood River to the reservoir site is estimated to be an additional $6 million above the $21+ million for the dam itself. 11) Construction costs and O&M costs for the diversion from the Nowood to Paint Rock Creek at the confluence with Alkali Creek is estimated to be $13 million above the $21+ million for the dam itself. 12) Total estimated construction and O&M costs are $40 million.

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Table C-4. Alkali Reservoir Project Screening Summary Table – Reservoir Alternatives

Reservoir Alternatives	Does the Alternative Meet Screening Criterion?					Carried Forward for Analysis?
	Purpose & Need / Reliability & Yield	Technological Feasibility	Environmental Impacts	Project Cost	Unique Considerations	
40 Initial Storage Alternatives						
Alkali Creek Reservoir	Yes	Yes	Yes	Yes	Yes	Yes
Alkali Creek South Reservoir	No					No
Big Trails Reservoir	No					No
Brunner Gulch Reservoir	No					No
Canyon Creek Reservoir	Yes	Yes	No			No
Cherry Creek Reservoir	No					No
Cornell Gulch Reservoir	No					No
Cottonwood Creek Reservoir	Maybe	No				No
County Line Reservoir	No					No
Deep Creek Reservoir	No					No
Little Canyon Creek Reservoir	Maybe	No				No
Little Cottonwood Creek Reservoir	No					No
Lone Tree Reservoir	No					No
Lower Brokenback Reservoir	No					No
Lower Luman Creek Reservoir	No					No
Lower Nowood Reservoir	No					No
Lower Trout Creek Reservoir	No					No
McDermott Draw Reservoir	No					No
Meadowlark Lake Reservoir Enlargement	No					No
Medicine Lodge Reservoir	No					No

Reservoir Alternatives	Does the Alternative Meet Screening Criterion?					Carried Forward for Analysis?
	Purpose & Need / Reliability & Yield	Technological Feasibility	Environmental Impacts	Project Cost	Unique Considerations	
North Brokenback Reservoir	No					No
Nowood-Crawford Reservoir	No					No
Nowood Mahogany Butte #1 Reservoir	No					No
Nowood Mahogany Butte #2 Reservoir	Yes	No				No
Otter Creek Reservoir	Yes	Yes	No			No
Paint Rock Creek Reservoir	Yes	No				No
Pete Reservoir	No					No
Solitude Reservoir	No					No
South Fork Otter Reservoir (Lower)	No					No
South Fork Otter Reservoir (Upper)	No					No
Summit Reservoir	No					No
Taylor Draw Reservoir	No					No
Upper Brokenback Reservoir	No					No
Upper Luman Creek Reservoir	No					No
Upper Nowood Reservoir	No					No
Weintz Draw Reservoir	No					No
West Fork Willow Creek Reservoir	No					No
West Tensleep Lake Reservoir	No					No
Willow Creek Reservoir	No					No
Woods Gulch Reservoir	No					No
Non-storage Alternatives						
Alluvial Groundwater Pumping	No					No

Reservoir Alternatives	Does the Alternative Meet Screening Criterion?					Carried Forward for Analysis?
	Purpose & Need / Reliability & Yield	**Technological Feasibility**	**Environmental Impacts**	**Project Cost**	**Unique Considerations**	
Non-tributary Groundwater Pumping – Tensleep Sandstone Aquifer	No					No
Non-tributary Groundwater Pumping – Madison-Bighorn Aquifer	No					No
Beaver Management	No				No	No
Water Conservation	No					No
Water Leasing	Maybe	No				No
Modifications to the Alkali Creek Alternative						
Alkali Creek Reservoir Location with Spillway – Modification #1	Yes	Yes	No			No
Alkali Creek Reservoir Location with Spillway - Modification #2	Yes	Yes	Yes Impacts reduced	N/A	Yes Reduced flooding impacts	**Yes**
Alkali Creek Reservoir Location with Modified Reservoir Filling Scenario	Yes	Yes	Yes	Yes	Yes	**Yes**
Alkali Creek Reservoir Location with Relocated Anita Supplemental Ditch Headgate	Yes	Yes	No			No
Alkali Creek Reservoir Location with a New Diversion Upstream of the Anita Supplemental Ditch	Yes	Yes	No			No
Alkali Creek Reservoir Location with Anita and Anita Supplemental Pipelines	Yes	Yes	No			No

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APPENDIX D

Socioeconomic Technical Appendix

SOCIOECONOMIC TECHNICAL APPENDIX

Introduction

This appendix provides additional information regarding the affected environment for socioeconomic conditions in the socioeconomic study area (SESA) and socioeconomic effects of the Proposed Action and Operational Alternatives.

Socioeconomic Study Area

The SESA comprises Big Horn County and Washakie County, which are adjacent counties located in north-central Wyoming. The counties are included within the SESA for two reasons. First, some of the economic data that help to depict the socioeconomic affected environment are only available at the county level. Second, some of the indirect effects of the Proposed Action and Operational Alternatives may extend beyond the area immediately adjacent to the Alkali Creek Dam and Reservoir. The SESA consists of 11 incorporated communities as well as surrounding rural areas.

Overview

The following subsections detail the SESA's population and households, including population growth rates, race and ethnicity, income and poverty, and housing. The economic portion of the affected environment discussion describes the economic conditions in Big Horn and Washakie Counties, including agricultural characteristics, employment and income by industry, non-market values, and recreation-based economic activity.

Methodology

Information was gathered from local, state, and federal data sources to characterize the current and future economic and demographic conditions in the SESA.

Socioeconomic Affected Environment

Population and Demography

POPULATION AND GROWTH

The estimated 2016 population of the combined counties in the SESA is 20,129 and constitutes 3.5 percent of Wyoming's population (U.S. Census Bureau Population Division 2018). Populations in the incorporated communities in the SESA ranged from a low of 117 (Manderson, Big Horn County) to a high of 5,273 (Worland, Washakie County). Seven of the 11 incorporated communities within the SESA have populations of fewer than 1,000 persons. According to 2016 population estimates published by the U.S. Census Bureau's Population Division, approximately one-third of residents in the SESA lived in rural areas outside of any incorporated community.

From 2000 to 2016, the average annual population growth rate for the SESA was 0.2 percent, which is smaller than the 1.1 percent population growth rate for Wyoming during the same period (U.S. Census Bureau 2000; U.S. Census Bureau, Population Division 2018). The low rate of population growth in the SESA is a result of domestic out-migration that is just offset by births and international in-migration.

HOUSEHOLDS AND HOUSEHOLD SIZE

The 2010 U.S. Census reported 8,053 households in the SESA, with an average household size of 2.47 persons. Average household size ranged from a low of 1.95 (Ten Sleep, Washakie County) to a high of 3.35 (Burlington, Big Horn County). The average annual household growth rate within the SESA was 0.4 percent between 2000 and 2010, which was a slower rate of growth than the 1.0 percent population growth rate for the State of Wyoming as a whole during the same period.

OTHER DEMOGRAPHIC CHARACTERISTICS

Table 1 shows the average racial and ethnic composition of residents living within the SESA between 2012 and 2016. Overall, the SESA is predominantly white and non-Hispanic. The most racially diverse communities are Frannie (Big Horn County), Greybull (Big Horn County), and Worland (Washakie County). Viewed as a whole, the racial and ethnic composition of the SESA does not differ meaningfully from the racial and ethnic composition of the State of Wyoming. The SESA contains a higher percentage of non-Hispanic white residents, but the percentage of minority residents is lower than the statewide average.

Table 1. Race and Ethnicity in the Socioeconomic Study Area, 2012 to 2016

	Race						Ethnicity	
Area	Percent White (Non-Hispanic)	Percent African American	Percent American Indian or Alaskan Native	Percent Asian	Percent Native Hawaiian or Pacific Islander	Percent Other	Percent Hispanic Latino	Total Percent Minorities
Big Horn County	**87.9**	**0.2**	**1.1**	**0.5**	**0.1**	**1.3**	**8.9**	**12.1**
Incorporated communities								
Basin	92.1	0.2	0.8	1.6	0.0	2.7	2.6	7.9
Burlington	88.5	0.0	2.0	0.0	1.2	5.5	2.8	11.5
Byron	95.5	0.0	0.0	0.0	0.0	0.9	3.6	4.5
Cowley	96.8	0.0	0.0	0.0	0.0	2.0	1.2	3.2
Deaver	98.3	0.0	0.0	1.7	0.0	0.0	0.0	1.7
Frannie	76.1	0.0	10.1	0.0	0.0	9.2	4.6	23.9
Greybull	75.8	0.0	0.8	0.6	0.0	2.1	20.7	24.2
Lovell	78.2	1.0	1.3	0.3	0.0	0.3	18.9	21.8
Manderson	92.0	0.0	3.2	0.0	0.0	4.8	0.0	8.0
Washakie County	**82.3**	**0.8**	**0.3**	**0.2**	**0.0**	**2.4**	**14.0**	**17.7**
Incorporated communities								
Worland	77.9	0.0	0.2	0.3	0.0	3.0	18.6	22.1
Ten Sleep	98.5	0.0	0.0	0.0	0.0	0.0	1.5	1.5
Wyoming	**84.3**	**1.1**	**2.0**	**0.9**	**0.1**	**1.9**	**9.7**	**15.7**

Source: U.S. Census Bureau American Community Survey (ACS) 5-year averages 2012–2016.

Income and Poverty

INCOME

As shown in Table 2, the median household income was $50,820 in Big Horn County and $46,212 in Washakie County between 2012 and 2016 (U.S. Census ACS 5-year averages, 2012 to 2016). The median household incomes in both counties are notably lower than the statewide median household income of $59,143 during the same time period. Median household incomes in the SESA have decreased since the time between 2007 and 2011 by 3.4 percent in Big Horn County and 7.9 percent in Washakie County. During the same time period the median household income in Wyoming increased by 4.9 percent.

Table 2. Median Household Incomes in the Socioeconomic Study Area 2007–2011 and 2012–2016

Area	2007–2011 Estimate	2012–2016 Estimate	Percent Change
Big Horn County	**$52,597**	**$50,820**	-3.4
Incorporated communities			
Basin	$44,464	$51,141	15.0
Burlington	$33,125	$58,125	75.5
Byron	$53,750	$54,219	0.9
Cowley	$60,795	$59,659	-1.9
Deaver	$54,250	$46,250	-14.7
Frannie	$33,214	$45,938	38.3
Greybull	$52,121	$42,829	-17.8
Lovell	$49,013	$40,898	-16.6
Manderson	$21,944	$24,375	11.1
Washakie County	**$50,177**	**$46,212**	-7.9
Incorporated communities			
Worland	$44,453	$39,904	-10.2
Ten Sleep	$31,250	$54,792	75.3
Wyoming	**$56,380**	**$59,143**	4.9

Source: U.S. Census Bureau ACS 5-year averages 2007–2011 and 2012–2016.

POVERTY

The poverty rate for individuals in the State of Wyoming averaged 11.6 percent of the state's population between 2012 and 2016 (Table 3). During the same time period, the poverty rates in Big Horn and Washakie Counties were 11.9 percent and 14.7 percent, respectively. Across the communities in the SESA, the average poverty rate between 2012 and 2016 ranged from a low of 4.8 percent in Manderson (Big Horn County) to a high of 27.5 percent in Frannie (Big Horn County) (U.S. Census Bureau ACS 5-year averages, 2012–2016).

Table 3. Poverty Rates for Individuals in the Socioeconomic Study Area, 2008–2012 and 2012–2016

	Poverty Rate Percent		
Area	**2008–2012**	**2012–2016**	**Estimated Number of People (2016)**
Big Horn County	10.0	11.9	1,453
Incorporated communities			
Basin	5.8	7.9	108
Burlington	9.2	8.3	16
Byron	25.1	17.2	102
Cowley	4.5	9.6	85
Deaver	15.3	15.3	50
Frannie	22.4	27.5	31
Greybull	13.3	11.8	251
Lovell	8.1	10.5	281
Manderson	1.4	4.8	8
Washakie County	11.5	14.7	1,136
Incorporated communities			
Worland	14.0	19.3	813
Ten Sleep	15.6	12.3	37
Wyoming	11.0	11.6	67,333

Note: Estimated number of people is based on multiplying the 2016 population estimates from the U.S. Census Bureau ACS 5-year averages, 2012–2016, by the average poverty rates between 2012 and 2016.

Source: U.S. Census Bureau ACS 5-year averages, 2008–2012 and 2012–2016.

Housing

The housing market in the SESA is relatively low cost compared to Wyoming as a whole as measured by median home values (Table 4). The median home value in Big Horn County was $148,200 between 2012 and 2016, compared to $156,900 in Washakie County during the same time period. The median home value in the State of Wyoming was $199,900 during this time. Frannie, in Big Horn County, had the lowest median home value between 2012 and 2016 at $55,000 and Burlington (Big Horn County) had the highest at $166,100.

Table 4. Median Home Values in the Socioeconomic Study Area, 2007–2011 and 2012–2016

Area	2007–2011	2012–2016	Percent Change
Big Horn County	**$120,400**	**$148,200**	**23.1**
Incorporated communities			
Basin	$107,700	$141,400	31.3
Burlington	$108,700	$166,100	52.8
Byron	$72,100	$119,200	65.3
Cowley	$121,400	$147,700	21.7
Deaver	$84,000	$82,500	-1.8
Frannie	$84,600	$55,000	-35.0
Greybull	$86,300	$99,400	15.2
Lovell	$119,600	$117,500	-1.8
Manderson	$61,700	$31,300	-49.3
Washakie County	**$148,400**	**$156,900**	**5.7**
Incorporated communities			
Worland	$121,600	$120,900	-0.6
Ten Sleep	$106,300	$115,800	8.9
Wyoming	**$181,900**	**$199,900**	**9.9**

Source: U.S. Census Bureau ACS 5-year averages, 2007–2011 and 2012–2016.

According to the U.S. Census Bureau's ACS 5-year averages between 2012 to 2016, there were an average of 9,187 housing units in the SESA between 2012 and 2016 (Table 5). The housing units in the SESA represent 3.4 percent of the total housing stock in Wyoming. In the incorporated communities within the SESA, the average housing stock ranged from a low of 58 units in Frannie (Big Horn County) to a high of 2,428 in Worland (Washakie County). The average housing stock across the State of Wyoming increased by 3.5 percent in 2007–2011 and 2012–2016. In Big Horn County during the same period, the average housing stock increased by 0.3 percent, and in Washakie County, it fell by 0.2 percent.

Table 5. Average Housing Stock in the Socioeconomic Study Area, 2007–2011 and 2012–2016

Area	2007–2011	2012–2016	Percent Change
Big Horn County	**5,360**	**5,376**	**0.3**
Incorporated communities			
Basin	558	540	-3.2
Burlington	95	75	-21.1
Byron	281	216	-23.1
Cowley	234	292	24.8
Deaver	87	92	5.7
Frannie	106	58	-45.3
Greybull	937	846	-9.7
Lovell	1004	1,013	0.9
Manderson	42	61	45.2
Remainder of County	2016	2,183	8.3-
Washakie County	**3,818**	**3,811**	**-0.2**
Incorporated communities			
Worland	2,515	2,428	-3.5
Ten Sleep	129	136	5.4
Wyoming	**258,990**	**267,987**	**3.5**

Source: U.S. Census Bureau ACS 5-year averages, 2007–2011 and 2012–2016.

Big Horn County had an average housing vacancy rate of 17.1 percent between 2012 and 2016. In Washakie County, vacancy rates were lower, averaging 8.3 percent between 2012 and 2016. In general, the vacancy rates across the SESA remained below the State of Wyoming average of 15.3 percent for the 2012–2016 period. Rental vacancy rates in the SESA were 7.0 percent in Big Horn County and 9.4 percent in Washakie County, respectively (U.S. Census Bureau ACS 5-year averages, 2012–2016). Vacancy rates over 5 percent typically reflect housing markets with the capacity to absorb additional housing demand without undue effects on availability or cost (Kasulis 2016).

Short-term accommodation is also available in the SESA. According to the 2012 Economic Census, there were 13 businesses offering accommodation services in the SESA in 2012 (U.S. Census Bureau 2012). These include businesses that provide lodging or short-term accommodation for travelers, vacationers, and others. There is a wide variety of accommodation types that range from short-term hotel and motel accommodations for vacationers, recreational vehicle camps, and parks to rooming and boardinghouses that provide temporary or longer term accommodation that may serve as a principal residence during the period of occupation.

Economic Environment

EMPLOYMENT AND EARNINGS BY INDUSTRY

In 2015, the SESA's top four nongovernment sectors in terms of employment were farming, retail trade, construction, and manufacturing (Bureau of Economic Analysis [BEA] 2016). The farm sector was the single largest nongovernment employer during this time, accounting for 8.7 percent of the SESA's total employment. Employees in the SESA received compensation totaling approximately $476.8 million in 2015, of which $12.5 million was paid to farm workers.

Since 2001, farm compensation in the SESA has increased by 48.5 percent to an average of $11,665 per worker. In general, farm wages account for approximately 2 percent of the total employee compensation in the SESA. While this may not appear substantial, it underscores the fact that farms often rely on unpaid family labor, the value of which is not accounted for in most standard economic indicators. As a result, agriculture's importance to local economic and social structures may be underrepresented in dollar-to-dollar comparisons with other industries. The construction sector employed about 900 people in the SESA in 2015, which constituted approximately 7 percent of the SESA's total workforce. During this time, construction workers in the SESA earned a total of $36.01 million, or $39,970 per worker, on average. The average value of annual salary and benefits in the SESA across all employees was about $38,680 per worker in 2015 (BEA 2016).

LABOR FORCE AND UNEMPLOYMENT

Between 2012 and 2016, the labor force in the SESA averaged 9,608 individuals. Between 2012 and 2016, the average unemployment rate in the SESA was 3.3 percent in Big Horn County and 7.4 percent in Washakie County, compared to 4.9 percent for the State of Wyoming (Table 6) (U.S. Census Bureau ACS 5-year averages, 2012–2016). In 2007–2011 and 2012–2016, the average unemployment rate decreased by 2.1 percentage points in Big Horn County and increased by 3.0 percentage points in Washakie County. The unemployment rate increased by 0.2 percentage points across the State of Wyoming during the same time period (U.S. Census Bureau ACS 5-year averages, 2007–2011 and 2012–2016).

Table 6. Unemployment Rate in the Socioeconomic Study Area, 2007–2011 and 2012–2016

Area	2007–2011	2012–2016
Big Horn County	5.4%	3.3%
Washakie County	4.4%	7.4%
Wyoming	4.7%	4.9%

Source: U.S. Census Bureau ACS 5-year averages, 2007–2011 and 2012–2016.

Agriculture

CROPPING PATTERNS

There were 836 farms in the SESA in 2012, of which 317 were engaged in crop production while the remainder focused on ranching (Table 7). Of the total, 263 farms were engaged in beef cattle ranching and farming and 255 farms were classified as producing "other crops." In total, there were approximately 519 farms engaged in animal production of some kind, including horse and other equine production.

Table 7. Number of Farms, by Farm Type, in the Socioeconomic Study Area in 2012

Farm Type	Big Horn County	Washakie County
All farms	627	209
Oilseed and grain farming	47	9
Vegetable and melon farming	2	1
Fruit and nut tree farming	0	0
Greenhouse, nursery, etc.	1	2
Other crop farming	186	69
Beef cattle ranching and farming	174	89
Cattle feedlots	2	1
Dairy cattle and milk products	0	0
Hog and pig farming	1	0
Poultry and egg production	2	0
Sheep and goat farming	32	14
Animal aquaculture and other animal production	180	24

Source: U.S. Department of Agriculture (USDA) (2012).

The SESA also contained 147,133 acres of irrigated land in 2012, of which 112,313 acres was cropland and 34,820 acres was irrigated pasture or other irrigated land (Table 8). Overall, the total area of irrigated land in the SESA declined between 2007 and 2012. However, irrigated acreage increased as a percentage of total farmland between 2007 and 2012. By 2012, irrigated land composed 22.8 percent of the total farm land contained within the SESA compared to 17.1 percent in 2007.

Table 8. Total Land in Farms in the Socioeconomic Study Area, 2007 and 2012

Total Land in Farms (acres)	2007	2012
Big Horn County	438,033	302,555
Irrigated land	110,958	108,707
Harvest irrigated cropland	75,605	78,283
Irrigated pastureland and other land	35,353	30,424
Washakie County	469,804	341,347
Irrigated land	44,402	38,426
Harvest irrigated cropland	39,907	34,030
Irrigated pastureland and other land	4,495	4,396

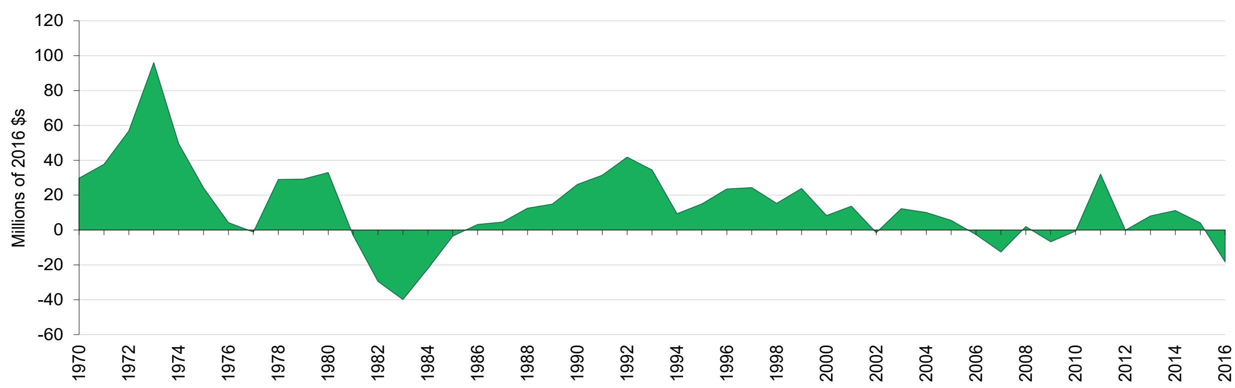
Source: USDA (2012).

The value of agricultural land in the two-county SESA, including buildings, was estimated to be approximately $765 million in 2012, corresponding to an average farm value of $915,107 (USDA 2012). The locally assessed value of irrigated agricultural land in the SESA was $25 million in 2016 (Wyoming Department of Revenue 2016).

EARNINGS

Agriculture is a significant contributor of income in the SESA, although farm income has tended to fluctuate considerably over time. Figure 1 shows the total net farm income—defined as the revenue received by farms less the costs incurred to produce farm output—in the SESA from 1970 to 2016. Net farm income remained positive in the SESA between 1990 and 2005—even peaking at about $40 million in 1992—but since 2006 net farm incomes have expressed more variability, including a few years when net incomes were negative, such as 2007, 2009, and 2016.

Figure 1. Total Net Income of Farms, Including Corporate Farms, in the SESA, from 1970 to 2016



Sources: BEA (2017a); Headwaters Economics (2017); U.S. Census Bureau (2017).

Farms in the SESA generated approximately $113.0 million of cash receipts and other income and $133.3 million of expenses in 2016 (Table 9). The production and sale of crops, including sugar beets, grain, beans, and hay, is the largest source of income for farms in the SESA. In 2016, the sale of crops generated approximately $59.8 million of income. The production of livestock and livestock products created $41.6 million of income during the same time period. Farms in the SESA also received $11.7 million in other income from government payments, rents, and other miscellaneous sources. Farms in the SESA lost an estimated total of $18.3 million in 2016 after accounting for production-related expenses and incorporating the value of inventory change.

Table 9. Source of Farm Income and Expenses in the SESA in 2016 ($1000s)

Farm Income	Big Horn County	Washakie County	Dual-County Area (SESA)
Total cash receipts and other income	**$73,881**	**$39,162**	**$113,043**
Cash receipts from marketing	$66,399	$34,921	$101,320
Livestock and products	$27,377	$14,175	$41,552
Crops	$39,022	$20,746	$59,768
Other income	$7,482	$4,241	$11,723
Government payments	$922	$1,471	$2,393
Imputed tent and miscellaneous income	$6,560	$2,770	$9,330

Farm Income	Big Horn County	Washakie County	Dual-County Area (SESA)
Total Production Expenses	**$84,971**	**$48,361**	**$133,332**
Realized net income	-$11,090	-$9,199	-$20,289
Value of inventory change	$1,322	$703	$2,025
Total net income, including corporate farms	**-$9,768**	**-$8,496**	**-$18,264**

Sources: BEA (2017b); Headwaters Economics (2017); U.S. Census Bureau (2017).

Non-market Economic Values

Many residents in the SESA place a high value on rural landscapes and rural lifestyles. Residents value the open space; rural viewscapes; the lifestyles associated with farm and ranch operations, livestock grazing, and abundant recreational opportunities; and prefer land uses that conserve or enhance these values (Bureau of Land Management 2015). Agricultural land in Wyoming is part of a broader cultural landscape that encompasses many of the non-market values that farmers hold in high regard, such as sense of place and purpose (Cross et al. 2011). As a result, farmers in Wyoming develop a sense of attachment to the landscapes that visitors, recreationists, and others may not. These values are not reflected in market prices. Instead, they are reflected in farmers' commitments to the land and the farming lifestyle.

Recreation Values

Residents of and visitors to the SESA participate in a number of recreational activities, including camping, hunting, hiking, use of off-highway vehicles, fishing, boating, flat-water recreation, horseback riding, and bird watching (Bureau of Land Management 2015).

Recreational fishing is the most important water-based recreation activity in the Bighorn Basin, which constitutes a large portion of the SESA. Although outdoor recreation is not measured in one industry sector, it often stimulates economic activity in a wide range of industries, including accommodation, food service, transportation, and entertainment and the arts. In 2015, industries contributing to the recreational and outdoor economy were reported to support 784 jobs within the SESA (U.S. Census Bureau 2017). A portion of these local employment opportunities are attributable to water-based recreation opportunities like fishing and boating on public lands within the SESA.

Environmental Justice Communities

Environmental justice is defined as the fair treatment and meaningful involvement of all people—regardless of race, ethnicity, or income level—in environmental decision-making. Environmental justice programs promote the protection of human health and the environment, empowerment by means of public participation, and the dissemination of relevant information to inform and educate affected communities. Consideration of environmental justice issues is mandated by Executive Order (EO) 12898, which was published on February 11, 1994. This EO requires that all federal agencies incorporate environmental justice into their mission by "identifying and addressing . . . disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations, low-income populations, and Indian tribes and allowing all portions of the population a meaningful opportunity to participate in the development of, compliance with, and enforcement of federal laws, regulations, and policies affecting human health or the environment regardless of race, color, national origin, or income" (Council on Environmental Quality [CEQ] 1997).

The following discussion of baseline conditions within the SESA uses data at the county, community, and census tract levels to determine if there are environmental justice communities within the analysis area with meaningfully higher percentages of minority or low-income residents than the state in which they are located.

The CEQ defines a community with potential environmental justice populations as one that has a greater percentage of minority or low-income populations than does an identified reference community. Minority populations are those populations having 1) 50 percent minority population in the affected area, or 2) a meaningfully greater minority population than the reference area (CEQ 1997). The CEQ has not specified what percentage of the population can be characterized as "meaningfully greater" in order to define environmental justice populations. Therefore, for the purposes of this analysis, a conservative approach was used to identify potential environmental justice populations; it is assumed that if the affected area minority and/or poverty status populations are more than 5 percentage points greater than those of the reference area (e.g., the state in which the counties are located), there may be an environmental justice population of concern. Low-income populations were defined as those individuals and families who are considered to be living below the poverty level For determining the presence of minority and/or low-income communities as environmental justice populations, communities in the analysis area were evaluated against a reference population defined as the State of Wyoming.

Based on the approach just described, the following communities are considered environmental justice communities for this evaluation:

- Greybull, Big Horn County (proportion of minority residents)
- Frannie, Big Horn County (proportion of minority residents and proportion of residents living below the poverty line)
- Lovell, Big Horn County (proportion of minority residents)
- Worland, Washakie County (proportion of minority residents and proportion of residents living below the poverty line)
- Byron, Big Horn County (proportion of residents living below the poverty line)

Socioeconomic Effects Analysis

This section describes the methodology used to estimate the socioeconomic effects associated with the construction, maintenance, and operations of the Proposed Action and Operational Alternatives, including the agricultural and recreational impacts and the socioeconomic analysis. Transportation impacts were qualitatively analyzed based on the size of the proposed workforce and previous experience with similar-sized projects. Socioeconomic impacts are discussed in terms of the combined effects on the economies of Big Horn and Washakie Counties.

Methods

The short- and long-term economic effects of the Proposed Action and Operational Alternatives were estimated using the IMPLAN regional economic model. IMPLAN is an input/output model originally developed for the U.S. Forest Service and is widely used by both private-sector and public-sector economists for impact analyses throughout the United States. The IMPLAN model used in this study incorporated 2016 data for Bighorn and Washakie Counties (IMPLAN 2016).

A total of three alternatives were analyzed:

ALTERNATIVE A – NO ACTION

Under the No Action Alternative, the proposed reservoir would not be built. There would be no change in irrigation supplies or recreational opportunities from existing conditions. Consequently, the No Action Alternative would have no effect on socioeconomic conditions.

ALTERNATIVE B – PROPOSED ACTION

Alternative B would create a number of direct, indirect, and induced socioeconomic effects over the short and long term. In the short term, construction activities would create direct effects through the hiring of local and nonlocal labor and the construction of the proposed reservoir. Construction activities would create two types of revenue streams that would increase the demand for goods and services in the local economy over the short term:

- Some goods and materials used in construction may be locally sourced within Big Horn and Washakie Counties
- Wages would be paid to local and nonlocal construction workers who would spend a portion of this income in the local economy

Each of these revenue streams was included in the IMPLAN analysis of short-term construction impacts. As workers spend their additional income, it would create induced effects throughout the economy. Construction firms would create indirect effects by purchasing some goods and services from local businesses. This would create additional induced effects as those businesses spend a part of their additional income in the local economy.

Once the proposed reservoir is complete, it would effect several long-term impacts. The proposed reservoir would supply agricultural producers in the SESA with additional irrigation water during the growing season to enhance crop yields. In addition, the proposed reservoir would require annual operations and maintenance and enhance the well-being of both recreationists and agricultural producers. This would have four effects on the SESA's economy:

- Additional irrigation water would increase the output and sales of agricultural producers
- Demand for agricultural inputs would potentially increase for the duration of the proposed reservoir's life
- Operations and maintenance would increase the income of the employee hired to perform the tasks associated with the position
- The consumer surplus of recreationists would be enhanced

The long-term irrigation effects would stimulate demand for goods and services in the SESA's economy and were included in the IMPLAN analysis of long-term irrigation impacts. The Action Alternative would also require ongoing operations oversight and maintenance. This would increase household income for the employee(s) tasked with fulfilling these duties but would have a very small impact on the broader SESA economy. The Action Alternative would also include recreation infrastructure, which would enhance opportunities for flat-water recreation. The economic benefit to recreation users was estimated based on projected use and previous studies.

ALTERNATIVE C – MODIFIED PROPOSED ACTION

The socioeconomic effects of the Operational Alternatives would be the same as the effects described for the Proposed Action Alternative.

The economic methods and results described below are based on regional economic modeling of the Proposed Action discussed above, unless otherwise noted. They include the methods used to estimate the direct, indirect, and induced impacts that would be anticipated during the construction and operational phases of the Proposed Action and Operational Alternatives. Indirect impacts would include effects caused by economic activity in sectors that support the construction sector. Induced effects are those associated with household spending. For socioeconomic resources, one example of a potential induced effect would include any multiplier effects on the economy resulting from the recirculation of money spent by agricultural producers as a result of the increased income they would receive from crops grown with the additional water stored by the proposed project.

Short-Term Socioeconomic Effects of the Action Alternative

Short-Term Construction Effects Methodology

The short-term economic effects from construction were estimated with IMPLAN using a two-county model of Big Horn and Washakie Counties. Construction impacts were modeled as a change in demand for the reservoir, pump station, and water pipeline construction sector (Sector 58 in IMPLAN). The default parameters of the sector were changed to reflect the ratio of capital and labor costs described in planning documents (Trihydro 2016a).

The Proposed Action and Operational Alternatives would cost between $36.1 and $42.4 million to construct depending on which design option is chosen. Approximately $26.1 to $31.0 million is projected for construction activities, while the remaining budget includes legal fees, permitting, acquisitions of rights-of-way, design and preparation, engineering, and contingencies. These activities are likely to take place outside of the SESA and were not included in the impact analysis. The construction phase would take approximately 23 months to complete, corresponding to annual construction expenditures of approximately $13.7 to $16.2 million per year (Trihydro 2016a).

The Proposed Action and Operational Alternatives would directly employ a monthly average of 23 full-time employees during the 23-month construction period. The number of workers would vary from month to month, but it would be highest during April 2022 when approximately 39 workers would be employed on-site (Trihydro 2016a). The average earnings (including benefits) of construction workers in Wyoming between 2014 and 2016 were approximately $48,265 per year (BEA 2017). Updating to 2018, this analysis assumes total compensation per worker of $50,000 per year. With an average of 23 workers, annual labor costs for construction would be approximately $1,150,000. The analysis assumed that labor and materials would be purchased locally. However, if construction was lead by a firm with employees outside of the SESA, the impacts on the SESA's economy would be smaller than what is reported.

Short-Term Construction Effects Results

As shown in Figure 11, construction of the proposed project is projected to support between 55 and 60 short-term jobs in the SESA, on average. This includes the projected 23 direct jobs associated with construction as well as 32 to 37 indirect and induced jobs that would be supported by the local purchases of supplies and materials for construction, household expenditures by locally hired workers, and local expenditures of nonlocal workers during the construction period. In addition to the $4.0 to $4.3 million in total compensation anticipated to be paid to local and nonlocal construction workers and proprietors, construction of the proposed project is estimated to indirectly produce an additional $1.8 to $2.4 million in total labor earnings during the 23-month construction period (see Table 10). Overall, construction of the proposed project is estimated to increase the SESA's economic output by $34.0 to $40.3 million during the 23-month construction period, including direct construction expenditures. The economic impacts created by short-term construction activities would also generate additional tax revenues for state and local governments between $1.8 and $2.2 million over the 23-month construction phase.

Table 10. Projected Total Economic Impact in the Socioeconomic Study Area from Construction of the Proposed Action and Operational Alternatives

Construction Option	Effect	Average Annual Employment	Total Labor Income	Total Output
1	Direct	23	$4,025,326	$26,704,121
	Indirect	22	$1,524,191	$5,670,807
	Induced	10	$541,079	$2,331,671
	Total	**55**	**$6,090,596**	**$34,706,599**
2	Direct	23	$4,321,434	$31,012,251
	Indirect	26	$1,798,060	$6,689,404
	Induced	11	$597,327	$2,574,296
	Total	**60**	**$6,716,820**	**$40,275,952**
3	Direct	23	$3,988,854	$26,173,241
	Indirect	22	$1,228,702	$5,545,141
	Induced	10	$534,144	$2,301,754
	Total	**55**	**$5,751,700**	**$34,020,136**

Note: Construction impacts would last approximately 23 months. Employment includes both part- and full-time positions. Labor income includes wages and benefits paid to workers and income received by local proprietors.

Source: IMPLAN 2016.

The construction activities of the Proposed Action Alternative are projected to increase the short-term demand for housing by approximately 17 units. This represents approximately 7 percent of vacant units for rent or sale in the SESA at any given time between 2012 and 2016 (U.S. Census Bureau ACS 5-year averages, 2012–2016). Based on the current size of the SESA's housing market and the rental vacancy rate, housing availability and rents in the SESA as a whole would be largely unaffected by the Proposed Action Alternative. Rents in some parts of the SESA could increase modestly if workers compete for housing in a single community or small geographic area, but the total effect on the SESA's housing market would be negligible.

The construction activities of the Proposed Action Alternative would increase the number of trips made on roads in the SESA. However, given the relatively small size of the construction workforce and the rural location of the proposed reservoir site, impacts on roads and road maintenance costs throughout the SESA are likely to be small.

Long-Term Socioeconomic Effects of the Proposed Action and Operational Alternatives

Long-Term Operations Effects Methodology and Results

Once construction is completed, the operation and maintenance of the proposed project would require wetland maintenance for the first 5 years. Annual monitoring and reporting would be required until the wetlands are established, adding additional expense onto the annual operation and maintenance costs during this time. Once the wetlands are established, the operation and maintenance costs would require approximately 20 hours of labor per week for 7 months each year. In total, these annual operations and maintenance costs are anticipated to be around $76,000 per year during the first 5 years and $45,000 each year thereafter (Trihydro 2016a). These expenditures are expected to support approximately one full-time equivalent local job. The recirculation of the wages paid to the operations and maintenance staff would produce modest ongoing economic benefits in the SESA.

Long-Term Irrigation-Related Effects Methodology

The long-term irrigation effects of the Proposed Action and Operational Alternatives were modeled in IMPLAN as a change in output in the vegetable and melon farming sector (Sector 3 in IMPLAN). Crop-yield response functions were used to estimate the increase in crop production that would result from the water made available under the Proposed Action and Operational Alternatives. The gross revenue associated with the increased crop production was estimated using market prices from the USDA, Agricultural Marketing Service (2018). Net revenue was estimated by deducting the costs associated with the increased crop production.

CROP PRODUCTION METHODOLOGY

Increased access to reliable irrigation water supplies could enable agricultural producers to increase crop yields by using water from the project to finish their crops. The irrigated land below the proposed reservoir is used to grow a mix of crops, including alfalfa, grass hay, corn, various grains, and beets (Trihydro 2012). However, alfalfa is the predominant irrigated crop grown in the SESA and accounts for approximately 90 percent of hay production (USDA 2016).

This analysis assumes that agricultural producers in the SESA will adapt to having additional irrigation water by applying it to the most commonly irrigated crop in the SESA—alfalfa—thus avoiding the costs of converting fields to grow high-value crops and limiting their financial exposure to uncertain conditions in the future.

The crop yield response for irrigated alfalfa was estimated for Bighorn and Washakie Counties using data from the Wyoming Office of the National Agricultural Statistics Service. Alfalfa in the SESA has a crop irrigation requirement of 2.08 acre-feet per acre according to the StateMOD model of the Bighorn watershed (Trihydro 2013). This suggests the crop yield response function for the SESA is

Alfalfa yield = 1.68 tons per acre-foot

Data from the 2010 Wind/Bighorn Update Task 3A – Agricultural Water Use Technical Memorandum provided estimates of the system-wide efficiencies for multiple SESAs within the Wing and Bighorn Basins that ranged from 20 percent to 44 percent. The basin-wide average irrigation efficiency was estimated to be 29 percent (Trihydro 2013). The proposed project would store approximately 5,996 acre-feet of water for irrigation each year. Under the efficiency factor, approximately 1,738 acre-feet would be consumed by crops and would result in an annual increase in alfalfa yields of 2,921 tons.

CROP REVENUE

As of March 2018, 1 ton of alfalfa sold for between $140 and $200 in Wyoming (USDA 2018). Assuming an average price of $160 per ton, the additional yield in the SESA would generate total gross revenues of approximately $467,400 per year at an additional cost of $146,063. This assumes that the average cost of the additional production is $50 per ton (States West Water Resources Corporation 2015).

Long-term Irrigation-related Effects Results

As shown in Table 11, the crop output generated by the additional irrigation water is likely to support approximately seven direct, indirect, and induced jobs per year during the operational life of the proposed project. This includes five direct jobs on local farms as well as two indirect and induced jobs supported by local purchases of supplies and materials and household expenditures by farm owners and workers. In addition to the $470,000 in additional annual agricultural output expected to be produced in the SESA from the additional water supply, the direct, indirect, and induced economic activity associated with the growth in agricultural output is expected to produce about $158,000 in additional annual labor income.

Table 11. Projected Annual Economic Impact from Agricultural Production in the Socioeconomic Study Area as a Result of the Action Alternatives

Effect	Annual Employment	Labor Income	Output
Direct	5	$128,916	$470,000
Indirect	1	$15,284	$65,090
Induced	1	$13,804	$59,400
Total	**7**	**$158,004**	**$594,490**

Note: Economic impacts assume that additional water stored by the proposed project would be used to finish crops based on the existing allocation of land devoted to each crop.

Source: IMPLAN 2016.

Overall, the additional irrigation water stored by the proposed project would be expected to increase the SESA's economic output by about $600,000 per year. This total includes the projected $470,000 increase in direct output due to higher crop yields an additional economic output due to recirculation of wages and expenditures. Following the construction of the proposed reservoir, the agricultural sector would contribute approximately $27,000 more to state and local tax revenues each year. The enhanced water supply and greater productivity of farms receiving irrigation supplies under the Proposed Action would lead to a minor increase in property values for those farms.

The agricultural activities related to the Proposed Action Alternative are projected to increase the long-term demand for housing in the SESA by approximately 5 units. Although conditions in the local housing market could have changed since 2016, the last year for which data are available, it seems likely that the SESA could accommodate the increase in long-term housing demand under the Proposed Action Alternative without much difficulty.

Long-Term Recreation-Related Effects Results

The proposed project would cover an area of approximately 280 acres when full. The proposed reservoir would have a conservation pool of approximately 1,900 acre-feet. If irrigators used their full allotment each year, the minimum footprint of the proposed reservoir would be approximately 100 acres and the average footprint throughout the year would be about 190 acres. Additionally, construction of the proposed reservoir would include the addition of a boat ramp, picnic facilities, restrooms, trash facilities, parking areas, and access roads. The additional surface area and recreational facilities would provide opportunities for flat-water recreation, including boating and fishing.

Alkali Reservoir would be small in comparison to other reservoirs in the region, including Bighorn Lake (17,300 acres), Buffalo Bill Reservoir (8,315 acres), Boysen Reservoir (20,000 acres), and Lake DeSmet (3,000 acres). Consequently, the proposed reservoir is likely to be primarily visited by SESA residents, limiting any economic effects.

It is unclear how the proposed reservoir would affect consumer surplus in the study area or change the visitation patterns of local recreationists. Recreationists may experience small increases in consumer surplus if recreational opportunities at the reservoir cause local residents to increase the total number of days they spend participating in activities like fishing or boating or if the new location reduced travel times and out-of-pocket costs associated with the current number of reservoir-related recreation days. If the reservoir expansion caused the total number of recreation days to remain constant and only resulted in a change in the location where people recreate, there would be no change to consumer surplus.

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APPENDIX E

Technical Memorandum: Alkali Reservoir EIS – Average and Median Streamflow With and Without Project

Technical Memo

WENCK
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To: SWCA
From: Wenck Associates, Inc.
Date: January 3, 2019

Subject: Alkali Reservoir EIS – Average and Median Streamflow With and Without Project and Simulated End of Month Reservoir Contents

Simulated streamflow data was extracted from the StateMod model (Trihydro 2016) (revised 2018) for the following scenarios: Alternative A – No Action (baseline), Alternative B - Proposed Action, and Alternative C – Modified Proposed Action. The currently irrigated acreage scenario was utilized for Alternative A (baseline) to represent current conditions in the watershed. Both the currently irrigated acreage scenario and the potentially irrigable permitted acreage scenario was utilized for Alternative B and Alternative C. This is to represent the proposed conditions which consists of Alkali Creek Reservoir with and without the irrigation of 3,150 currently idle acres. Three comparisons are presented:

1) With Potentially Irrigable Permitted Acreage in Production: compares No Action **without** idle acres to Proposed Action **with** idle acres

2) Without Potentially Irrigable Permitted Acreage in Production: compares No Action **without** idle acres to Proposed Action **without** idle acres

3) Potentially Irrigable Permitted Acreage in Production Independent of the Proposed Action: compares No Action **with** idle acres to Proposed Action **with** idle acres

Wet, normal, and dry water year median monthly stream flows are provided in the figures and tables below. Alternative C could reduce effects to streamflow by limiting the amount of water that can be diverted from Paint Rock Creek and Medicine Lodge Creek and supplied to Alkali Creek Reservoir. However, based on the StateMod simulation, changes in streamflow are unchanged from Alternative B. Therefore, the figures and tables below compare Alternative A and Alternative B only, and Alternative C is not shown for clarity.

Wet, normal, and dry water years on Paint Rock Creek were determined by ranking the naturalized water year discharge at USGS Site No. 06272500 (Paint Rock Creek near Hyattville) from wettest to driest and then selecting the 20 percent wettest and driest water years. Figure E-1 indicates the point locations where streamflow data is analyzed.

The Bighorn River streamflow data was developed by first averaging the overlap between the USGS Site No. 06274300 (Bighorn River at Basin, WY) period of record and the modeling period (1983 through 2016) and then subtracting the average change in streamflow in the Nowood River at the confluence with the Bighorn River.

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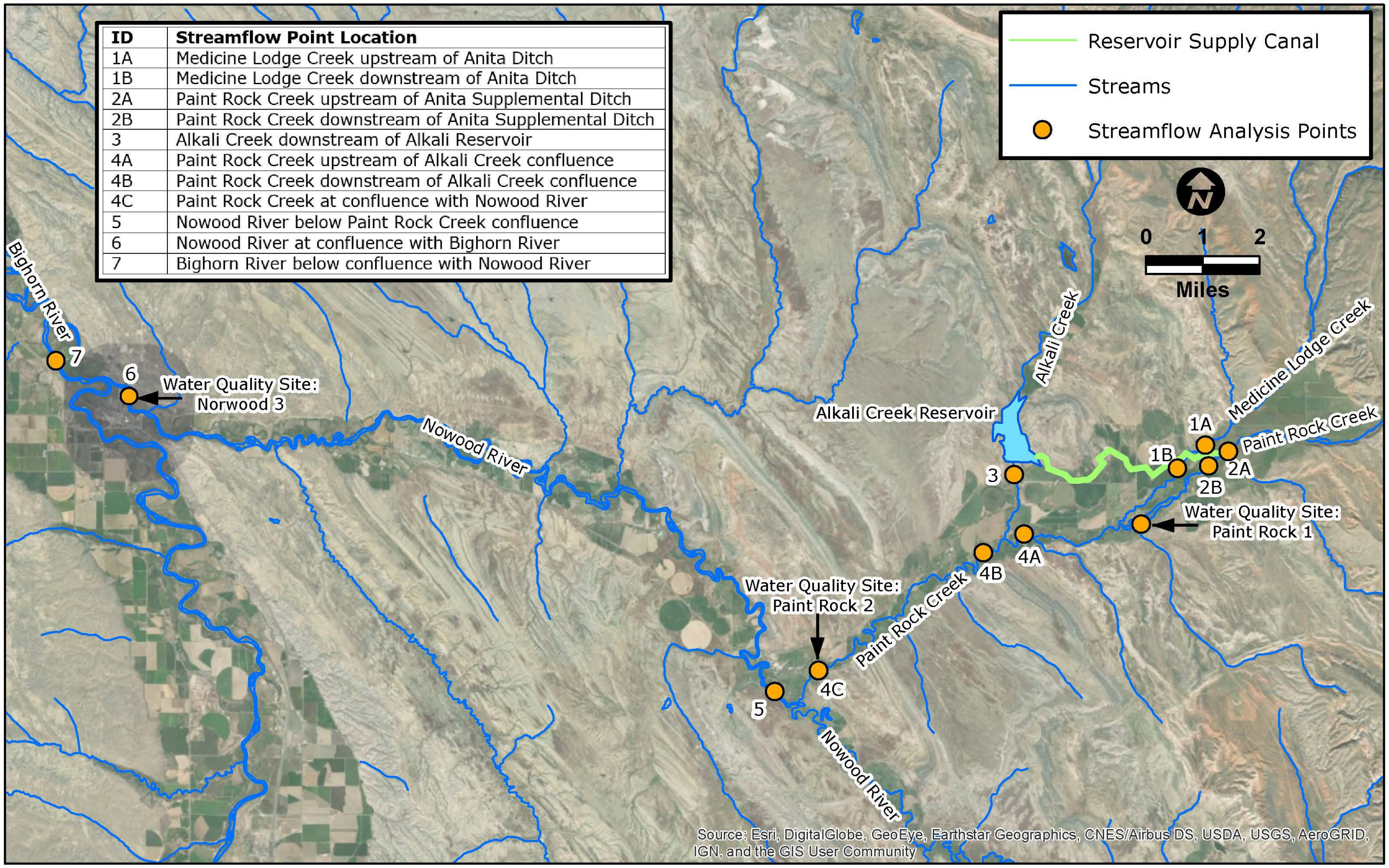
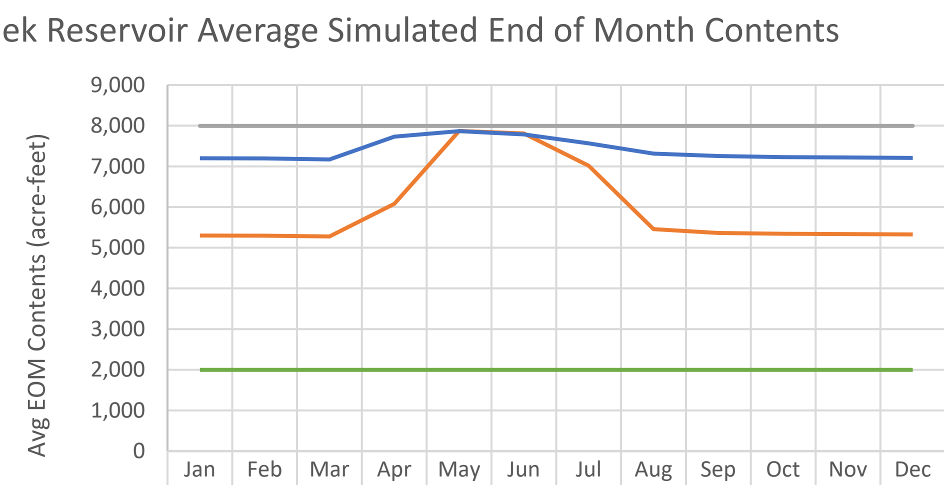
Table E-1: Point Locations of Streamflow Analysis

ID	Streamflow Point Location
1A	Medicine Lodge Creek upstream of Anita Ditch
1B	Medicine Lodge Creek downstream of Anita Ditch
2A	Paint Rock Creek upstream of Anita Supplemental Ditch
2B	Paint Rock Creek downstream of Anita Supplemental Ditch
3	Alkali Creek downstream of Alkali Reservoir
4A	Paint Rock Creek upstream of Alkali Creek confluence
4B	Paint Rock Creek downstream of Alkali Creek confluence
4C	Paint Rock Creek at the Confluence with the Nowood River
5	Nowood River below Paint Rock Creek confluence
6	Nowood River at the Confluence with the Bighorn River
7	Bighorn River below Confluence with Nowood River

Simulated end of month (EOM) reservoir contents data for Alkali Creek Reservoir was extracted from the StateMod model (Trihydro 2016) (revised 2018) for Alternative B - Proposed Action both with and without idle lands. Figure E-2 shows average simulated EOM contents data, and Figure E-3 shows simulated EOM contents data through the modeling period (1973-2017).



Alkali Creek Reservoir EIS	WENCK Responsive partner. Exceptional outcomes.	JAN 2019
Location of Streamflow Analysis		Figure E-1



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg EOM Contents - With Idle Acres	5299	5297	5277	6078	7870	7810	7015	5457	5364	5343	5336	5328
Avg EOM Contents - Without Idle Acres	7198	7195	7170	7731	7865	7784	7566	7312	7254	7228	7218	7209
Conservation Pool	1998	1998	1998	1998	1998	1998	1998	1998	1998	1998	1998	1998
Full Pool	7994	7994	7994	7994	7994	7994	7994	7994	7994	7994	7994	7994

Figure E-2: Alkali Creek Reservoir Average Simulated End of Month Contents

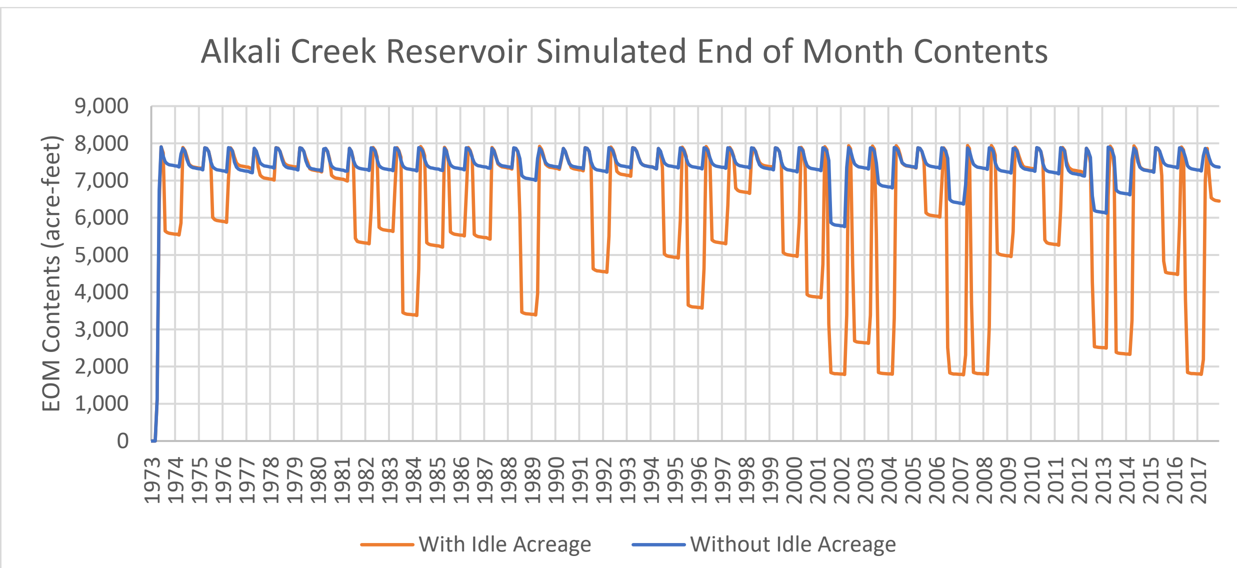


Figure E-3: Alkali Creek Reservoir Simulated End of Month Contents

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Table E-2: Median Streamflow: Alternative A - No Action (without idle acres) and Alternative B - Proposed Action (with idle acres)

= greater than 10% increase = greater than 10% decrease

1A) Medicine Lodge Creek upstream of Anita Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	12	12	11	8	58	182	53	9	14	21	20	16
Proposed Action (with idle acres)	12	12	11	8	57	179	49	15	14	20	20	16
Percent Change	-1%	-1%	0%	0%	-3%	-2%	-8%	70%	-1%	-2%	-2%	-1%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	12	12	10	9	65	107	14	8	10	20	20	16
Proposed Action (with idle acres)	12	12	10	9	66	107	25	15	14	19	20	16
Percent Change	-1%	-1%	0%	1%	2%	0%	77%	76%	36%	-1%	-1%	-2%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	13	12	11	11	65	35	12	8	9	15	18	16
Proposed Action (with idle acres)	13	11	11	13	62	32	19	15	13	15	18	16
Percent Change	-1%	-1%	0%	12%	-4%	-9%	63%	96%	41%	-2%	-1%	-1%

1B) Medicine Lodge Creek downstream of Anita Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	12	12	11	8	51	173	45	4	13	21	20	16
Proposed Action (with idle acres)	12	12	11	8	43	166	37	6	6	20	20	16
Percent Change	-1%	-1%	0%	-2%	-15%	-4%	-18%	57%	-52%	-4%	-2%	-1%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	12	12	10	9	61	99	8	3	8	20	20	16
Proposed Action (with idle acres)	12	12	10	9	50	88	14	6	5	19	20	16
Percent Change	-1%	-1%	0%	-2%	-18%	-11%	71%	72%	-32%	-5%	-1%	-2%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	13	12	11	11	54	28	3	2	9	15	18	16
Proposed Action (with idle acres)	13	11	11	11	44	19	7	6	6	13	18	16
Percent Change	-1%	-1%	0%	-7%	-19%	-31%	105%	248%	-27%	-10%	-1%	-1%

4B) Paint Rock Creek downstream of Alkali Creek confluence

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	42	37	31	50	346	994	438	85	103	100	81	58
Proposed Action (with idle acres)	42	37	31	34	288	987	429	108	100	99	82	59
Percent Change	0%	0%	0%	-33%	-17%	-1%	-2%	26%	-3%	0%	1%	0%

0

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	42	37	31	50	375	708	175	65	86	89	79	57
Proposed Action (with idle acres)	42	36	31	38	327	700	176	88	82	90	79	58
Percent Change	0%	0%	0%	-24%	-13%	-1%	1%	34%	-4%	1%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	43	36	31	42	307	268	90	51	55	74	75	58
Proposed Action (with idle acres)	43	36	31	25	252	261	134	66	57	72	76	58
Percent Change	1%	0%	0%	-42%	-18%	-3%	49%	29%	4%	-3%	2%	0%

4C) Paint Rock Creek at Confluence with Nowood River

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	29	33	32	71	276	770	254	46	54	100	76	45
Proposed Action (with idle acres)	30	33	32	53	256	762	239	62	50	101	77	46
Percent Change	2%	0%	0%	-25%	-7%	-1%	-6%	34%	-6%	0%	2%	2%

0

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	32	32	31	64	304	642	106	30	45	78	72	45
Proposed Action (with idle acres)	32	32	31	51	265	616	100	53	45	78	73	45
Percent Change	0%	0%	0%	-20%	-13%	-4%	-6%	78%	-1%	0%	1%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	35	31	32	53	298	239	58	21	46	62	74	47
Proposed Action (with idle acres)	36	32	33	41	228	227	88	41	50	65	74	47
Percent Change	2%	1%	0%	-23%	-24%	-5%	51%	93%	9%	4%	0%	1%

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5) Nowood River below Paint Rock Creek confluence

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	163	185	468	405	944	1609	553	110	154	261	210	170
Proposed Action (with idle acres)	168	187	469	387	922	1558	488	105	143	279	224	178
Percent Change	3%	1%	0%	-4%	-2%	-3%	-12%	-4%	-7%	7%	6%	5%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	168	183	470	408	1059	1356	245	77	145	207	202	172
Proposed Action (with idle acres)	173	186	470	391	977	1285	205	92	133	229	214	180
Percent Change	3%	1%	0%	-4%	-8%	-5%	-16%	18%	-8%	10%	6%	5%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	177	181	466	422	1047	514	163	51	128	166	192	174
Proposed Action (with idle acres)	182	183	466	403	928	454	136	75	127	179	202	181
Percent Change	3%	1%	0%	-5%	-11%	-12%	-16%	45%	-1%	8%	5%	4%

6) Nowood River at Confluence with Bighorn River

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	172	189	471	396	926	1571	502	88	144	271	232	182
Proposed Action (with idle acres)	180	192	472	383	870	1499	381	59	144	302	249	196
Percent Change	4%	2%	0%	-3%	-6%	-5%	-24%	-33%	0%	11%	7%	7%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	176	188	470	399	1020	1312	205	51	133	226	222	186
Proposed Action (with idle acres)	185	191	470	382	927	1159	113	36	122	247	240	199
Percent Change	5%	2%	0%	-4%	-9%	-12%	-45%	-30%	-8%	10%	8%	7%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	184	185	468	411	1008	470	115	30	121	179	214	189
Proposed Action (with idle acres)	193	187	468	388	866	381	33	35	121	204	232	200
Percent Change	5%	1%	0%	-6%	-14%	-19%	-71%	18%	0%	14%	8%	5%

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Table E-3: Median Streamflow: Alternative A - NoAction (without idle acres) and Alternative B - Proposed Action (without idle acre

= greater than 10% increase   = greater than 10% decrease

1A) Medicine Lodge Creek upstream of Anita Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	12	12	11	8	58	182	53	9	14	21	20	16
Proposed Action (without idle acres)	12	12	11	8	58	182	53	9	14	21	20	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	12	12	10	9	65	107	14	8	10	20	20	16
Proposed Action (without idle acres)	12	12	10	9	66	107	14	8	10	20	20	16
Percent Change	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	13	12	11	11	65	35	12	8	9	15	18	16
Proposed Action (without idle acres)	13	12	11	11	65	35	12	8	9	15	18	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	5%	1%	0%	0%

1B) Medicine Lodge Creek downstream of Anita Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	12	12	11	8	51	173	45	4	13	21	20	16
Proposed Action (without idle acres)	12	12	11	8	51	173	45	4	13	21	20	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	12	12	10	9	61	99	8	3	8	20	20	16
Proposed Action (without idle acres)	12	12	10	9	61	99	8	3	8	20	20	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	-5%	0%	0%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	13	12	11	11	54	28	3	2	9	15	18	16
Proposed Action (without idle acres)	13	12	11	11	54	28	3	2	9	15	18	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	5%	1%	0%	0%

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2A) Paint Rock Creek upstream of Anita Supplemental Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	21	20	18	28	296	839	404	77	75	51	37	28
Proposed Action (without idle acres)	21	20	18	28	296	839	404	77	75	51	37	28
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	21	19	18	28	317	588	169	58	54	45	36	28
Proposed Action (without idle acres)	21	19	18	28	317	588	169	58	54	45	36	28
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	21	19	18	22	266	245	87	41	29	33	32	27
Proposed Action (without idle acres)	21	19	18	22	266	245	87	37	30	33	32	27
Percent Change	0%	0%	0%	0%	0%	0%	0%	-11%	2%	0%	0%	0%

2B) Paint Rock Creek downstream of Anita Supplemental Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	21	20	18	25	292	827	393	65	63	49	37	28
Proposed Action (without idle acres)	21	20	18	25	292	827	393	65	63	49	37	28
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	21	19	18	26	305	576	157	46	44	43	36	28
Proposed Action (without idle acres)	21	19	18	26	303	576	157	46	44	43	36	28
Percent Change	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	21	19	18	16	255	233	75	29	17	28	32	27
Proposed Action (without idle acres)	21	19	18	16	255	233	75	25	18	29	32	27
Percent Change	0%	0%	0%	0%	0%	0%	0%	-16%	3%	1%	0%	0%

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3) Alkali Creek downstream of Alkali Reservoir

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	3	2	1	17	1.8	2	3	5	9	9	8	5
Proposed Action (without idle acres)	3	2	1	5.0	1.8	2	4	6	10	9	8	5
Percent Change	0%	0%	0%	-70%	0%	0%	20%	8%	3%	0%	2%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	3	2	1	16	2.1	3	4	6	11	8	8	5
Proposed Action (without idle acres)	3	2	1	4.9	0.9	3	4	6	11	8	8	5
Percent Change	0%	0%	0%	-69%	-59%	0%	8%	0%	2%	0%	1%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	3	2	1	16	3.3	4	5	7	14	9	8	5
Proposed Action (without idle acres)	3	2	1	3.6	3.3	4	5	8	14	9	9	5
Percent Change	2%	7%	0%	-77%	0%	0%	3%	6%	2%	4%	0%	1%

4A) Paint Rock Creek upstream of Alkali Creek confluence

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	38	35	30	32	343	990	432	78	89	87	71	53
Proposed Action (without idle acres)	38	35	30	32	343	990	432	78	89	87	71	53
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	38	34	30	35	369	703	168	56	72	79	71	52
Proposed Action (without idle acres)	38	34	30	35	353	703	168	56	72	79	71	52
Percent Change	0%	0%	0%	0%	-4%	0%	0%	0%	0%	0%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	40	33	30	23	301	260	82	39	38	62	64	52
Proposed Action (without idle acres)	40	34	30	23	301	260	82	36	40	62	65	52
Percent Change	0%	1%	0%	0%	0%	0%	0%	-8%	5%	0%	1%	1%

4B) Paint Rock Creek downstream of Alkali Creek confluence

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	42	37	31	50	346	994	438	85	103	100	81	58
Proposed Action (without idle acres)	42	37	31	40	346	994	439	86	103	100	81	59
Percent Change	0%	0%	0%	-19%	0%	0%	0%	0%	0%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	42	37	31	50	375	708	175	65	86	89	79	57
Proposed Action (without idle acres)	42	37	31	39	355	708	175	66	86	89	80	58
Percent Change	0%	0%	0%	-22%	-5%	0%	0%	1%	0%	0%	1%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	43	36	31	42	307	268	90	51	55	74	75	58
Proposed Action (without idle acres)	43	36	32	30	307	268	91	53	57	74	76	58
Percent Change	1%	1%	0%	-28%	0%	0%	0%	4%	4%	0%	1%	0%

4C) Paint Rock Creek at Confluence with Nowood River

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	29	33	32	71	276	770	254	46	54	100	76	45
Proposed Action (without idle acres)	29	33	32	60	276	770	255	47	54	100	76	45
Percent Change	0%	0%	0%	-15%	0%	0%	0%	1%	0%	0%	0%	0%
								0		0		

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	32	32	31	64	304	642	106	30	45	78	72	45
Proposed Action (without idle acres)	32	32	31	54	300	642	106	30	45	78	72	45
Percent Change	0%	0%	0%	-16%	-1%	0%	0%	0%	0%	0%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	35	31	32	53	298	239	58	21	46	62	74	47
Proposed Action (without idle acres)	35	32	32	44	294	239	59	22	49	63	74	47
Percent Change	2%	2%	0%	-18%	-1%	0%	2%	2%	6%	2%	0%	1%

5) Nowood River below Paint Rock Creek confluence

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	163	185	468	405	944	1609	553	110	154	261	210	170
Proposed Action (without idle acres)	163	185	468	393	944	1609	554	110	154	261	210	170
Percent Change	0%	0%	0%	-3%	0%	0%	0%	0%	0%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	168	183	470	408	1059	1356	245	77	145	207	202	172
Proposed Action (without idle acres)	169	183	470	396	1053	1356	245	78	145	208	202	172
Percent Change	0%	0%	0%	-3%	-1%	0%	0%	1%	0%	0%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	177	181	466	422	1047	514	163	51	128	166	192	174
Proposed Action (without idle acres)	177	182	466	410	1047	514	163	54	129	168	192	174
Percent Change	0%	0%	0%	-3%	0%	0%	0%	6%	1%	1%	0%	0%

6) Nowood River at Confluence with Bighorn River

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	172	189	471	396	926	1571	502	88	144	271	232	182
Proposed Action (without idle acres)	172	189	471	387	926	1571	503	88	144	271	232	182
Percent Change	0%	0%	0%	-2%	0%	0%	0%	1%	0%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	176	188	470	399	1020	1312	205	51	133	226	222	186
Proposed Action (without idle acres)	176	188	470	388	1020	1312	205	51	133	226	222	186
Percent Change	0%	0%	0%	-3%	0%	0%	0%	0%	0%	0%	0%	0%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (without idle acres)	184	185	468	411	1008	470	115	30	121	179	214	189
Proposed Action (without idle acres)	184	186	468	398	1005	470	116	30	124	181	215	189
Percent Change	0%	0%	0%	-3%	0%	0%	1%	1%	3%	1%	1%	0%

Table E-4: Median Streamflow: Alternative A - NoAction (with idle acres) and Alternative B - Proposed Action (with idle acre

= greater than 10% increase   = greater than 10% decrease

1A) Medicine Lodge Creek upstream of Anita Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	12	12	11	8	57	179	49	15	13	20	20	16
Proposed Action (with idle acres)	12	12	11	8	57	179	49	15	14	20	20	16
Percent Change	1%	1%	0%	0%	0%	0%	0%	-1%	2%	1%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	12	12	10	9	65	107	25	15	14	19	20	16
Proposed Action (with idle acres)	12	12	10	9	66	107	25	15	14	19	20	16
Percent Change	0%	0%	0%	0%	2%	0%	0%	-1%	3%	1%	0%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	13	11	11	13	62	32	19	15	13	14	18	16
Proposed Action (with idle acres)	13	11	11	13	62	32	19	15	13	15	18	16
Percent Change	1%	0%	0%	0%	0%	0%	-2%	-1%	0%	3%	0%	1%

1B) Medicine Lodge Creek downstream of Anita Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	12	12	11	8	48	166	37	6	6	20	20	16
Proposed Action (with idle acres)	12	12	11	8	43	166	37	6	6	20	20	16
Percent Change	1%	1%	0%	0%	-9%	0%	0%	-3%	0%	1%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	12	12	10	9	57	88	14	6	5	19	20	16
Proposed Action (with idle acres)	12	12	10	9	50	88	14	6	5	19	20	16
Percent Change	0%	0%	0%	0%	-12%	0%	0%	-2%	0%	0%	0%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	13	11	11	11	47	19	7	6	6	13	18	16
Proposed Action (with idle acres)	13	11	11	11	44	19	7	6	6	13	18	16
Percent Change	1%	0%	0%	0%	-7%	0%	-5%	0%	0%	3%	0%	1%

2A) Paint Rock Creek upstream of Anita Supplemental Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	21	20	18	28	296	838	402	75	73	50	37	28
Proposed Action (with idle acres)	21	20	18	28	296	838	402	74	73	50	37	28
Percent Change	1%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	21	19	18	28	316	587	165	60	53	44	36	27
Proposed Action (with idle acres)	21	19	18	28	316	587	165	55	53	44	36	27
Percent Change	0%	0%	0%	0%	0%	0%	0%	-8%	1%	0%	0%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	21	19	18	22	265	243	95	41	27	32	31	27
Proposed Action (with idle acres)	21	19	18	22	265	243	83	37	28	32	31	27
Percent Change	0%	1%	0%	0%	0%	0%	-12%	-10%	5%	1%	2%	1%

2B) Paint Rock Creek downstream of Anita Supplemental Ditch (reservoir supply POD)

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	21	20	18	26	293	827	391	63	61	49	37	28
Proposed Action (with idle acres)	21	20	18	26	258	827	391	62	62	49	37	28
Percent Change	1%	0%	0%	0%	-12%	0%	0%	0%	2%	1%	0%	0%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	21	19	18	26	307	575	153	48	45	43	36	27
Proposed Action (with idle acres)	21	19	18	26	275	575	153	43	45	43	36	27
Percent Change	0%	0%	0%	0%	-11%	0%	0%	-11%	1%	1%	0%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	21	19	18	18	253	231	81	29	15	29	31	27
Proposed Action (with idle acres)	21	19	18	18	218	231	69	26	16	29	31	27
Percent Change	0%	1%	0%	0%	-14%	0%	-15%	-13%	8%	1%	2%	1%

3) Alkali Creek downstream of Alkali Reservoir

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	3	2	1	17	1.6	2	4	10	10	9	8	5
Proposed Action (with idle acres)	3	2	1	0.4	0.9	2	4	15	10	9	8	5
Percent Change	3%	6%	0%	-98%	-45%	0%	1%	49%	6%	0%	5%	4%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	3	2	1	16	1.6	3	4	9	10	8	7	4
Proposed Action (with idle acres)	3	2	1	0.4	0.4	3	4	34	11	8	7	5
Percent Change	2%	6%	0%	-98%	-76%	-4%	0%	265%	7%	1%	1%	4%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	3	2	1	16	2.2	4	6	13	13	9	8	5
Proposed Action (with idle acres)	3	2	1	0.4	0.4	4	32	37	13	9	8	5
Percent Change	4%	10%	0%	-97%	-82%	0%	412%	188%	2%	3%	4%	4%

4A) Paint Rock Creek upstream of Alkali Creek confluence

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	37	35	30	31	332	981	416	72	75	79	69	51
Proposed Action (with idle acres)	37	35	30	31	286	981	416	72	80	83	70	51
Percent Change	0%	0%	0%	0%	-14%	0%	0%	0%	7%	5%	1%	1%

5

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	37	34	30	35	359	690	160	56	59	72	67	50
Proposed Action (with idle acres)	38	34	30	35	321	689	160	50	61	75	68	51
Percent Change	2%	0%	0%	0%	-11%	0%	0%	-11%	4%	3%	1%	1%

2

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	38	32	30	23	286	247	84	37	30	53	61	49
Proposed Action (with idle acres)	39	33	30	23	247	247	74	31	34	56	63	51
Percent Change	2%	2%	0%	0%	-14%	0%	-11%	-16%	13%	6%	3%	3%

4B) Paint Rock Creek downstream of Alkali Creek confluence

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	42	37	31	50	338	987	429	92	92	96	80	58
Proposed Action (with idle acres)	42	37	31	34	288	987	429	108	100	99	82	59
Percent Change	1%	0%	0%	-33%	-15%	0%	0%	17%	8%	4%	2%	1%

3

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	41	36	31	50	367	700	173	76	78	86	78	57
Proposed Action (with idle acres)	42	36	31	38	327	700	176	88	82	90	79	58
Percent Change	1%	1%	0%	-23%	-11%	0%	2%	16%	5%	5%	2%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	42	35	31	42	295	261	104	57	50	68	73	56
Proposed Action (with idle acres)	43	36	31	25	252	261	134	66	57	72	76	58
Percent Change	2%	3%	0%	-42%	-14%	0%	29%	16%	15%	6%	5%	3%

4C) Paint Rock Creek at Confluence with Nowood River

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	28	33	32	70	270	762	238	46	44	97	75	44
Proposed Action (with idle acres)	30	33	32	53	256	762	239	62	50	101	77	46
Percent Change	6%	0%	0%	-24%	-5%	0%	0%	33%	14%	4%	3%	5%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	31	31	31	66	296	616	98	38	43	77	72	45
Proposed Action (with idle acres)	32	32	31	51	265	616	100	53	45	78	73	45
Percent Change	3%	3%	0%	-22%	-10%	0%	2%	40%	5%	1%	0%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	34	30	32	55	285	227	51	27	42	59	71	46
Proposed Action (with idle acres)	36	32	33	41	228	227	88	41	50	65	74	47
Percent Change	5%	5%	0%	-25%	-20%	0%	73%	52%	20%	9%	4%	3%

5) Nowood River below Paint Rock Creek confluence

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	167	187	469	405	936	1558	487	93	142	275	224	175
Proposed Action (with idle acres)	168	187	469	387	922	1558	488	105	143	279	224	178
Percent Change	1%	0%	0%	-4%	-1%	0%	0%	13%	1%	1%	0%	2%

Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	173	184	470	406	1015	1285	205	72	132	228	213	179
Proposed Action (with idle acres)	173	186	470	391	977	1285	205	92	133	229	214	180
Percent Change	0%	1%	0%	-4%	-4%	0%	0%	28%	1%	0%	0%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	180	182	466	421	982	454	111	52	120	173	199	179
Proposed Action (with idle acres)	182	183	466	403	928	454	136	75	127	179	202	181
Percent Change	1%	1%	0%	-4%	-6%	0%	23%	44%	6%	4%	2%	1%

6) Nowood River at Confluence with Bighorn River

Wet Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	178	192	472	396	895	1499	380	59	138	287	248	193
Proposed Action (with idle acres)	180	192	472	383	870	1499	381	59	144	302	249	196
Percent Change	1%	0%	0%	-3%	-3%	0%	0%	0%	4%	5%	1%	2%
										15		

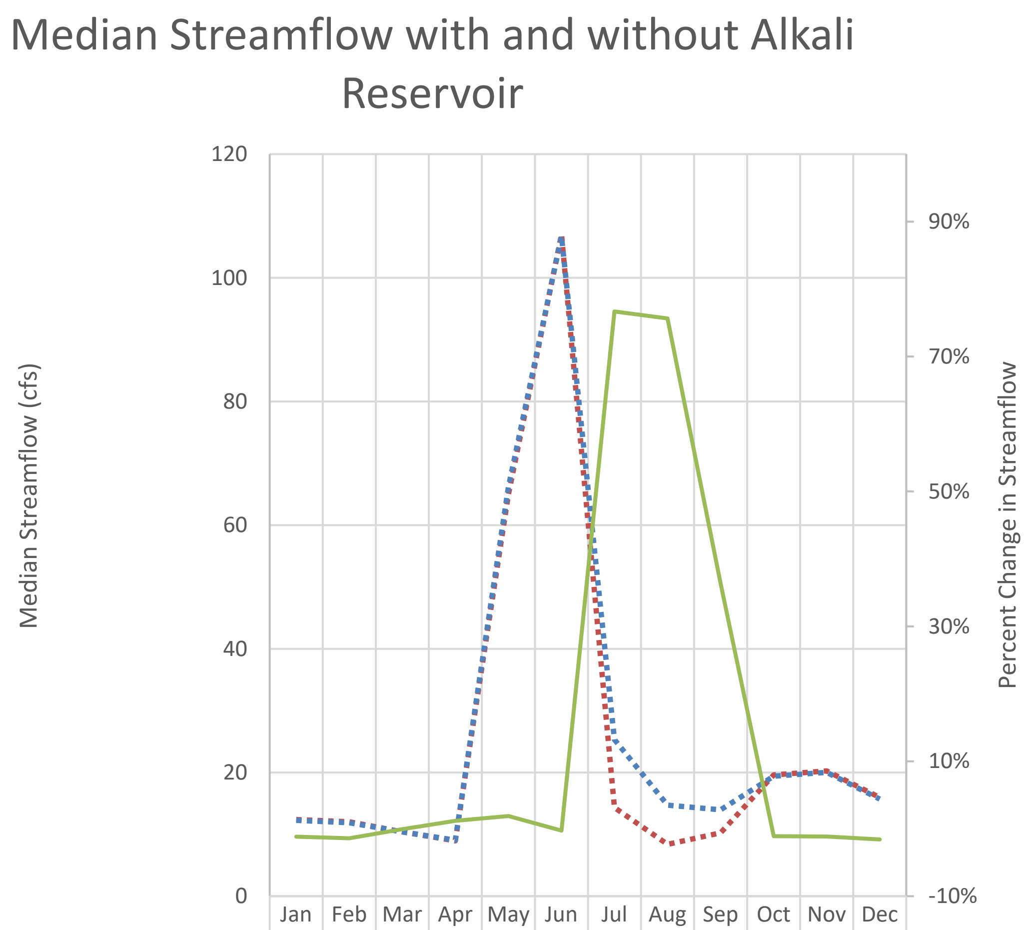
Normal Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	184	190	470	399	968	1159	113	29	117	245	239	196
Proposed Action (with idle acres)	185	191	470	382	927	1159	113	36	122	247	240	199
Percent Change	1%	1%	0%	-4%	-4%	0%	0%	23%	4%	1%	1%	1%

Dry Year Median (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No Action (with idle acres)	188	185	468	412	916	379	21	27	107	189	223	197
Proposed Action (with idle acres)	193	187	468	388	866	381	33	35	121	204	232	200
Percent Change	2%	1%	0%	-6%	-6%	1%	59%	30%	13%	8%	4%	1%

Median Streamflow for a Normal Water Year

Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (with idle acres)

1A) Medicine Lodge Creek upstream of Anita Ditch

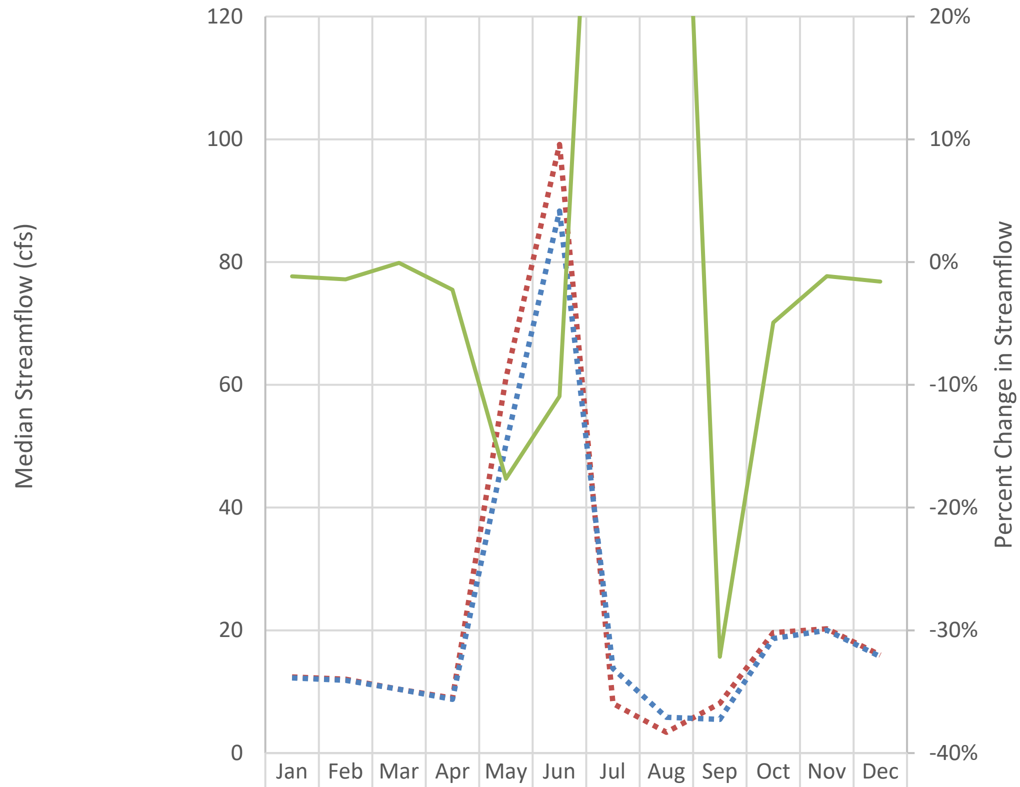


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	12	12	10	9	65	107	14	8	10	20	20	16
Normal Year - Proposed Action (with idle acres)	12	12	10	9	66	107	25	15	14	19	20	16
Percent Change	-1%	-1%	0%	1%	2%	0%	77%	76%	36%	-1%	-1%	-2%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B – Proposed Action (with idle acres)
Normal Water Year

1B) Medicine Lodge Creek downstream of Anita Ditch

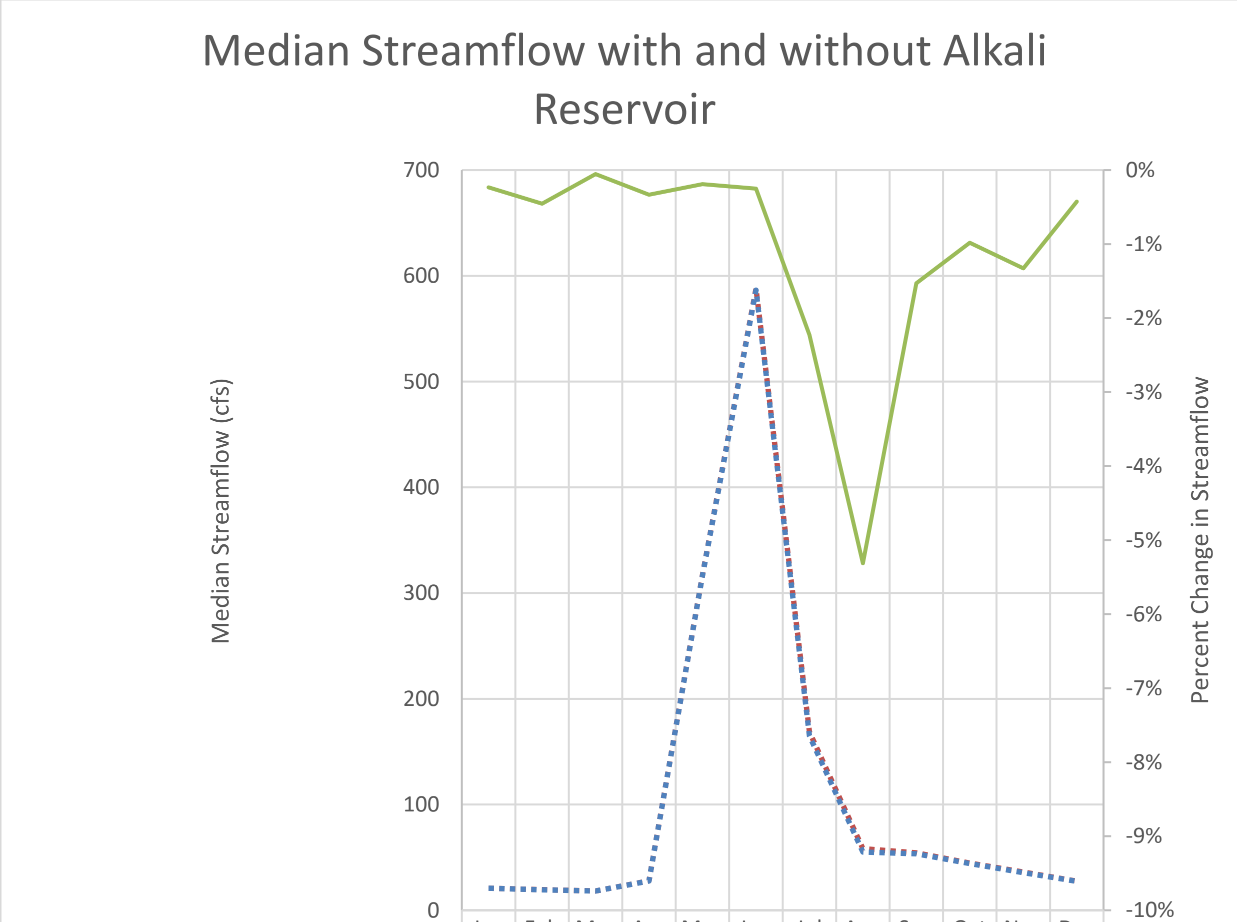
Median Streamflow with and without Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	12	12	10	9	61	99	8	3	8	20	20	16
Normal Year - Proposed Action (with idle acres)	12	12	10	9	50	88	14	6	5	19	20	16
Percent Change	-1%	-1%	0%	-2%	-18%	-11%	71%	72%	-32%	-5%	-1%	-2%

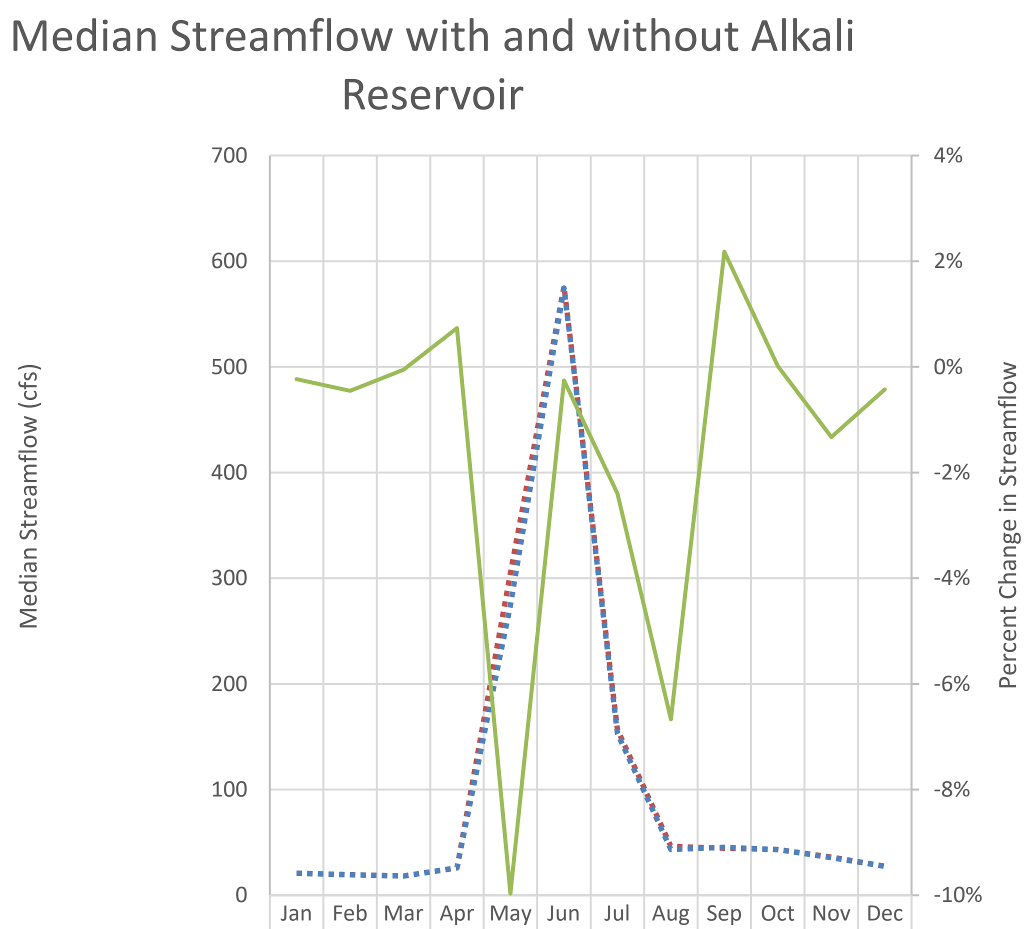
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B – Proposed Action (with idle acres)
Normal Water Year

2A) Paint Rock Creek upstream of Anita Supplemental Ditch



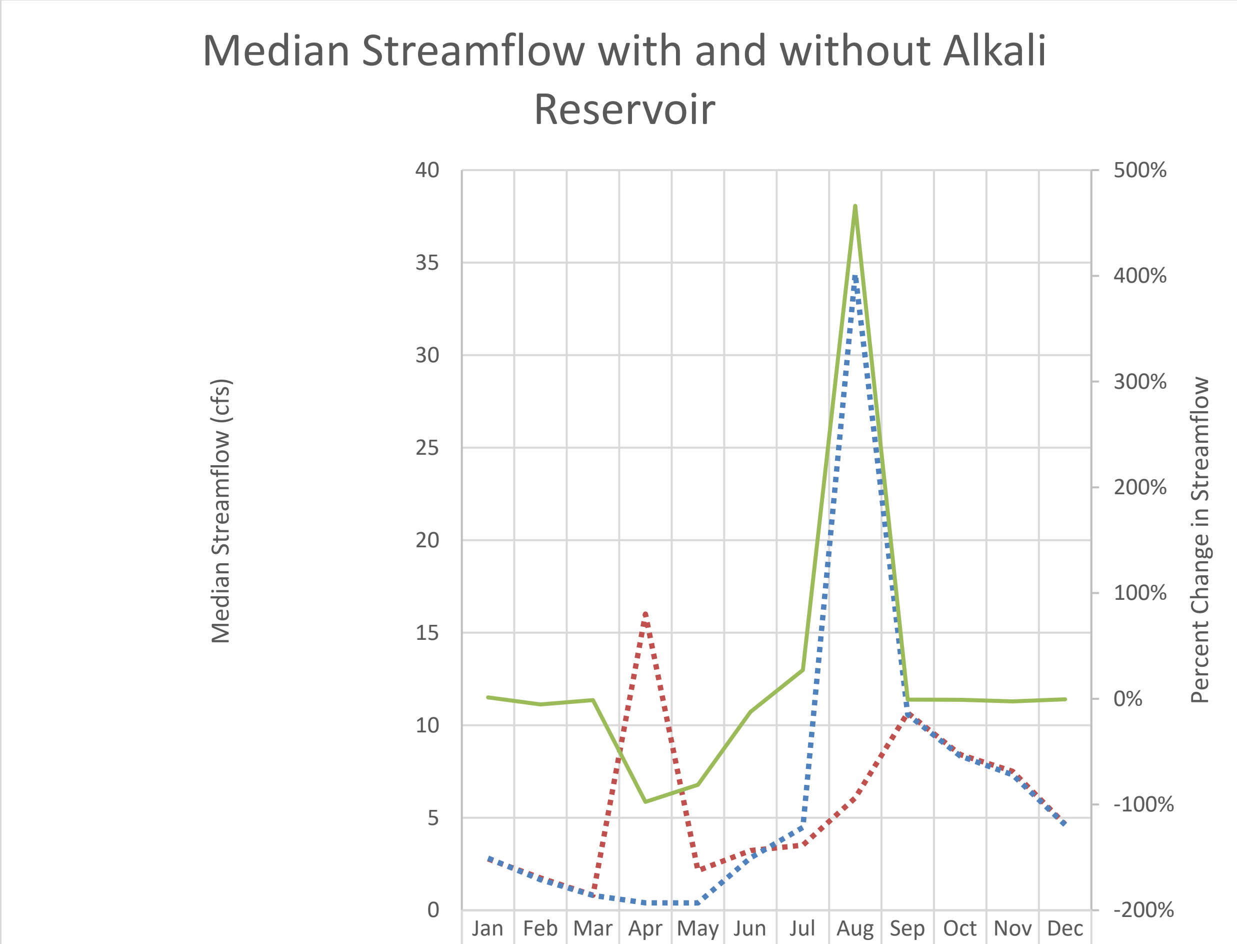
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	21	19	18	28	317	588	169	58	54	45	36	28
Normal Year - Proposed Action (with idle acres)	21	19	18	28	316	587	165	55	53	44	36	27
Percent Change	0%	0%	0%	0%	0%	0%	-2%	-5%	-2%	-1%	-1%	0%

2B) Paint Rock Creek downstream of Anita Supplemental Ditch



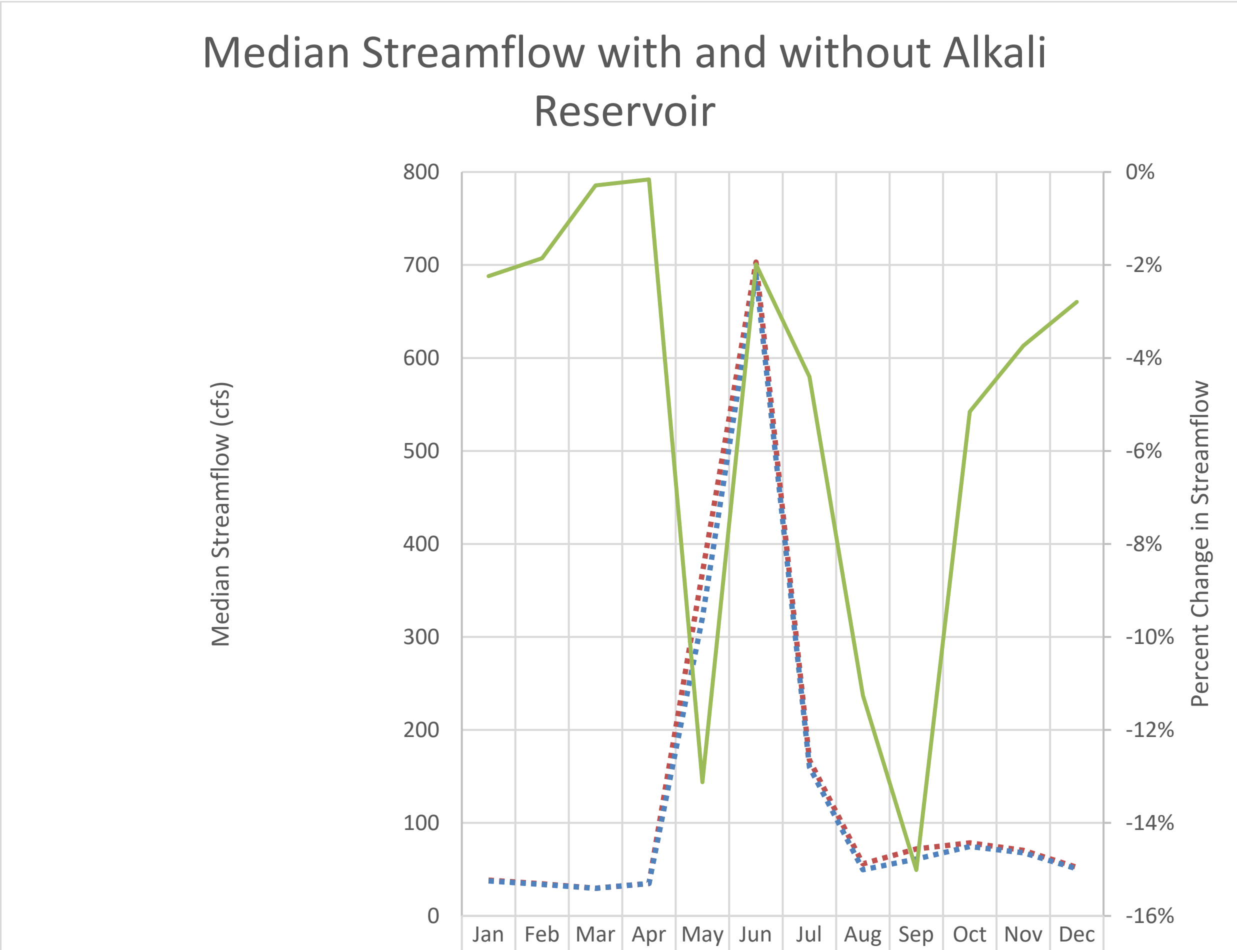
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	21	19	18	26	305	576	157	46	44	43	36	28
Normal Year - Proposed Action (with idle acres)	21	19	18	26	275	575	153	43	45	43	36	27
Percent Change	0%	0%	0%	1%	-10%	0%	-2%	-7%	2%	0%	-1%	0%

3) Alkali Creek downstream of Alkali Reservoir



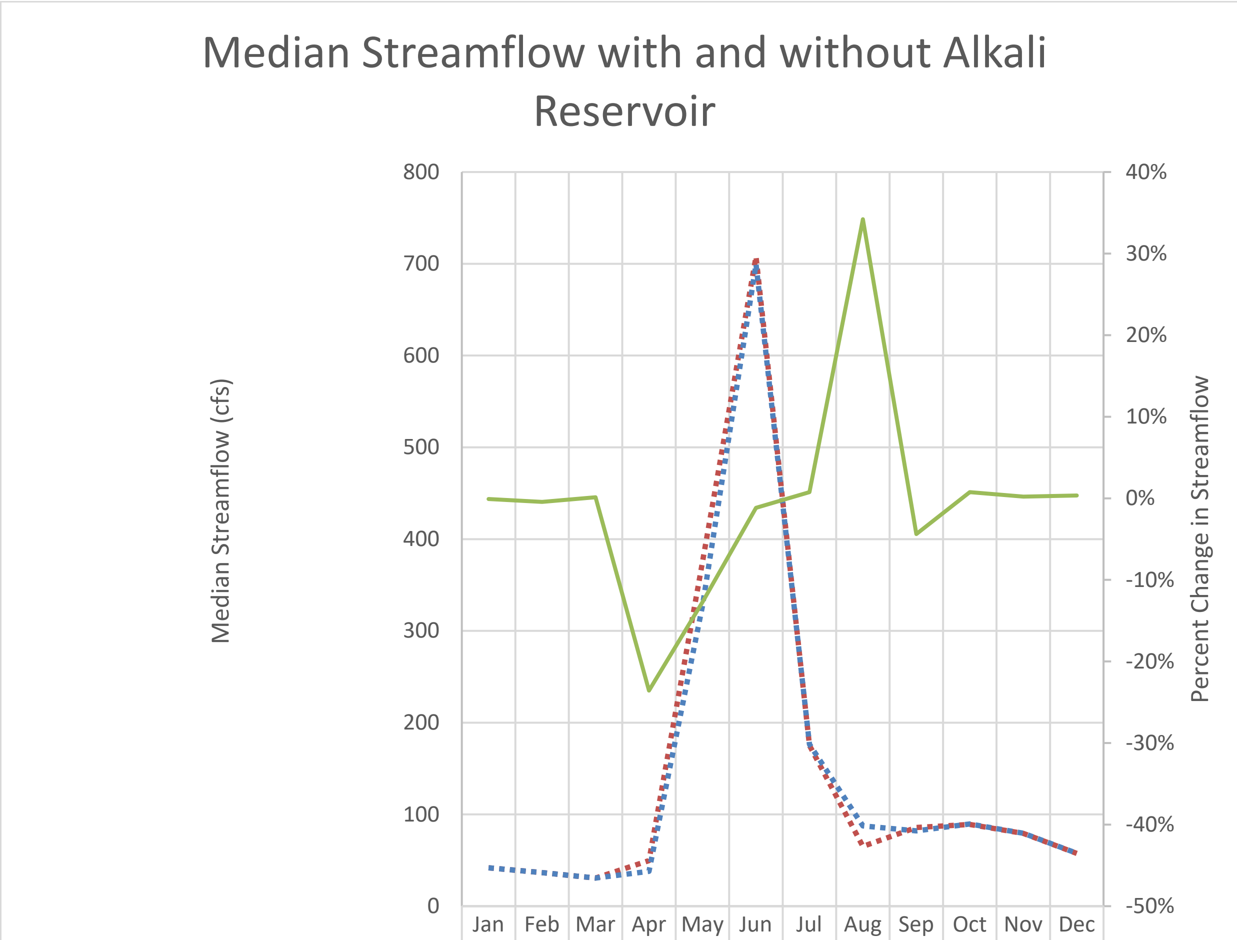
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	3	2	1	16	2	3	4	6	11	8	8	5
Normal Year - Proposed Action (with idle acres)	3	2	1	0	0	3	4	34	11	8	7	5
Percent Change	1%	-5%	-1%	-98%	-81%	-13%	27%	466%	-1%	-1%	-2%	-1%

4A) Paint Rock Creek upstream of Alkali Creek confluence



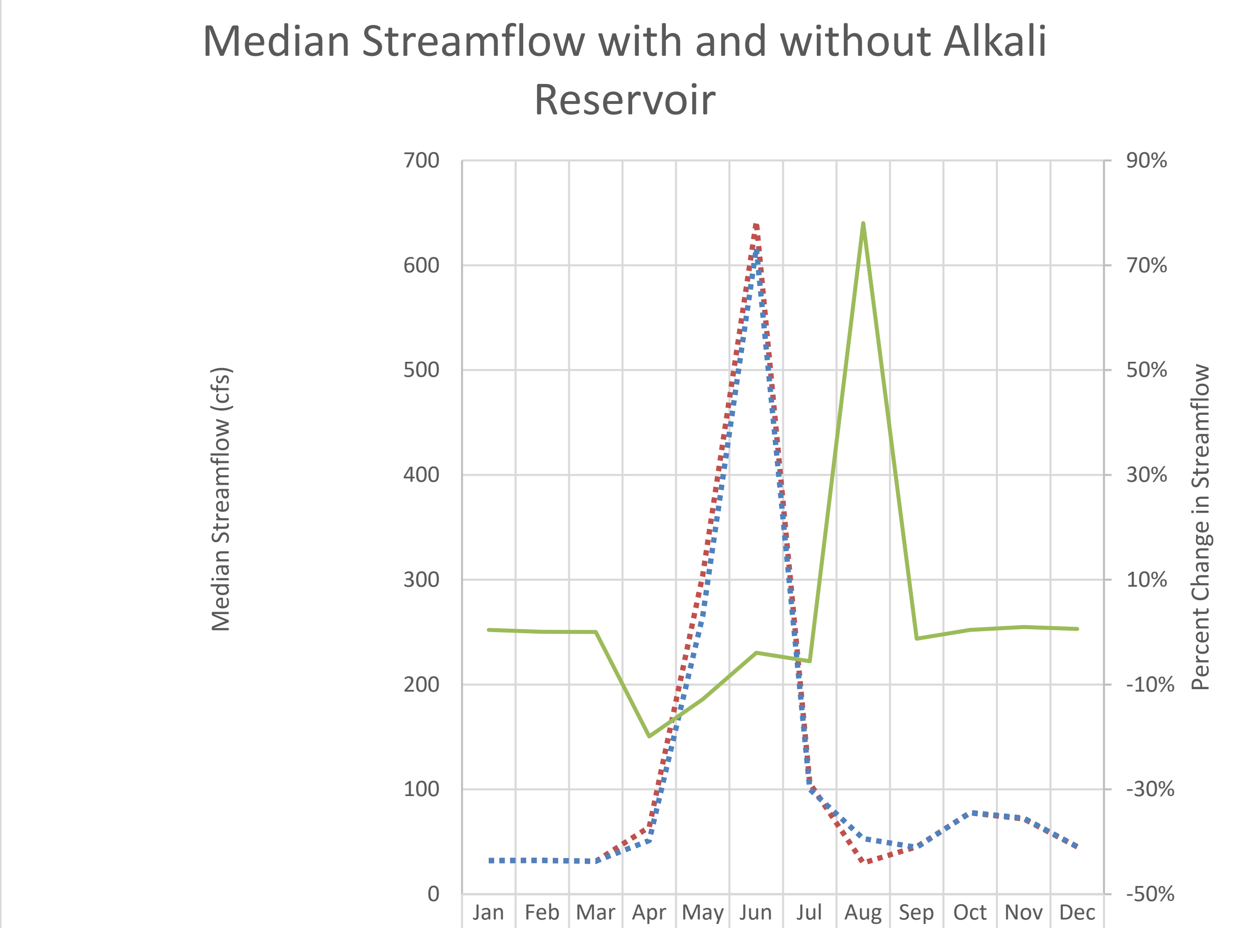
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	38	34	30	35	369	703	168	56	72	79	71	52
Normal Year - Proposed Action (with idle acres)	38	34	30	35	321	689	160	50	61	75	68	51
Percent Change	-2%	-2%	0%	0%	-13%	-2%	-4%	-11%	-15%	-5%	-4%	-3%

4B) Paint Rock Creek downstream of Alkali Creek confluence



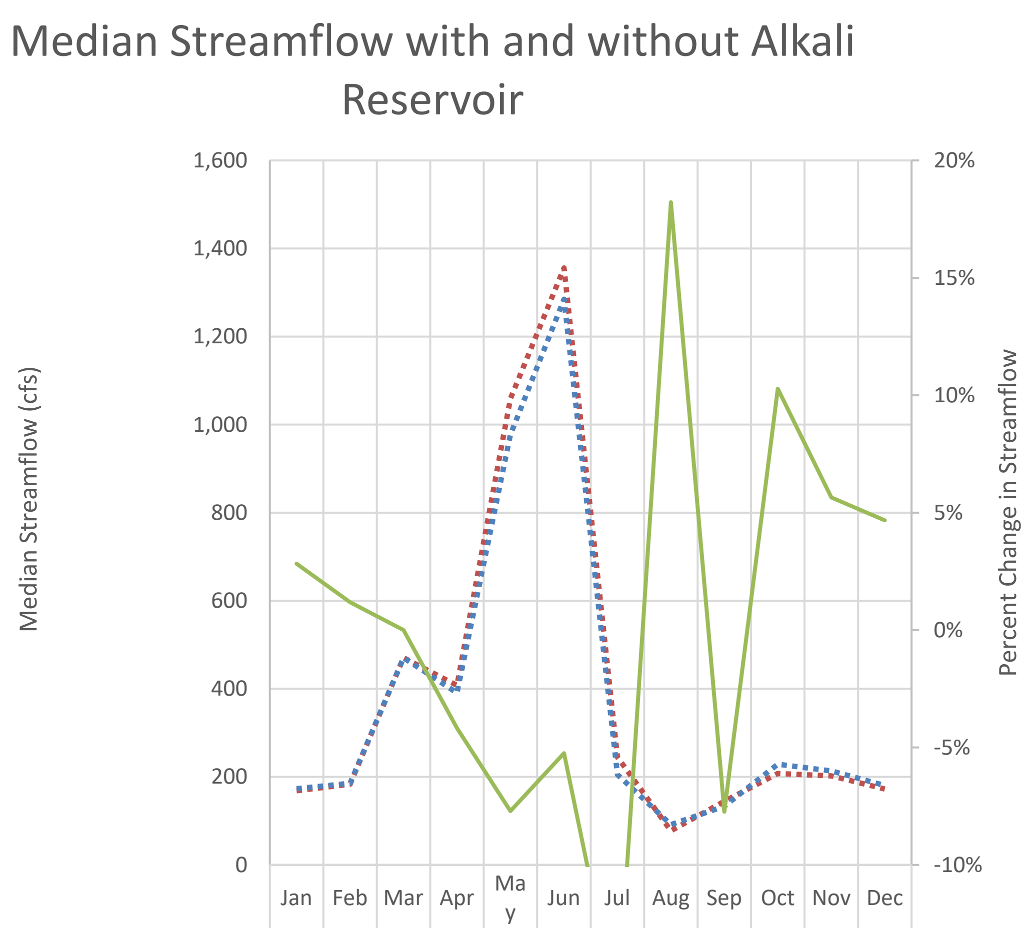
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	42	37	31	50	375	708	175	65	86	89	79	57
Normal Year - Proposed Action (with idle acres)	42	36	31	38	327	700	176	88	82	90	79	58
Percent Change	0%	0%	0%	-24%	-13%	-1%	1%	34%	-4%	1%	0%	0%

4C) Paint Rock Creek at the Confluence with the Nowood River



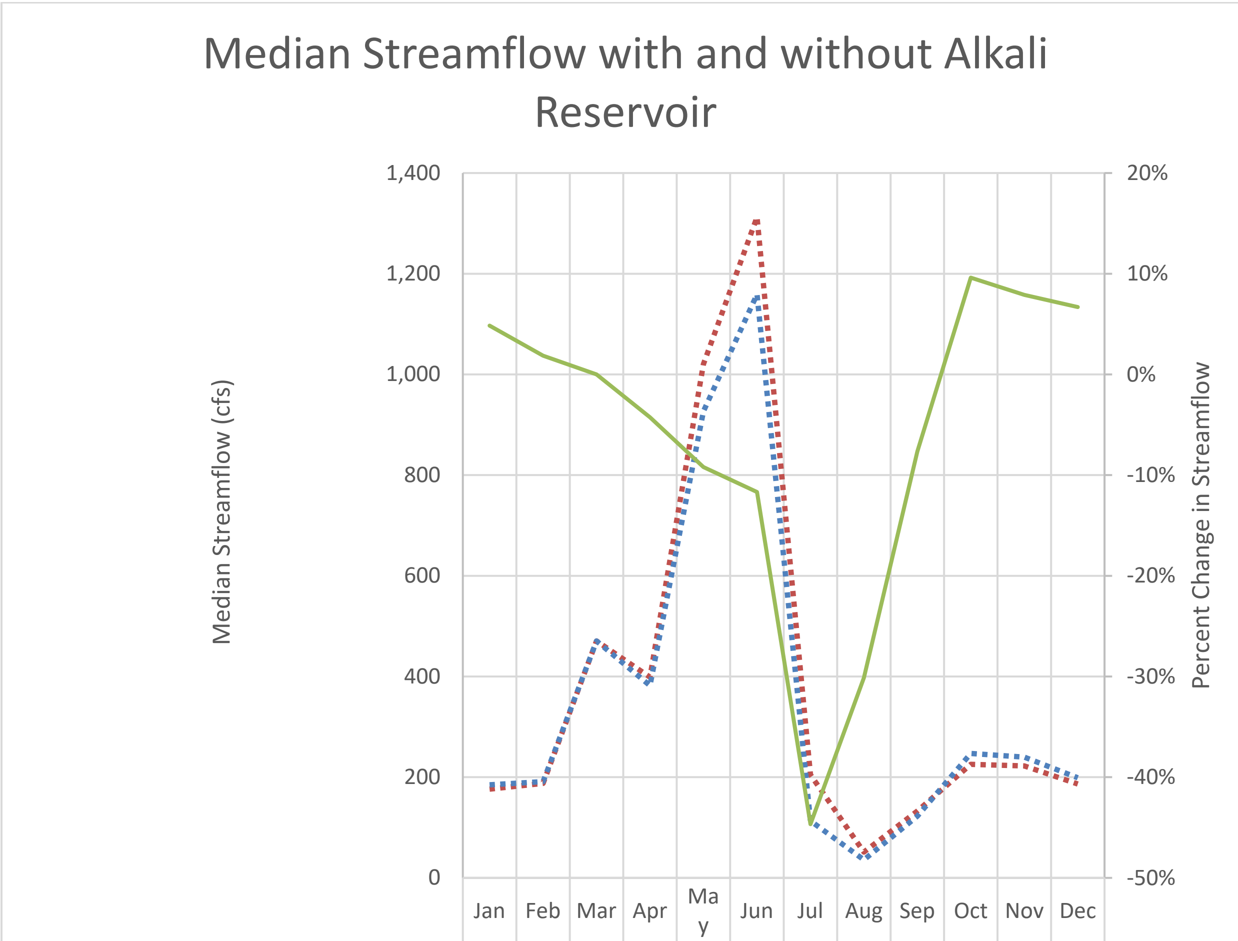
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	32	32	31	64	304	642	106	30	45	78	72	45
Normal Year - Proposed Action (with idle acres)	32	32	31	51	265	616	100	53	45	78	73	45
Percent Change	0%	0%	0%	-20%	-13%	-4%	-6%	78%	-1%	0%	1%	1%

5) Nowood River below Paint Rock Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	168	183	470	408	1059	1356	245	77	145	207	202	172
Normal Year - Proposed Action (with idle acres)	173	186	470	391	977	1285	205	92	133	229	214	180
Percent Change	3%	1%	0%	-4%	-8%	-5%	-16%	18%	-8%	10%	6%	5%

6) Nowood River at Confluence with Bighorn River

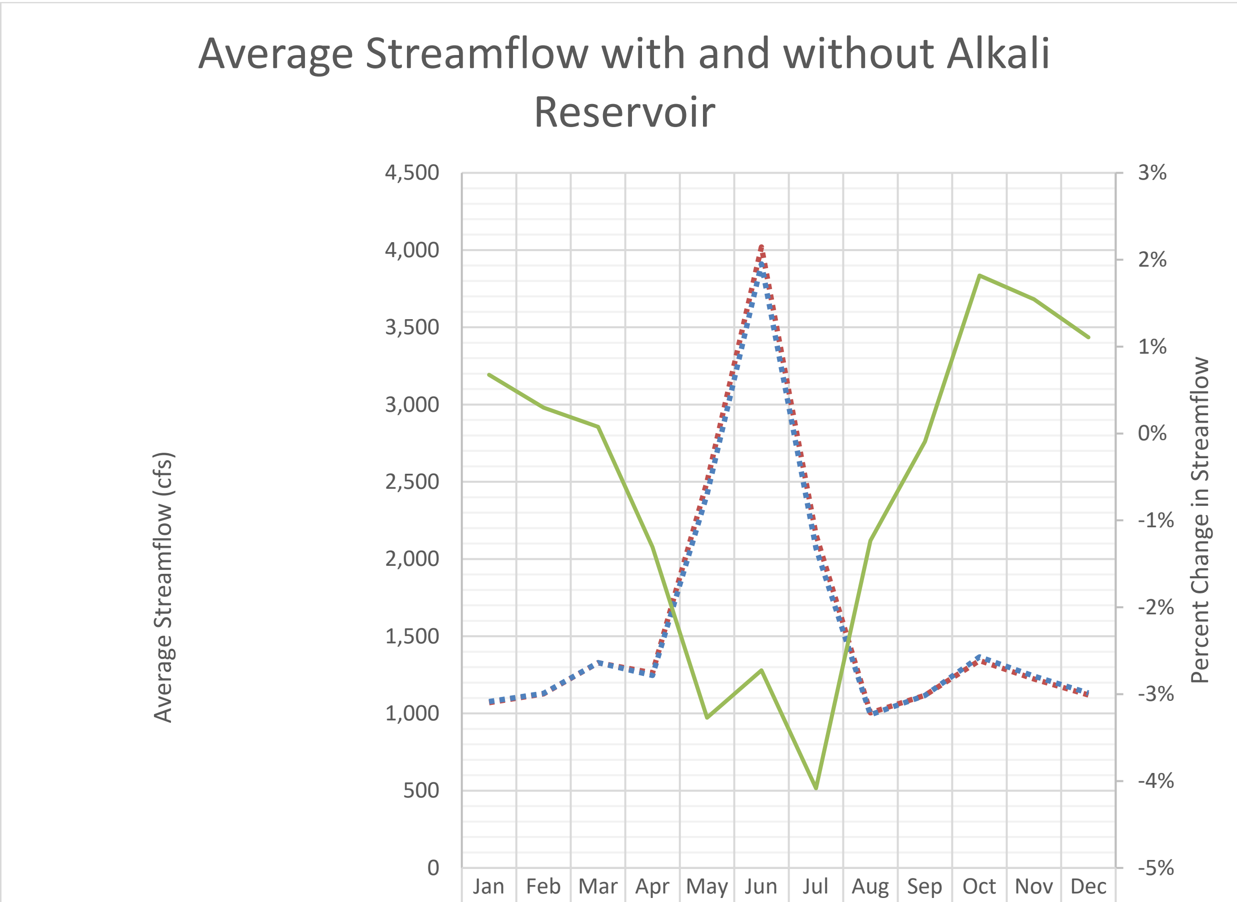


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	176	188	470	399	1020	1312	205	51	133	226	222	186
Normal Year - Proposed Action (with idle acres)	185	191	470	382	927	1159	113	36	122	247	240	199
Percent Change	5%	2%	0%	-4%	-9%	-12%	-45%	-30%	-8%	10%	8%	7%

Average Streamflow

Alternative A – No Action (without idle acres and Alternative B – Proposed Action (with idle acres)

7) Bighorn River below Confluence with Nowood River

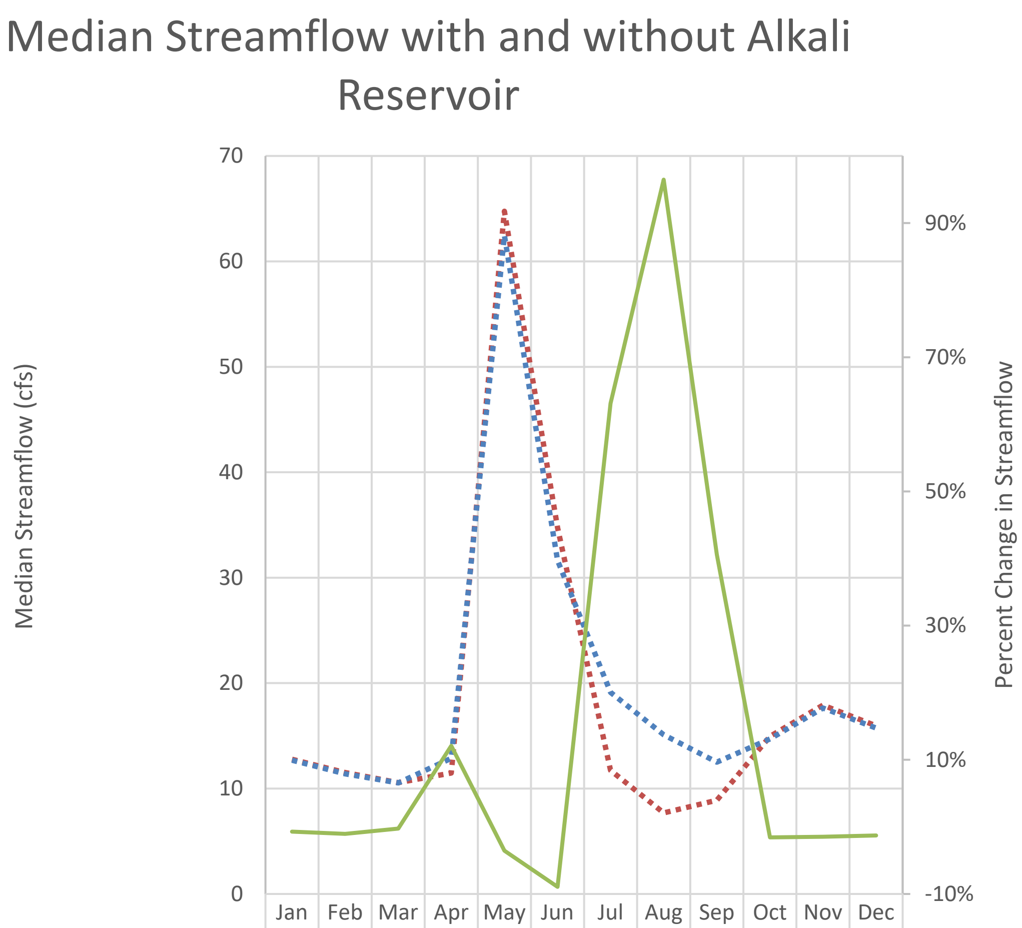


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	1,070	1,127	1,328	1,262	2,501	4,020	2,158	1,004	1,118	1,342	1,223	1,120
Normal Year - Proposed Action (with idle acres)	1,077	1,130	1,329	1,246	2,419	3,911	2,070	992	1,117	1,367	1,242	1,132
Percent Change	1%	0%	0%	-1%	-3%	-3%	-4%	-1%	0%	2%	2%	1%

Median Streamflow during a Dry Water Year

Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (with idle acres)

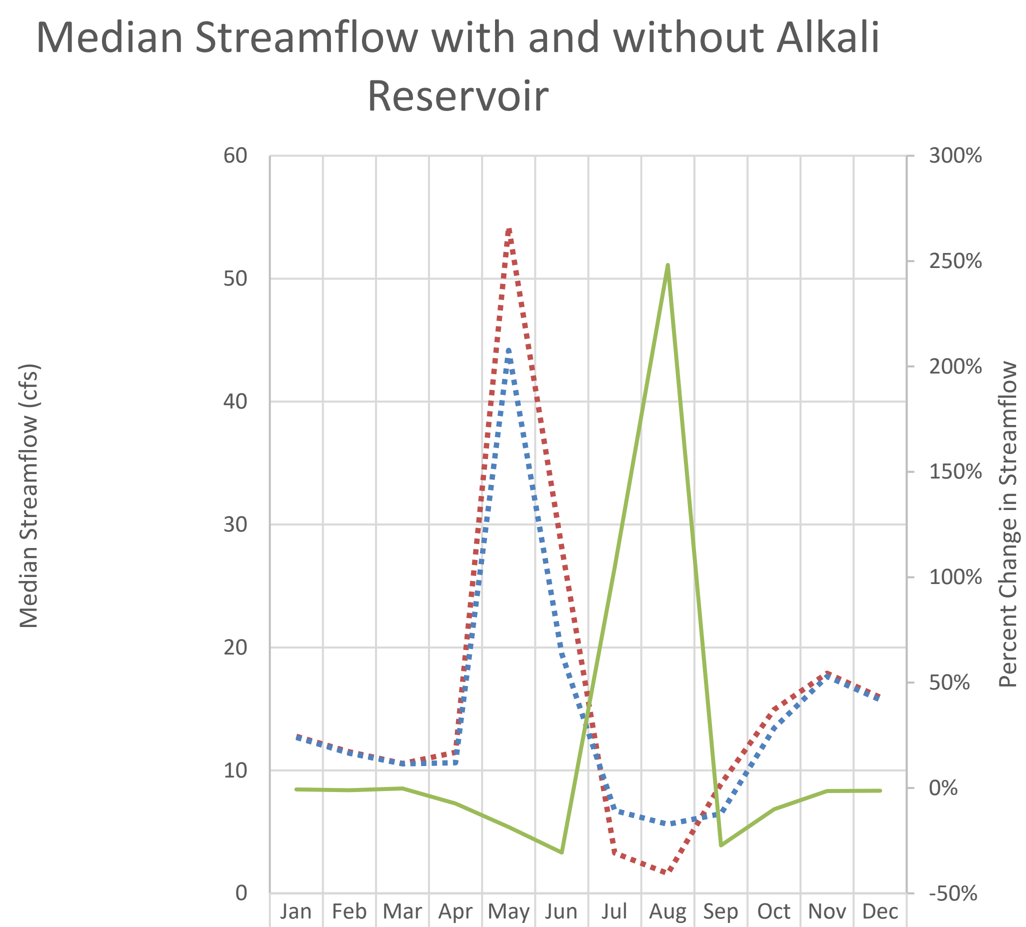
1A) Medicine Lodge Creek upstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	13	12	11	11	65	35	12	8	9	15	18	16
Dry Year - Proposed Action (with idle acres)	13	11	11	13	62	32	19	15	13	15	18	16
Percent Change	-1%	-1%	0%	12%	-4%	-9%	63%	96%	41%	-2%	-1%	-1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

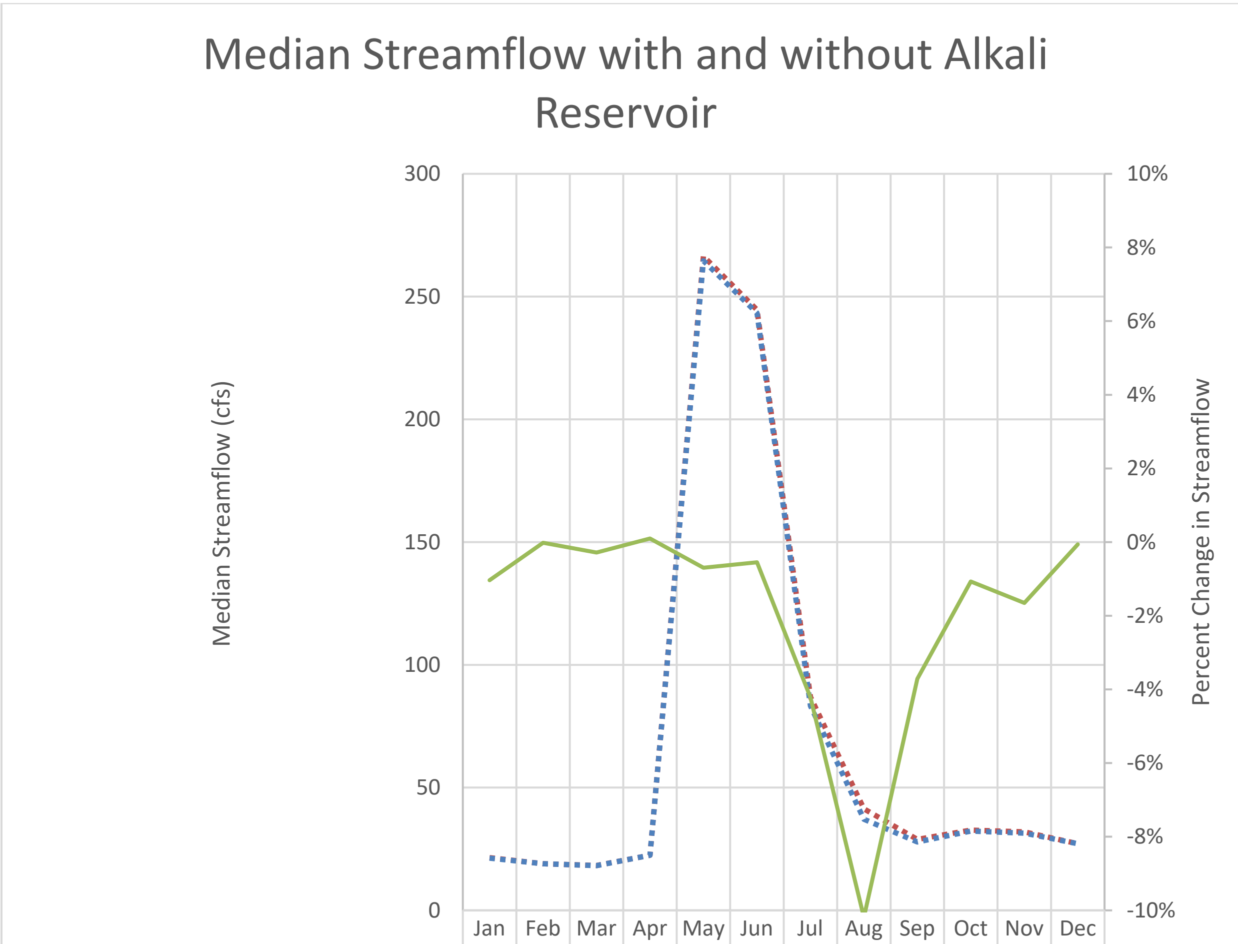
1B) Medicine Lodge Creek downstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	13	12	11	11	54	28	3	2	9	15	18	16
Dry Year - Proposed Action (with idle acres)	13	11	11	11	44	19	7	6	6	13	18	16
Percent Change	-1%	-1%	0%	-7%	-19%	-31%	105%	248%	-27%	-10%	-1%	-1%

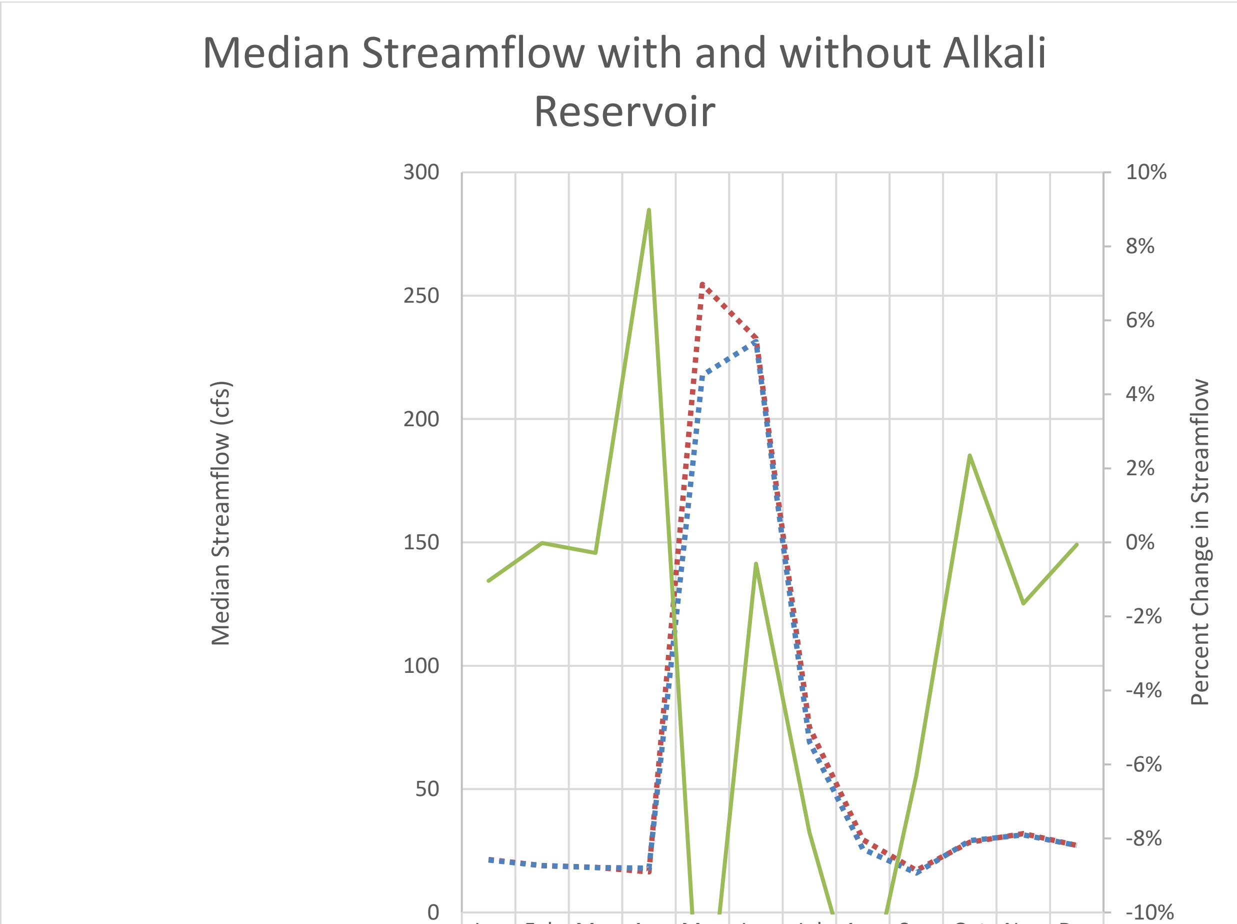
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

2A) Paint Rock Creek upstream of Anita Supplemental Ditch



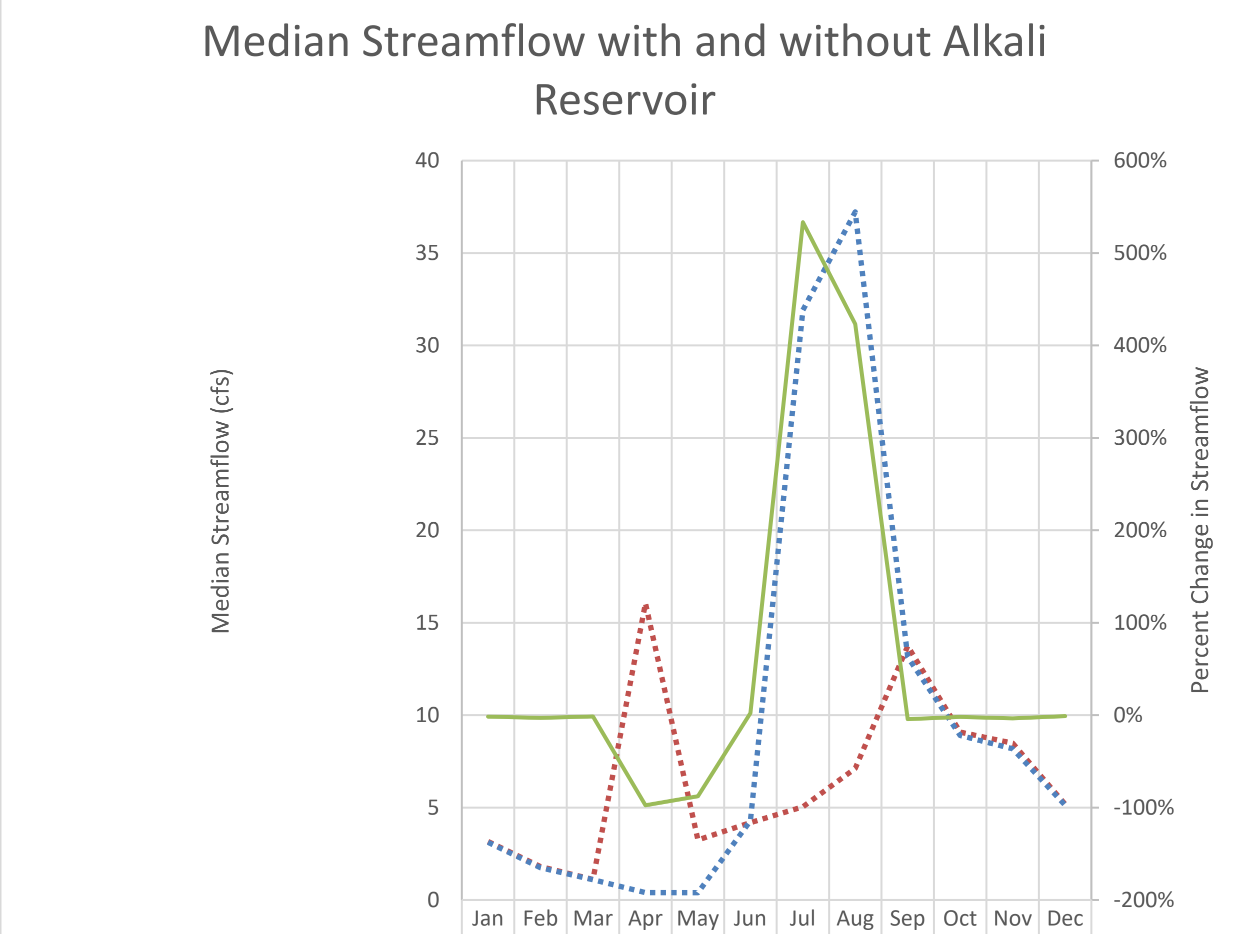
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	21	19	18	22	266	245	87	41	29	33	32	27
Dry Year - Proposed Action (with idle acres)	21	19	18	22	265	243	83	37	28	32	31	27
Percent Change	-1%	0%	0%	0%	-1%	-1%	-4%	-10%	-4%	-1%	-2%	0%

2B) Paint Rock Creek downstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	21	19	18	16	255	233	75	29	17	28	32	27
Dry Year - Proposed Action (with idle acres)	21	19	18	18	218	231	69	26	16	29	31	27
Percent Change	-1%	0%	0%	9%	-14%	-1%	-8%	-13%	-6%	2%	-2%	0%

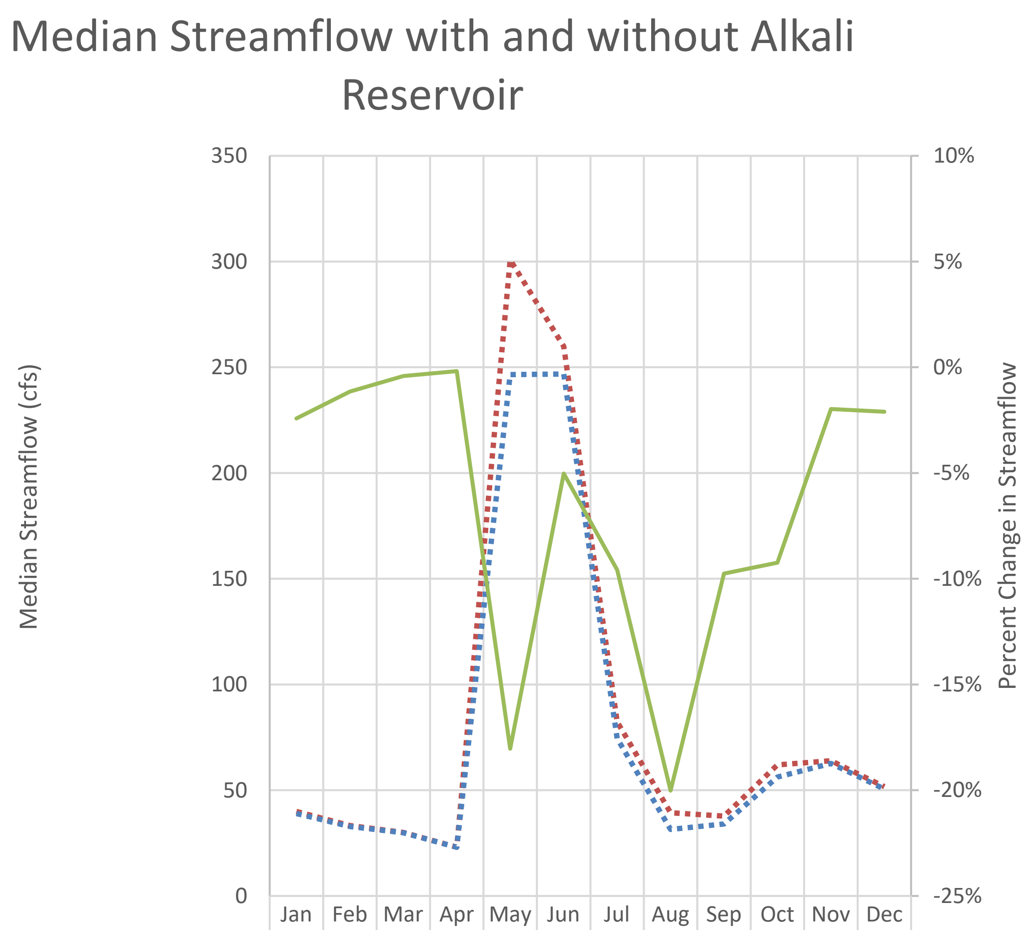
3) Alkali Creek downstream of Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	3	2	1	16	3	4	5	7	14	9	8	5
Dry Year - Proposed Action (with idle acres)	3	2	1	0	0	4	32	37	13	9	8	5
Percent Change	-2%	-3%	-1%	-98%	-88%	2%	533%	423%	-4%	-2%	-4%	-1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

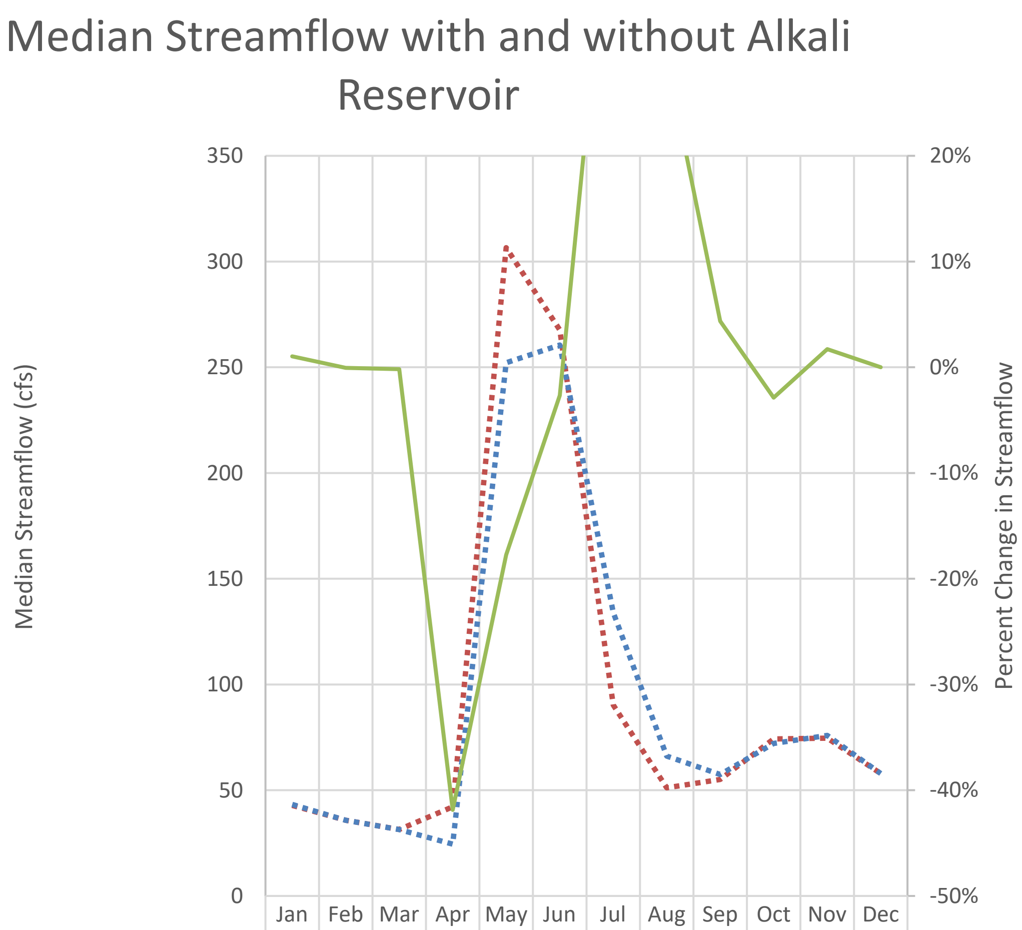
4A) Paint Rock Creek upstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	40	33	30	23	301	260	82	39	38	62	64	52
Dry Year - Proposed Action (with idle acres)	39	33	30	23	247	247	74	31	34	56	63	51
Percent Change	-2%	-1%	0%	0%	-18%	-5%	-10%	-20%	-10%	-9%	-2%	-2%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

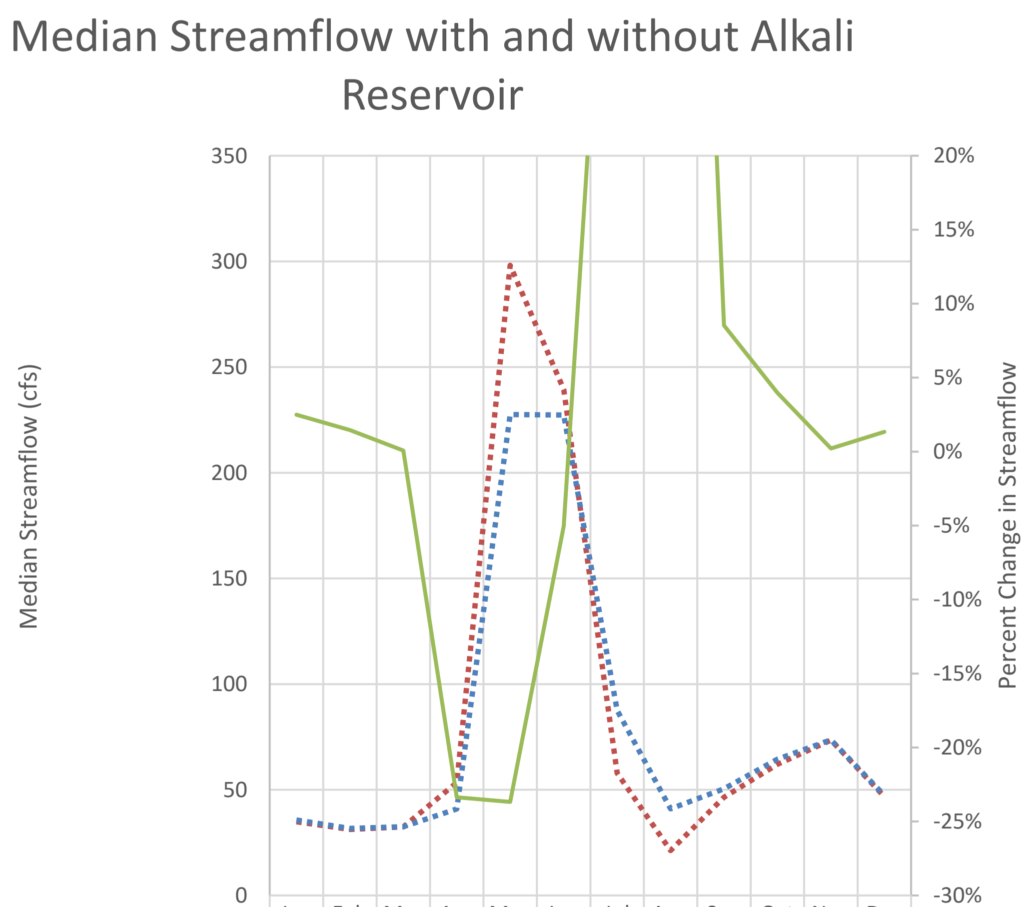
4B) Paint Rock Creek downstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	43	36	31	42	307	268	90	51	55	74	75	58
Dry Year - Proposed Action (with idle acres)	43	36	31	25	252	261	134	66	57	72	76	58
Percent Change	1%	0%	0%	-42%	-18%	-3%	49%	29%	4%	-3%	2%	0%

WENCK
Responsive partner.
Exceptional outcomes.

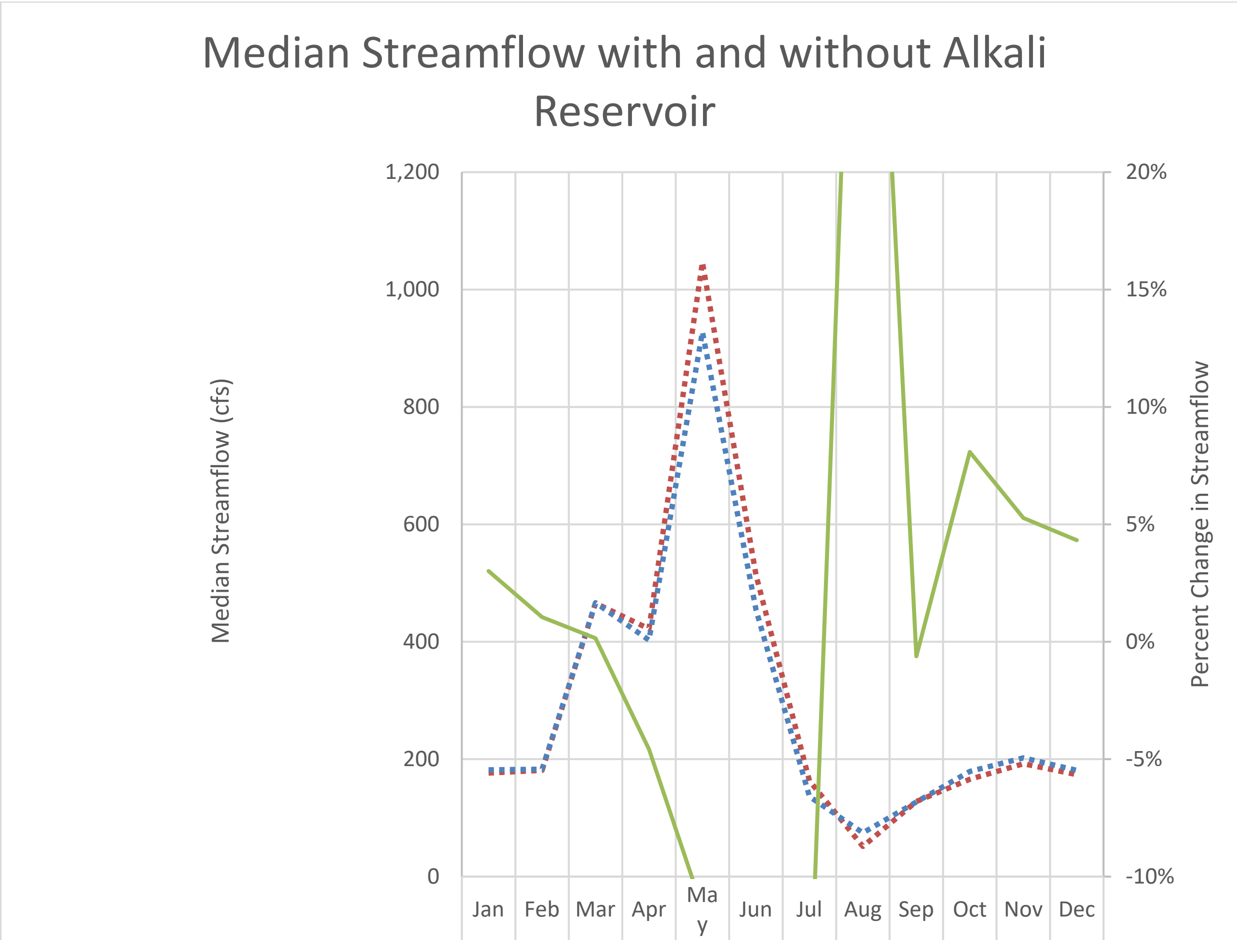
4C) Paint Rock Creek at the Confluence with the Nowood River



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	35	31	32	53	298	239	58	21	46	62	74	47
Dry Year - Proposed Action (with idle acres)	36	32	33	41	228	227	88	41	50	65	74	47
Percent Change	2%	1%	0%	-23%	-24%	-5%	51%	93%	9%	4%	0%	1%

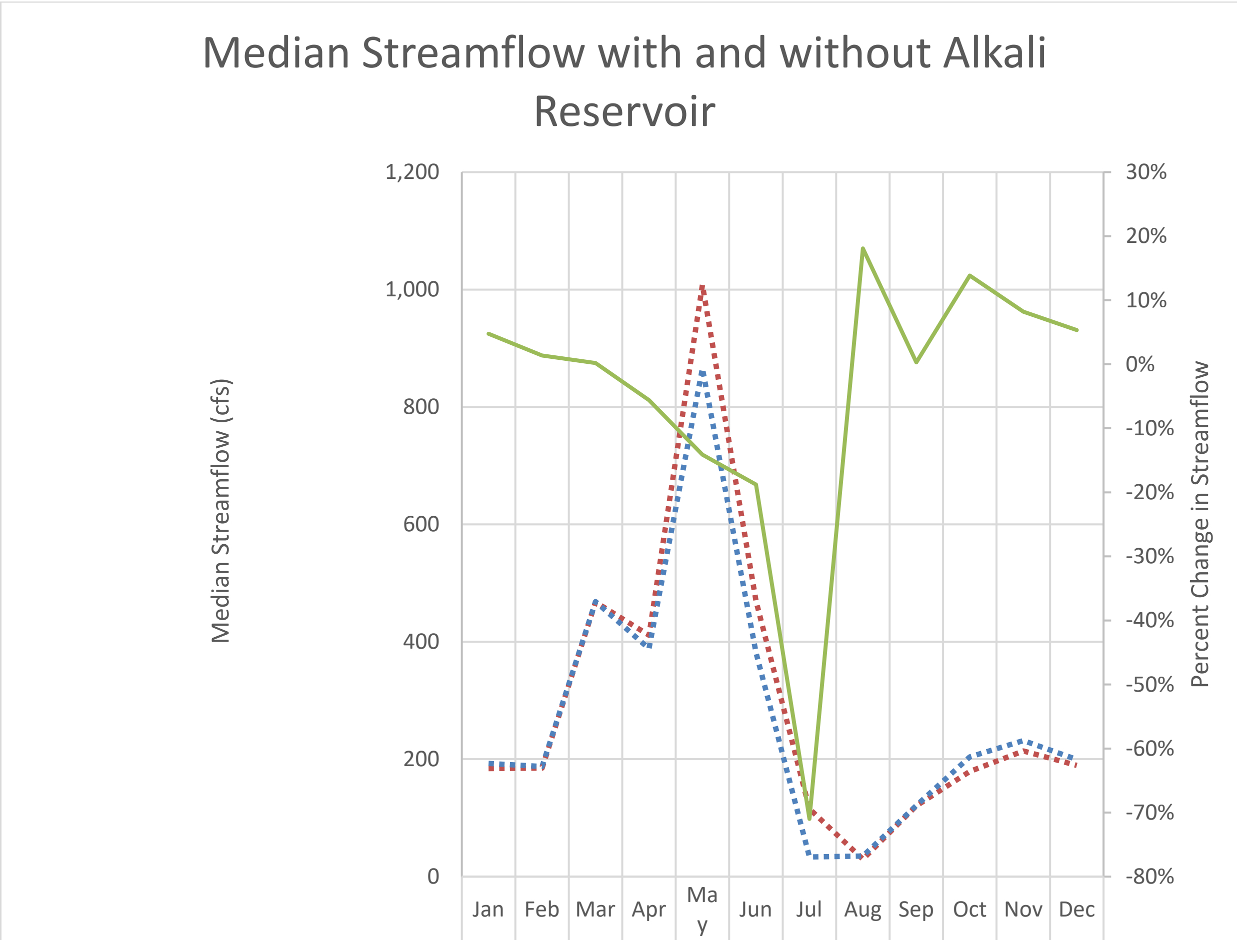
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

5) Nowood River below Paint Rock Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	177	181	466	422	1047	514	163	51	128	166	192	174
Dry Year - Proposed Action (with idle acres)	182	183	466	403	928	454	136	75	127	179	202	181
Percent Change	3%	1%	0%	-5%	-11%	-12%	-16%	45%	-1%	8%	5%	4%

6) Nowood River at Confluence with Bighorn River

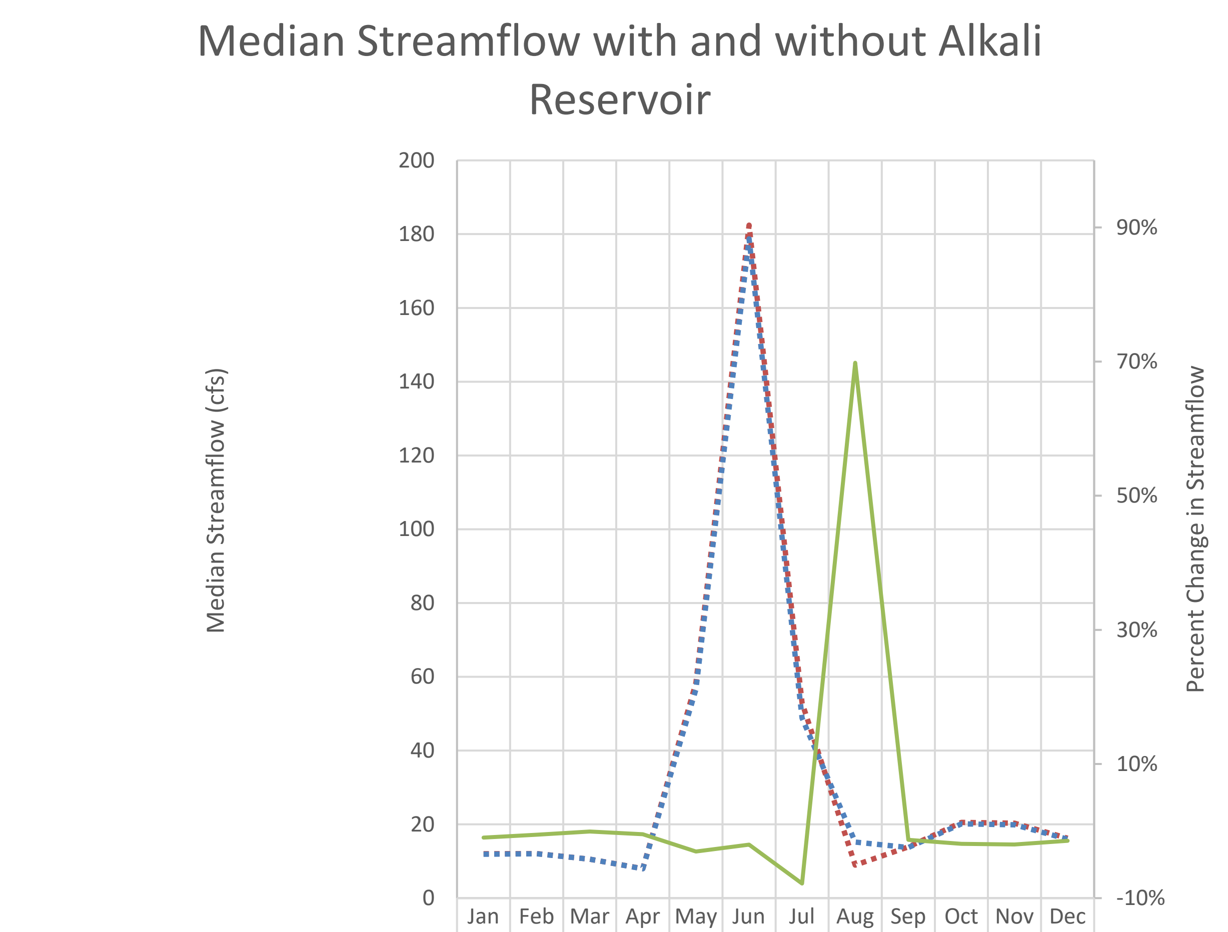


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	184	185	468	411	1008	470	115	30	121	179	214	189
Dry Year - Proposed Action (with idle acres)	193	187	468	388	866	381	33	35	121	204	232	200
Percent Change	5%	1%	0%	-6%	-14%	-19%	-71%	18%	0%	14%	8%	5%

Median Streamflow during a Wet Water Year

Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (with idle acres)

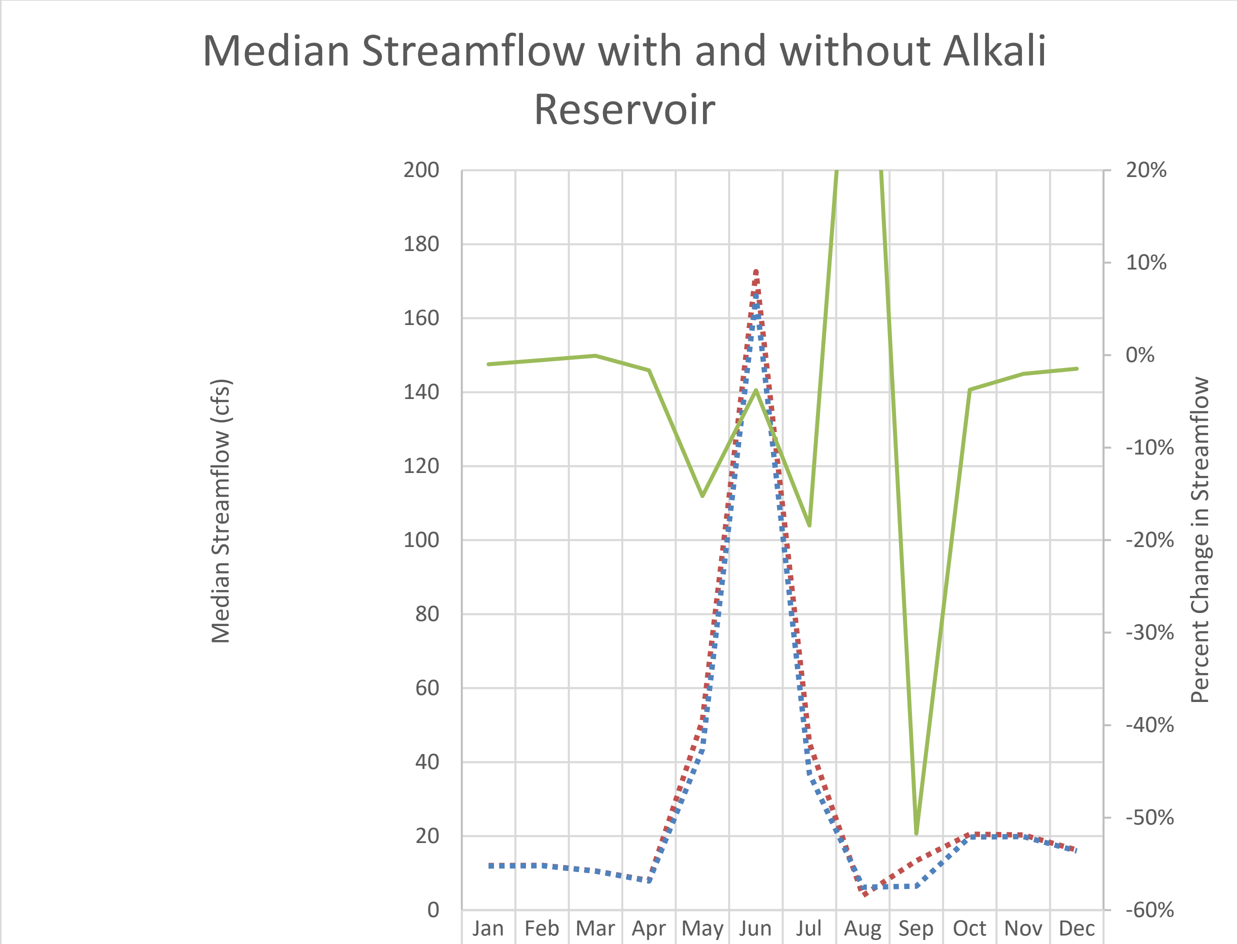
1A) Medicine Lodge Creek upstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	12	12	11	8	58	182	53	9	14	21	20	16
Wet Year - Proposed Action (with idle acres)	12	12	11	8	57	179	49	15	14	20	20	16
Percent Change	-1%	-1%	0%	0%	-3%	-2%	-8%	70%	-1%	-2%	-2%	-1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

1B) Medicine Lodge Creek downstream of Anita Ditch

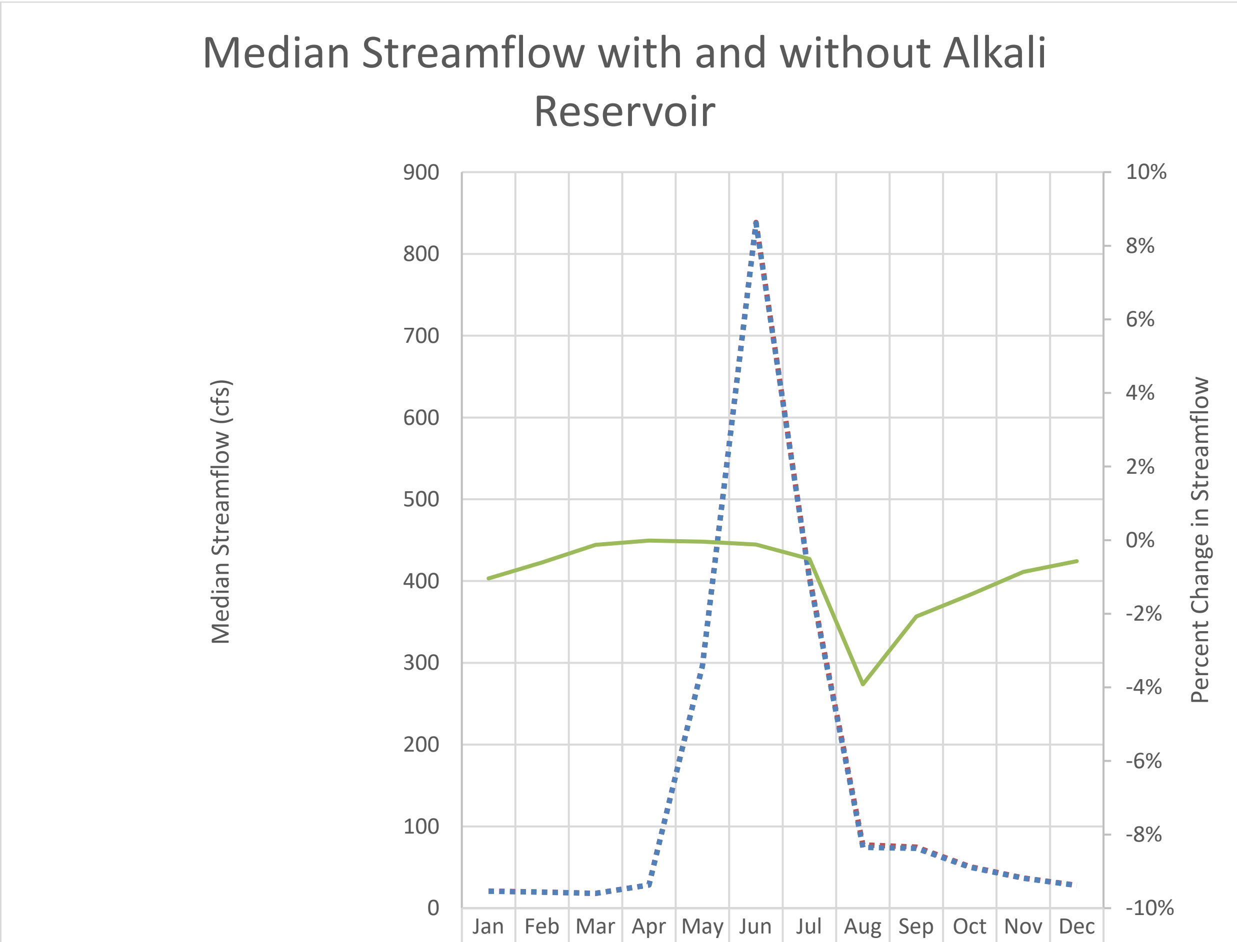


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	12	12	11	8	51	173	45	4	13	21	20	16
Wet Year - Proposed Action (with idle acres)	12	12	11	8	43	166	37	6	6	20	20	16
Percent Change	-1%	-1%	0%	-2%	-15%	-4%	-18%	57%	-52%	-4%	-2%	-1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

WENCK
Responsive partner.
Exceptional outcomes.

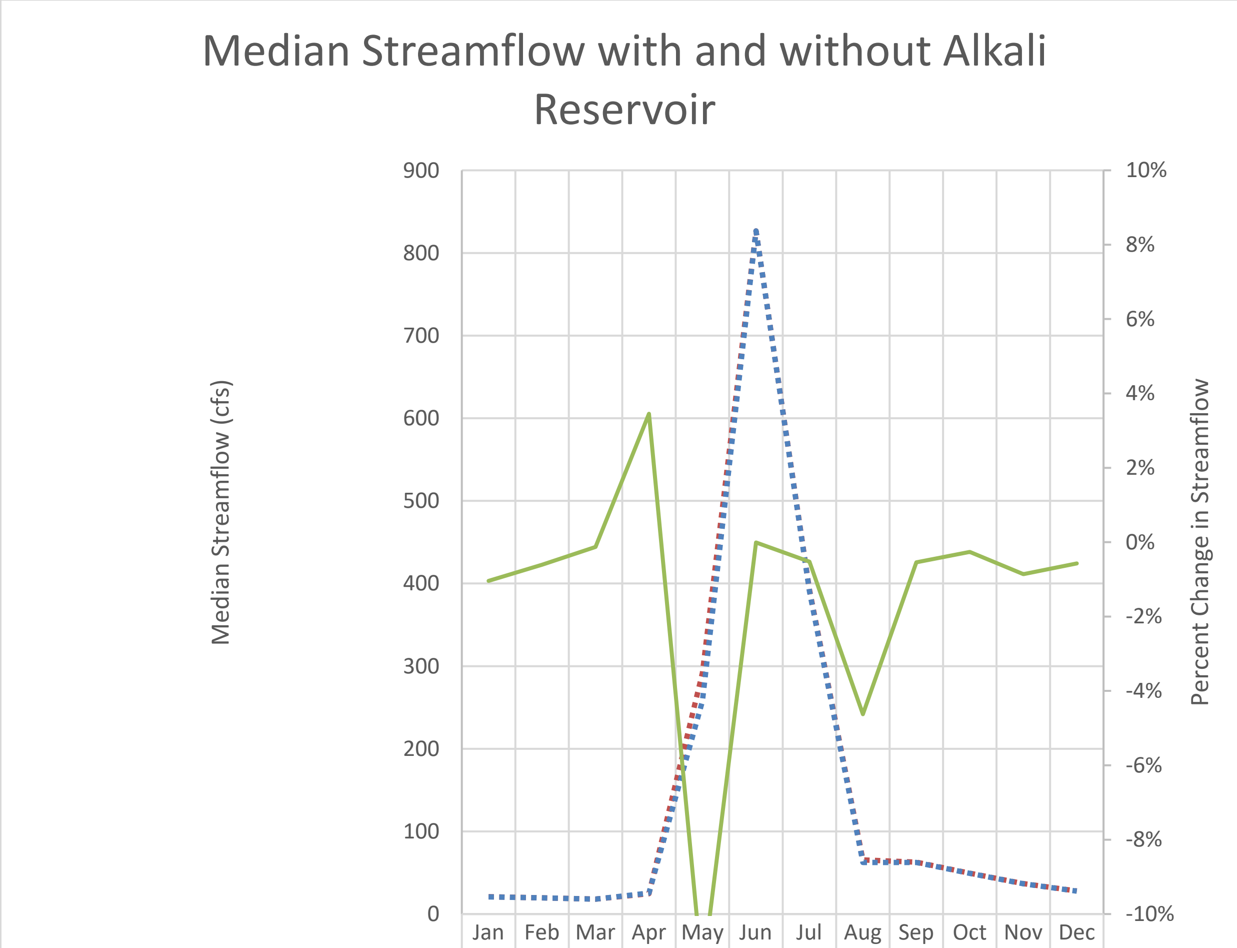
2A) Paint Rock Creek upstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	21	20	18	28	296	839	404	77	75	51	37	28
Wet Year - Proposed Action (with idle acres)	21	20	18	28	296	838	402	74	73	50	37	28
Percent Change	-1%	-1%	0%	0%	0%	0%	-1%	-4%	-2%	-1%	-1%	-1%

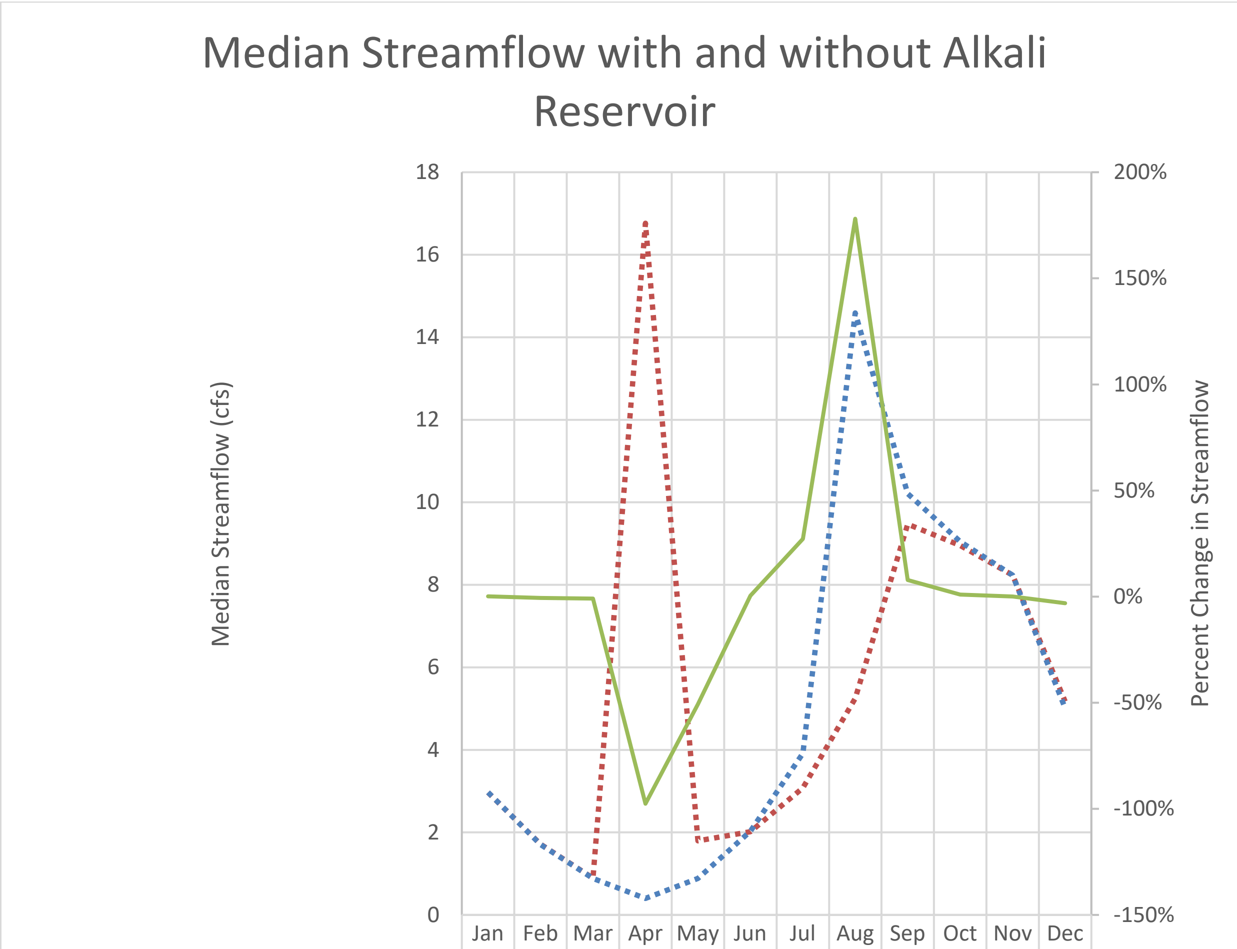
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

2B) Paint Rock Creek downstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	21	20	18	25	292	827	393	65	63	49	37	28
Wet Year - Proposed Action (with idle acres)	21	20	18	26	258	827	391	62	62	49	37	28
Percent Change	-1%	-1%	0%	3%	-12%	0%	-1%	-5%	-1%	0%	-1%	-1%

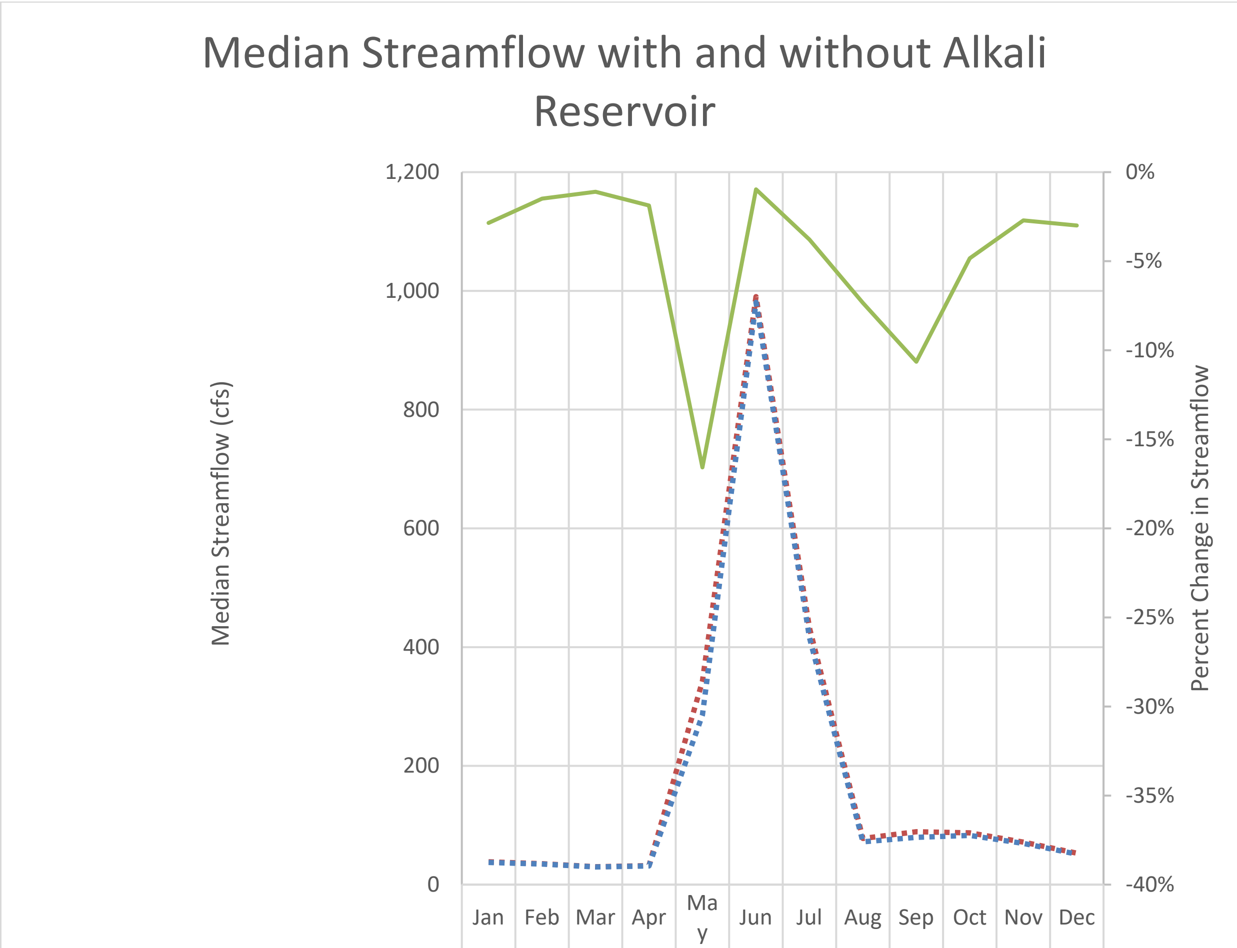
3) Alkali Creek downstream of Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	3	2	1	17	2	2	3	5	9	9	8	5
Wet Year - Proposed Action (with idle acres)	3	2	1	0	1	2	4	15	10	9	8	5
Percent Change	0%	-1%	-1%	-98%	-51%	0%	27%	178%	8%	1%	0%	-3%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

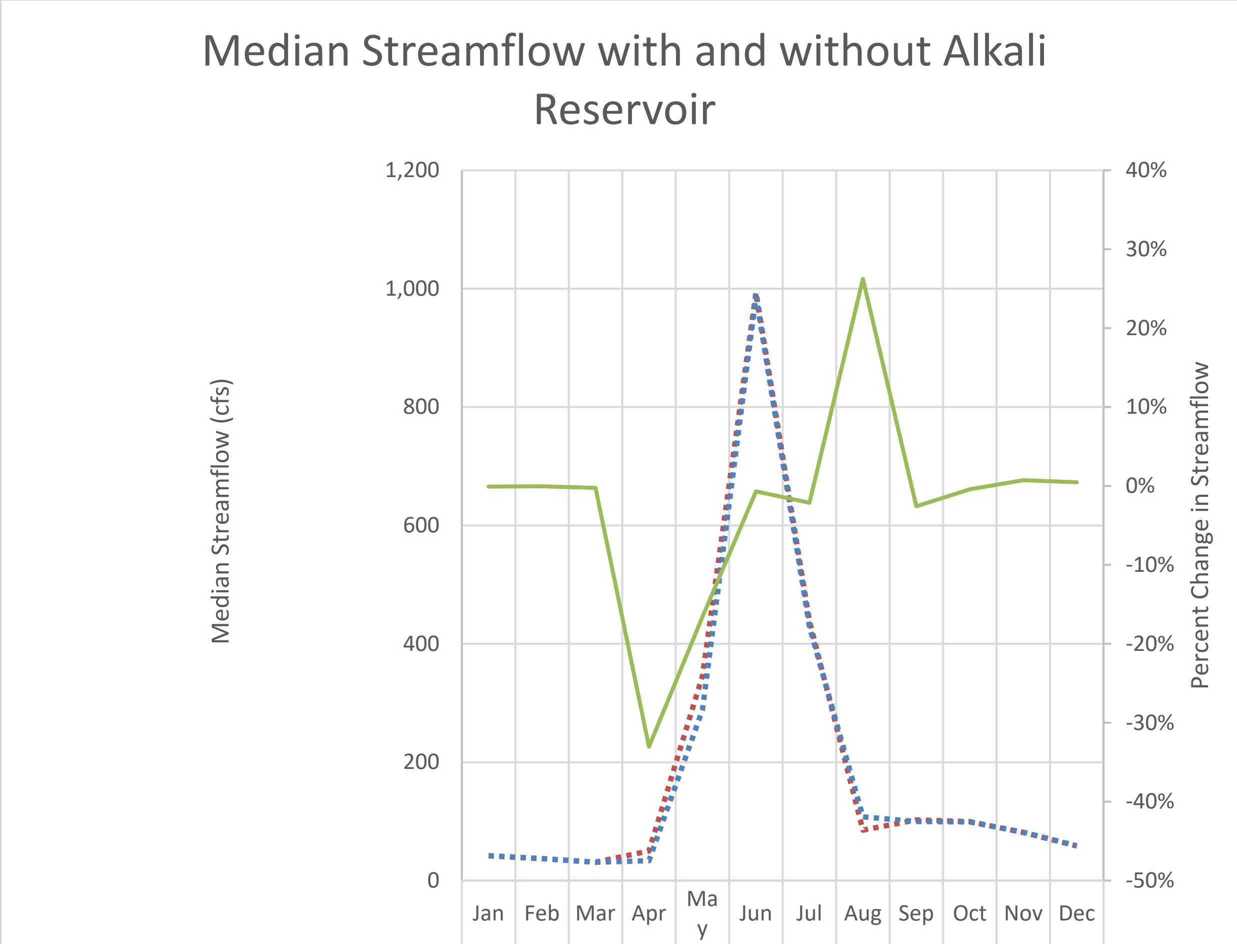
4A) Paint Rock Creek upstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	38	35	30	32	343	990	432	78	89	87	71	53
Wet Year - Proposed Action (with idle acres)	37	35	30	31	286	981	416	72	80	83	70	51
Percent Change	-3%	-1%	-1%	-2%	-17%	-1%	-4%	-7%	-11%	-5%	-3%	-3%

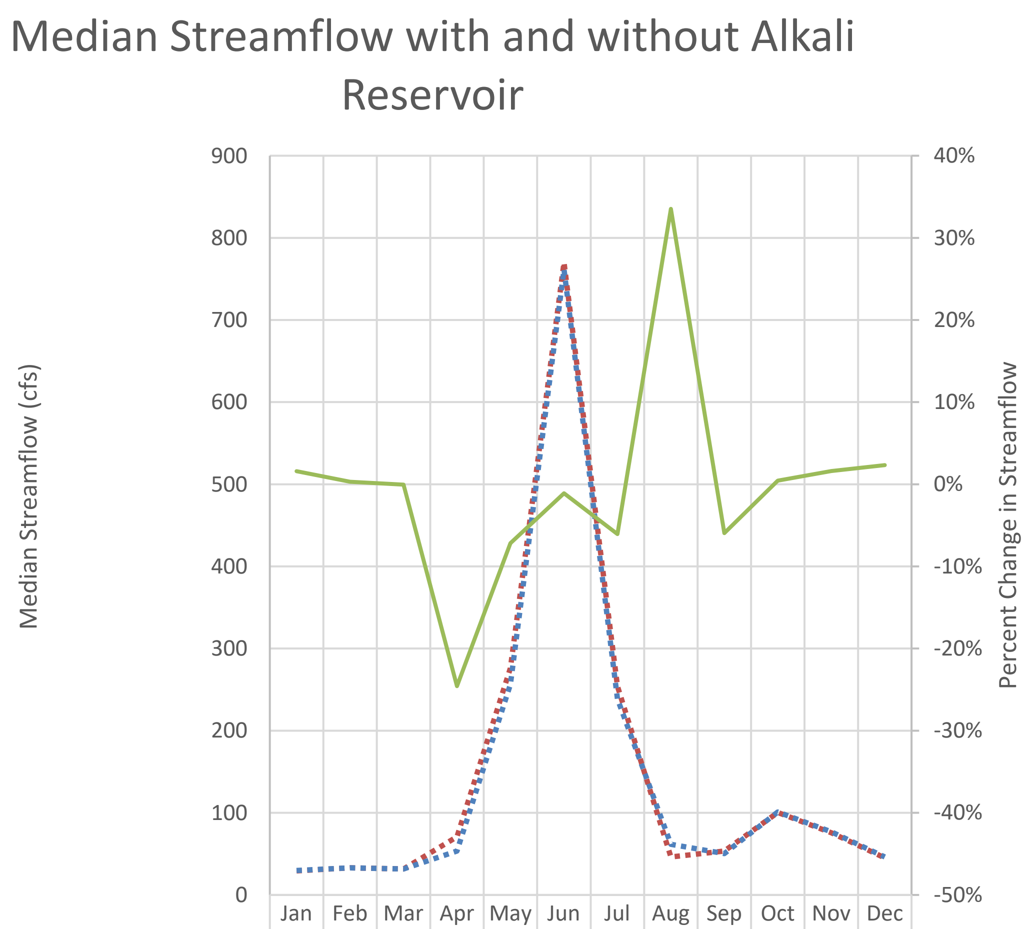
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

4B) Paint Rock Creek downstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	42	37	31	50	346	994	438	85	103	100	81	58
Wet Year - Proposed Action (with idle acres)	42	37	31	34	288	987	429	108	100	99	82	59
Percent Change	0%	0%	0%	-33%	-17%	-1%	-2%	26%	-3%	0%	1%	0%

4C) Paint Rock Creek at the Confluence with the Nowood River

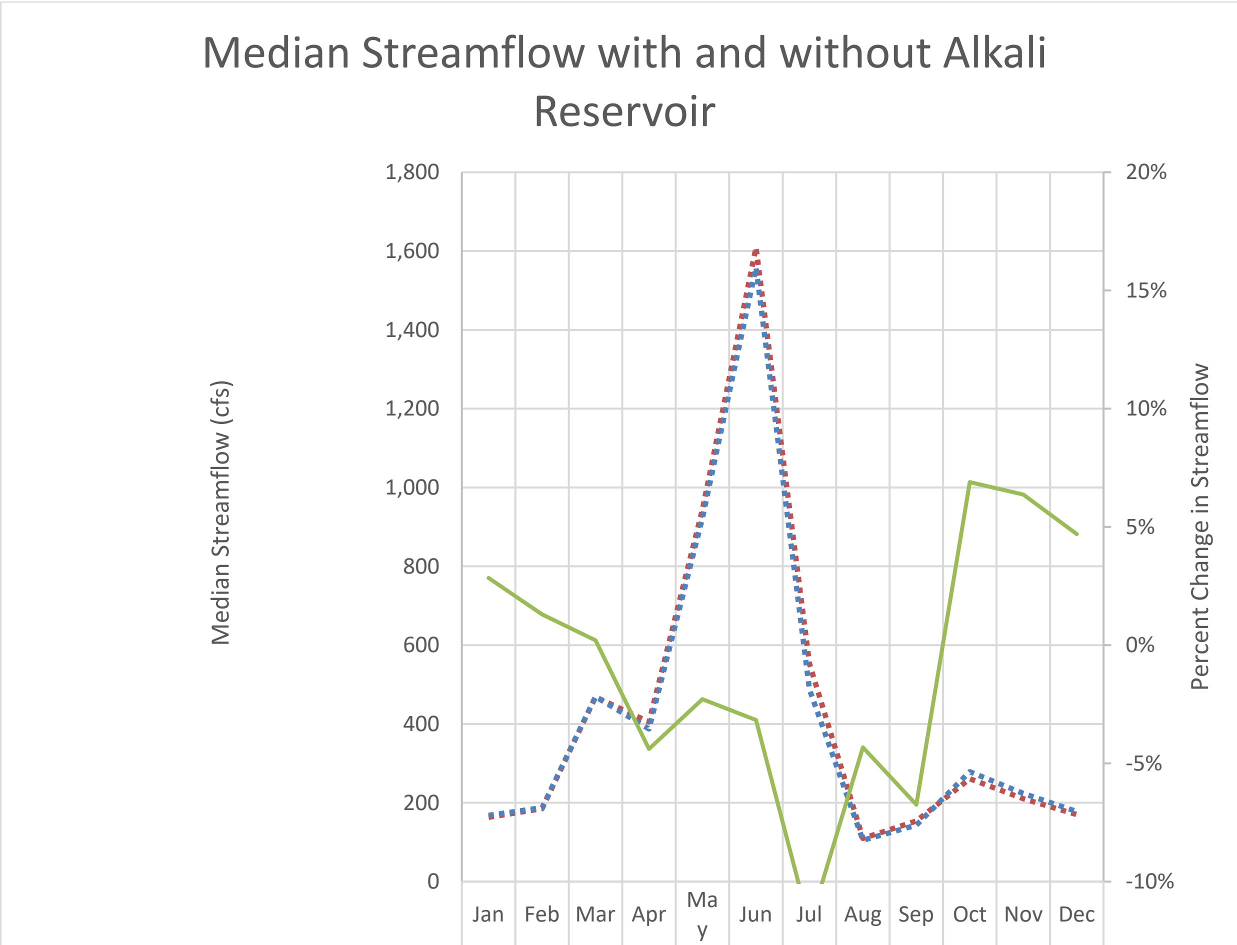


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	29	33	32	71	276	770	254	46	54	100	76	45
Wet Year - Proposed Action (with idle acres)	30	33	32	53	256	762	239	62	50	101	77	46
Percent Change	2%	0%	0%	-25%	-7%	-1%	-6%	34%	-6%	0%	2%	2%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

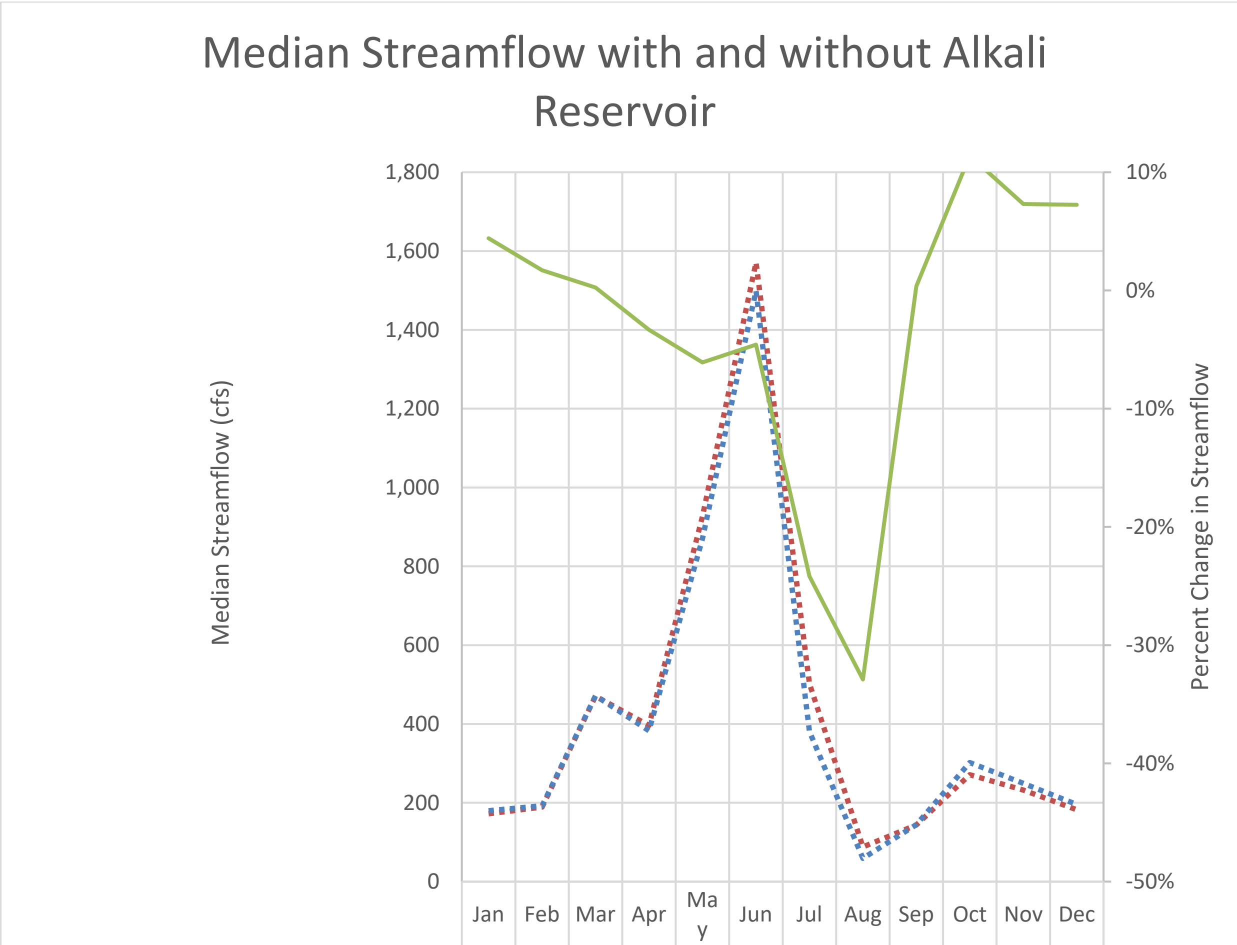
WENCK
Responsive partner.
Exceptional outcomes.

5) Nowood River below Paint Rock Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	163	185	468	405	944	1609	553	110	154	261	210	170
Wet Year - Proposed Action (with idle acres)	168	187	469	387	922	1558	488	105	143	279	224	178
Percent Change	3%	1%	0%	-4%	-2%	-3%	-12%	-4%	-7%	7%	6%	5%

6) Nowood River at Confluence with Bighorn River

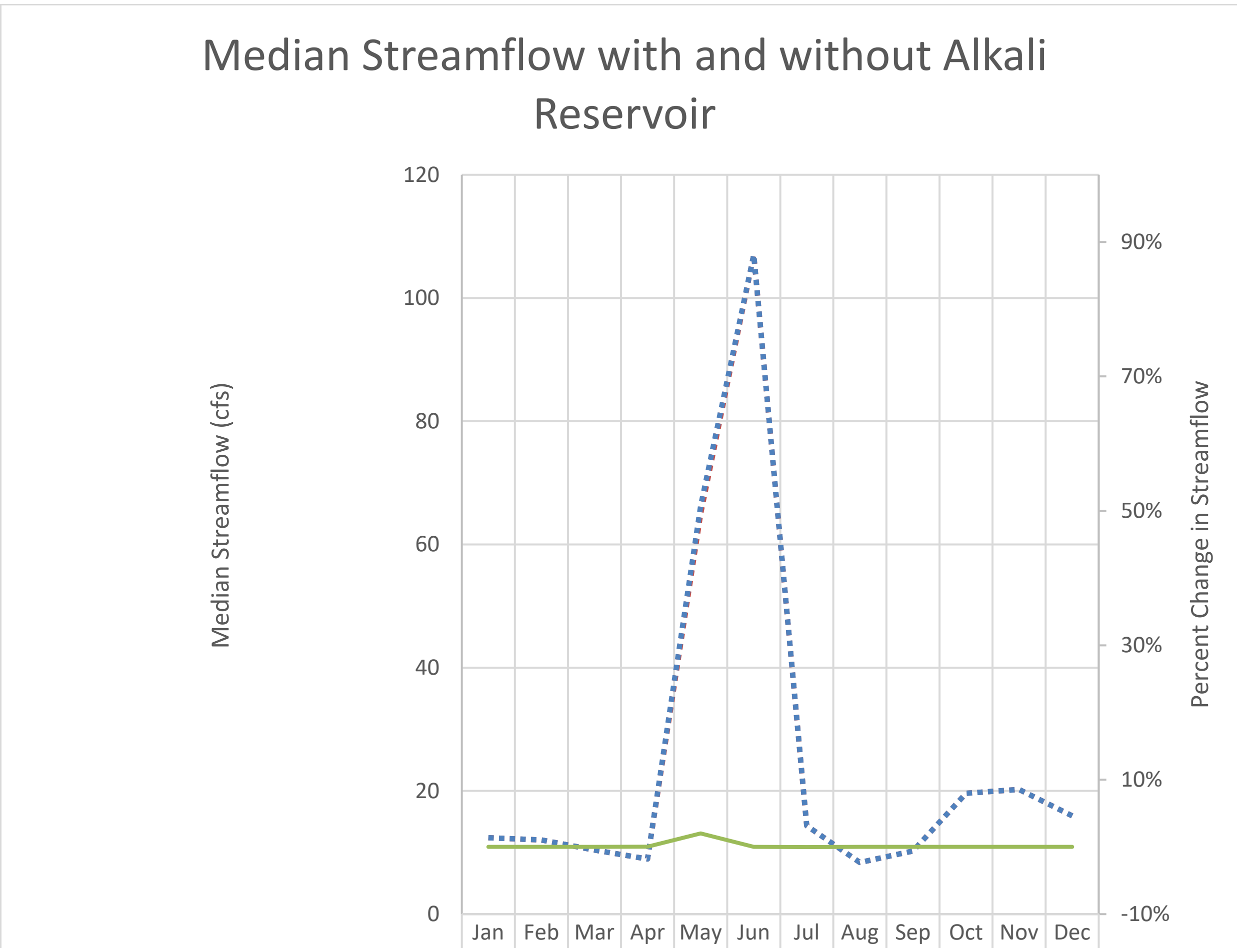


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	172	189	471	396	926	1571	502	88	144	271	232	182
Wet Year - Proposed Action (with idle acres)	180	192	472	383	870	1499	381	59	144	302	249	196
Percent Change	4%	2%	0%	-3%	-6%	-5%	-24%	-33%	0%	11%	7%	7%

Median Streamflow During a Normal Water Year

Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (without idle acres)

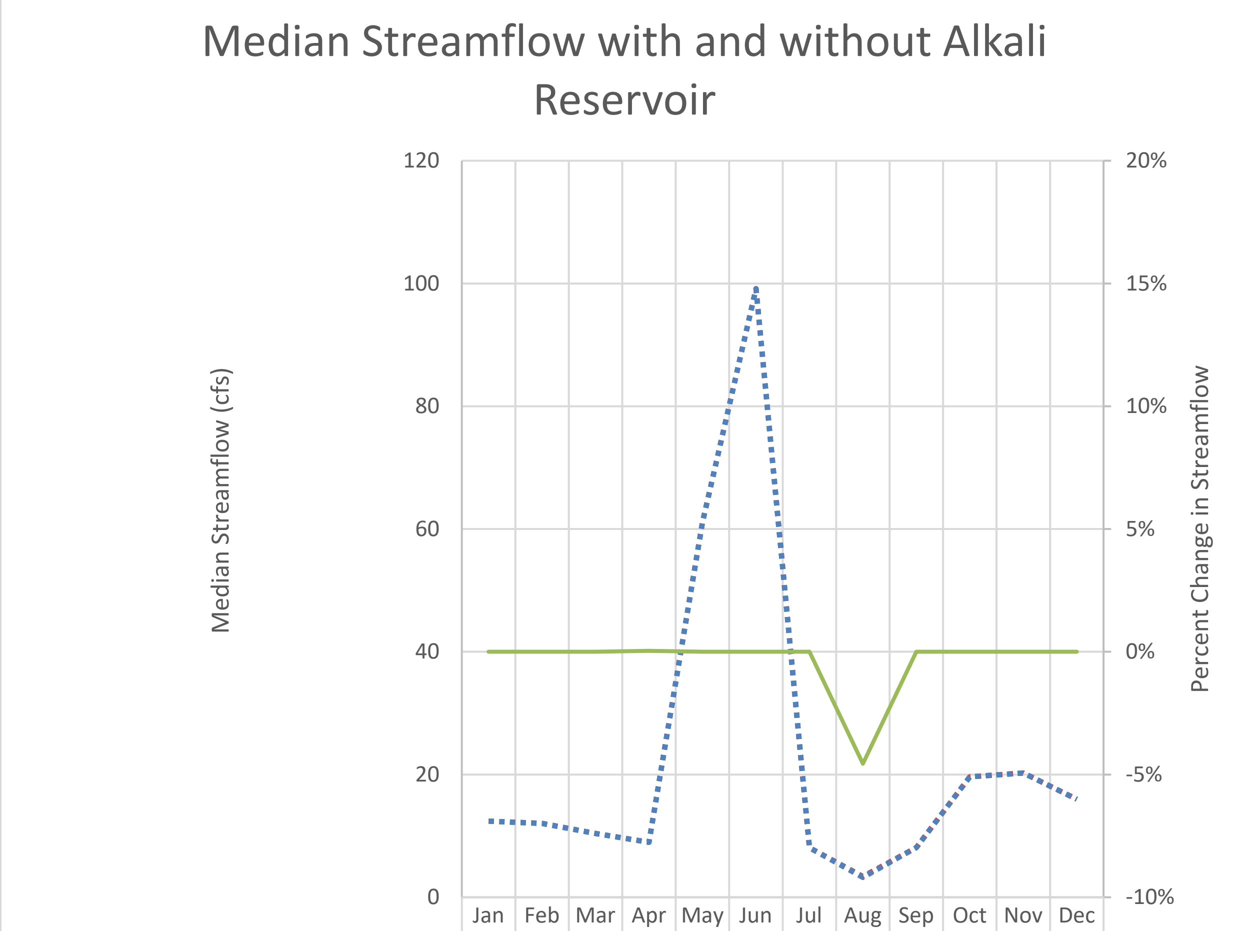
1A) Medicine Lodge Creek upstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	12	12	10	9	65	107	14	8	10	20	20	16
Normal Year - Proposed Action (without idle acres)	12	12	10	9	66	107	14	8	10	20	20	16
Percent Change	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%

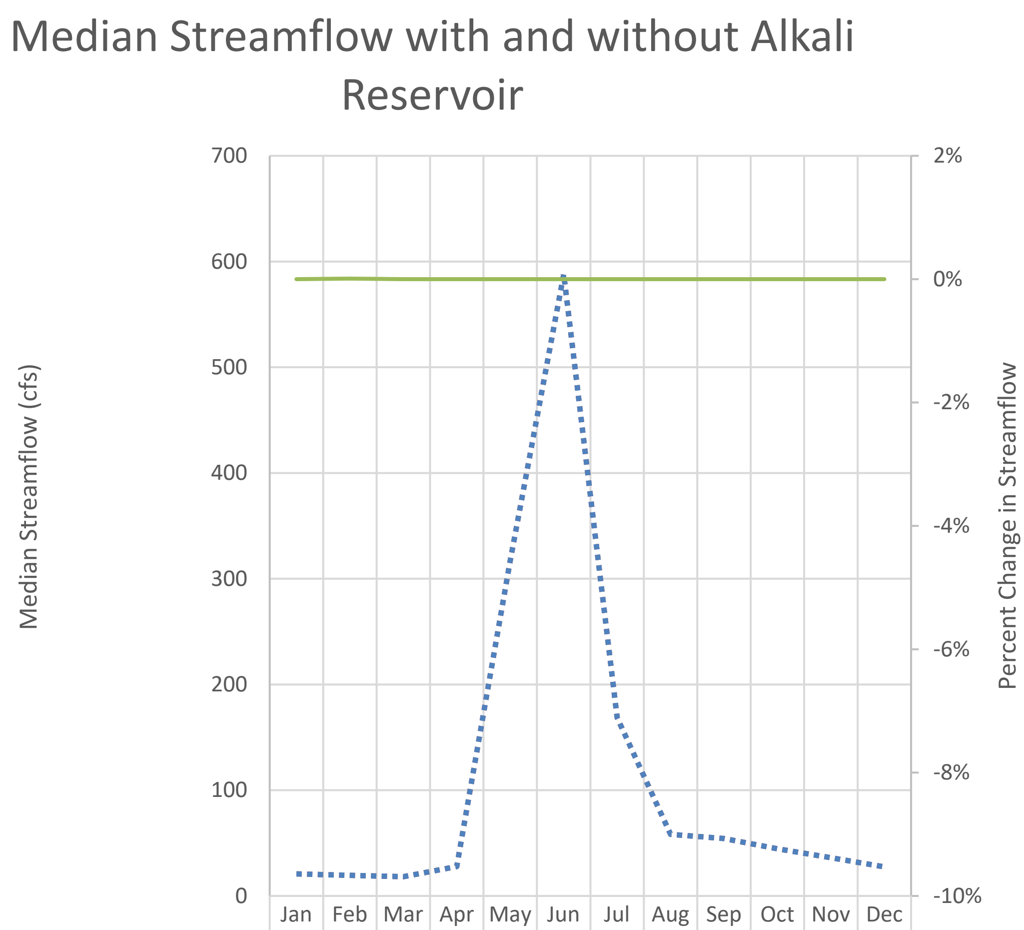
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

1B) Medicine Lodge Creek downstream of Anita Ditch



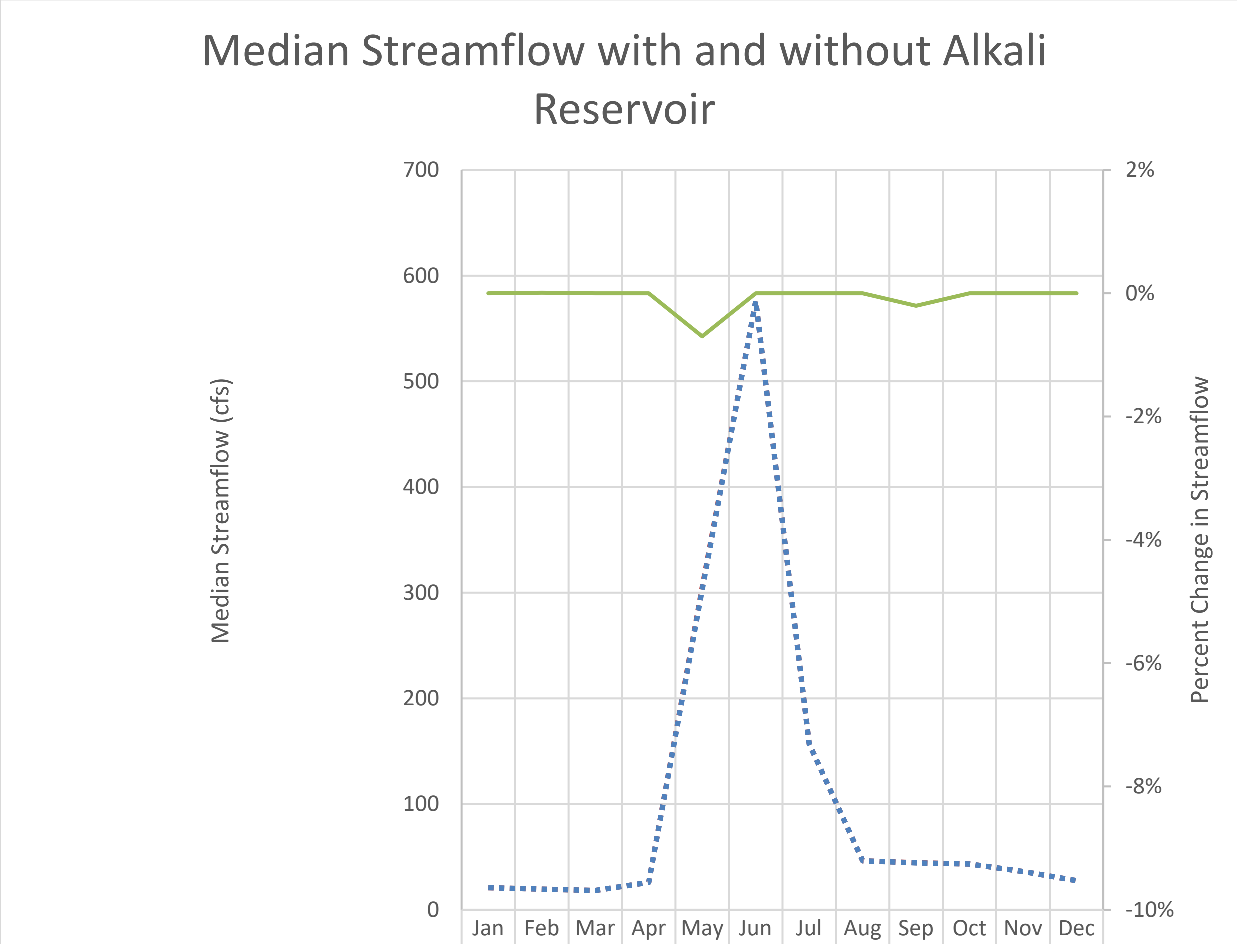
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	12	12	10	9	61	99	8	3	8	20	20	16
Normal Year - Proposed Action (without idle acres)	12	12	10	9	61	99	8	3	8	20	20	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	-5%	0%	0%	0%	0%

2A) Paint Rock Creek upstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	21	19	18	28	317	588	169	58	54	45	36	28
Normal Year - Proposed Action (without idle acres)	21	19	18	28	317	588	169	58	54	45	36	28
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

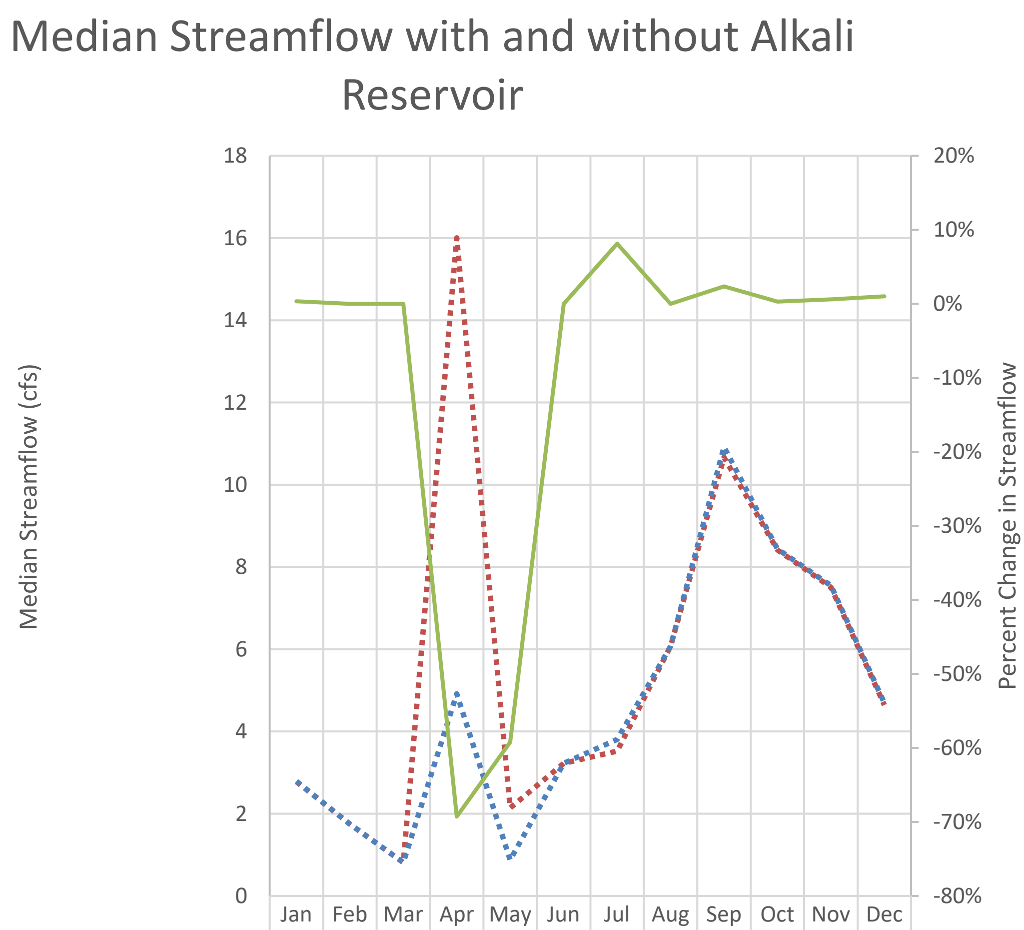
2B) Paint Rock Creek downstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	21	19	18	26	305	576	157	46	44	43	36	28
Normal Year - Proposed Action (without idle acres)	21	19	18	26	303	576	157	46	44	43	36	28
Percent Change	0%	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

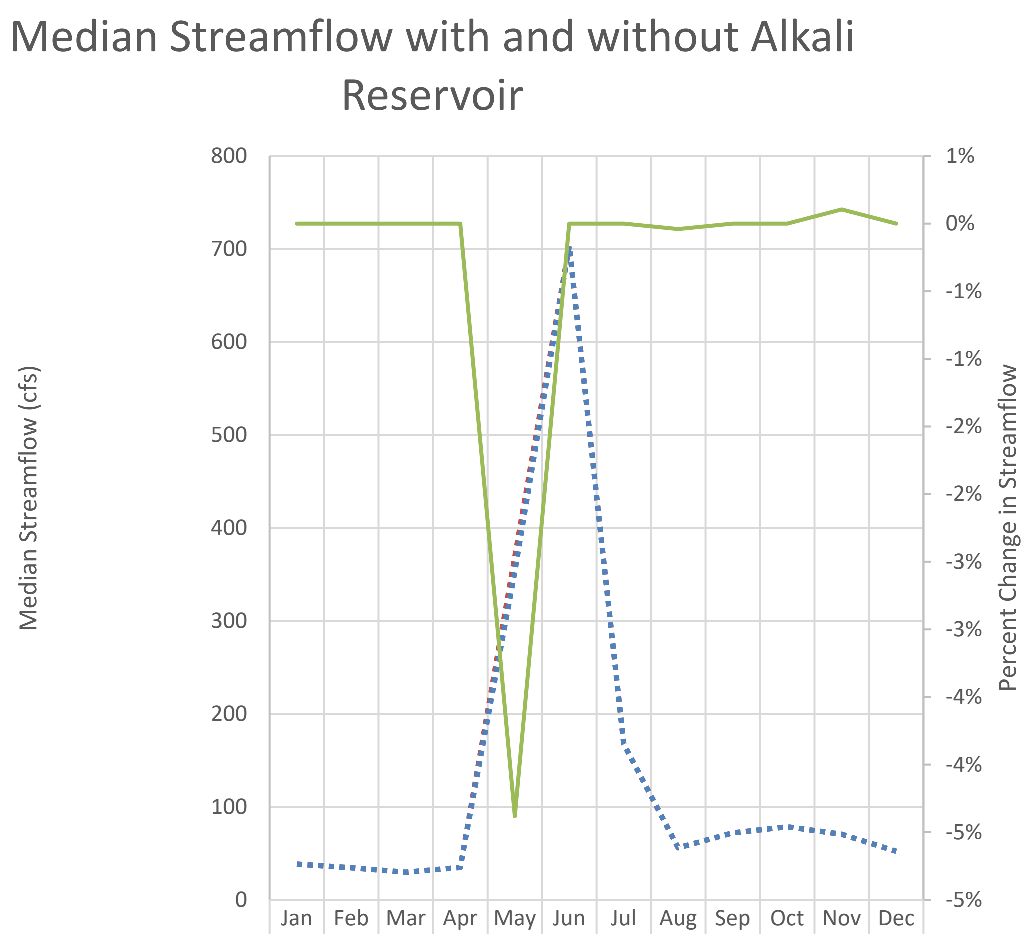
3) Alkali Creek downstream of Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	3	2	1	16	2	3	4	6	11	8	8	5
Normal Year - Proposed Action (without idle acres)	3	2	1	5	1	3	4	6	11	8	8	5
Percent Change	0%	0%	0%	-69%	-59%	0%	8%	0%	2%	0%	1%	1%

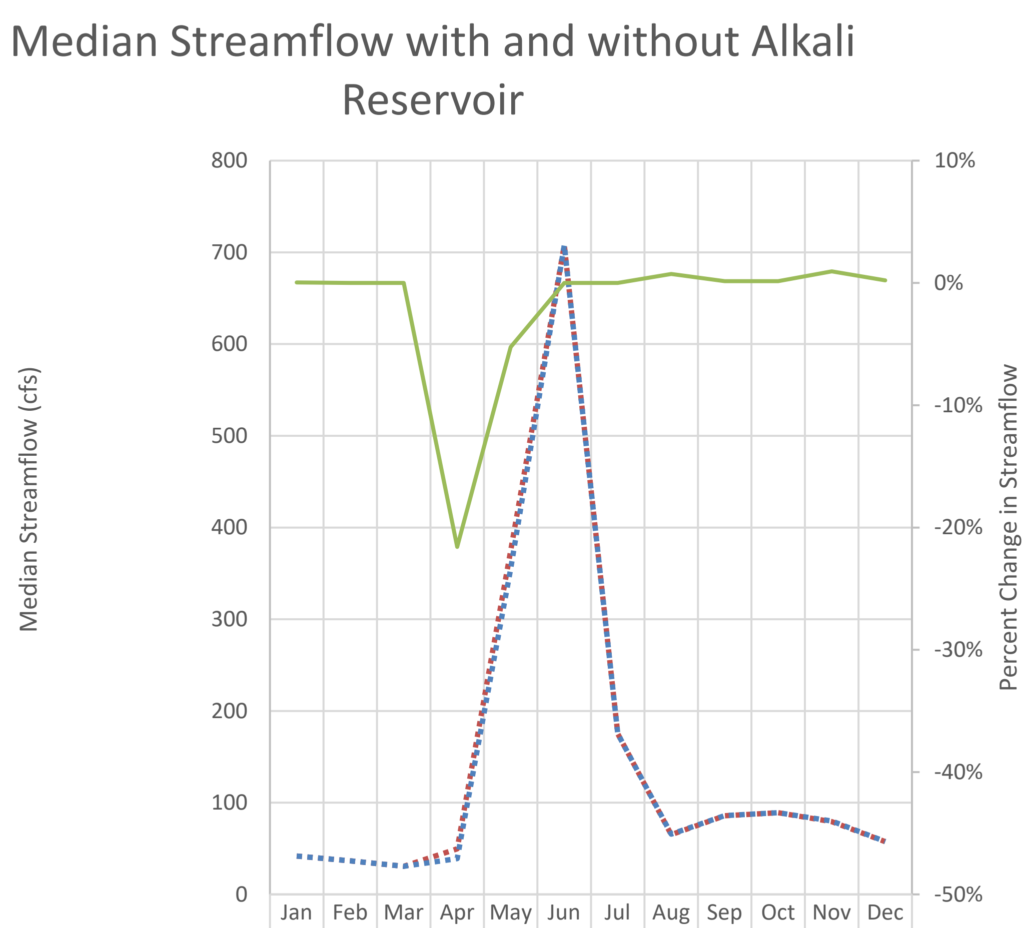
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

4A) Paint Rock Creek upstream of Alkali Creek confluence



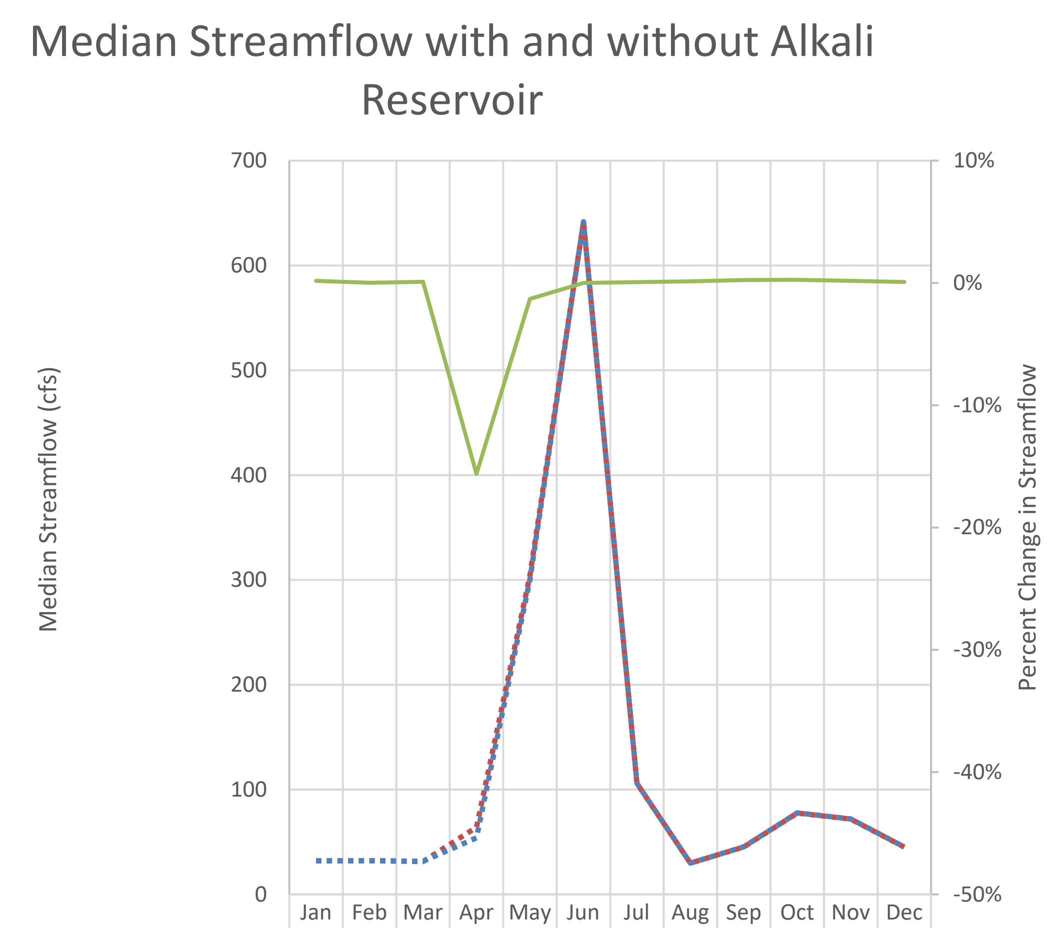
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	38	34	30	35	369	703	168	56	72	79	71	52
Normal Year - Proposed Action (without idle acres)	38	34	30	35	353	703	168	56	72	79	71	52
Percent Change	0%	0%	0%	0%	-4%	0%	0%	0%	0%	0%	0%	0%

4B) Paint Rock Creek downstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	42	37	31	50	375	708	175	65	86	89	79	57
Normal Year - Proposed Action (without idle acres)	42	37	31	39	355	708	175	66	86	89	80	58
Percent Change	0%	0%	0%	-22%	-5%	0%	0%	1%	0%	0%	1%	0%

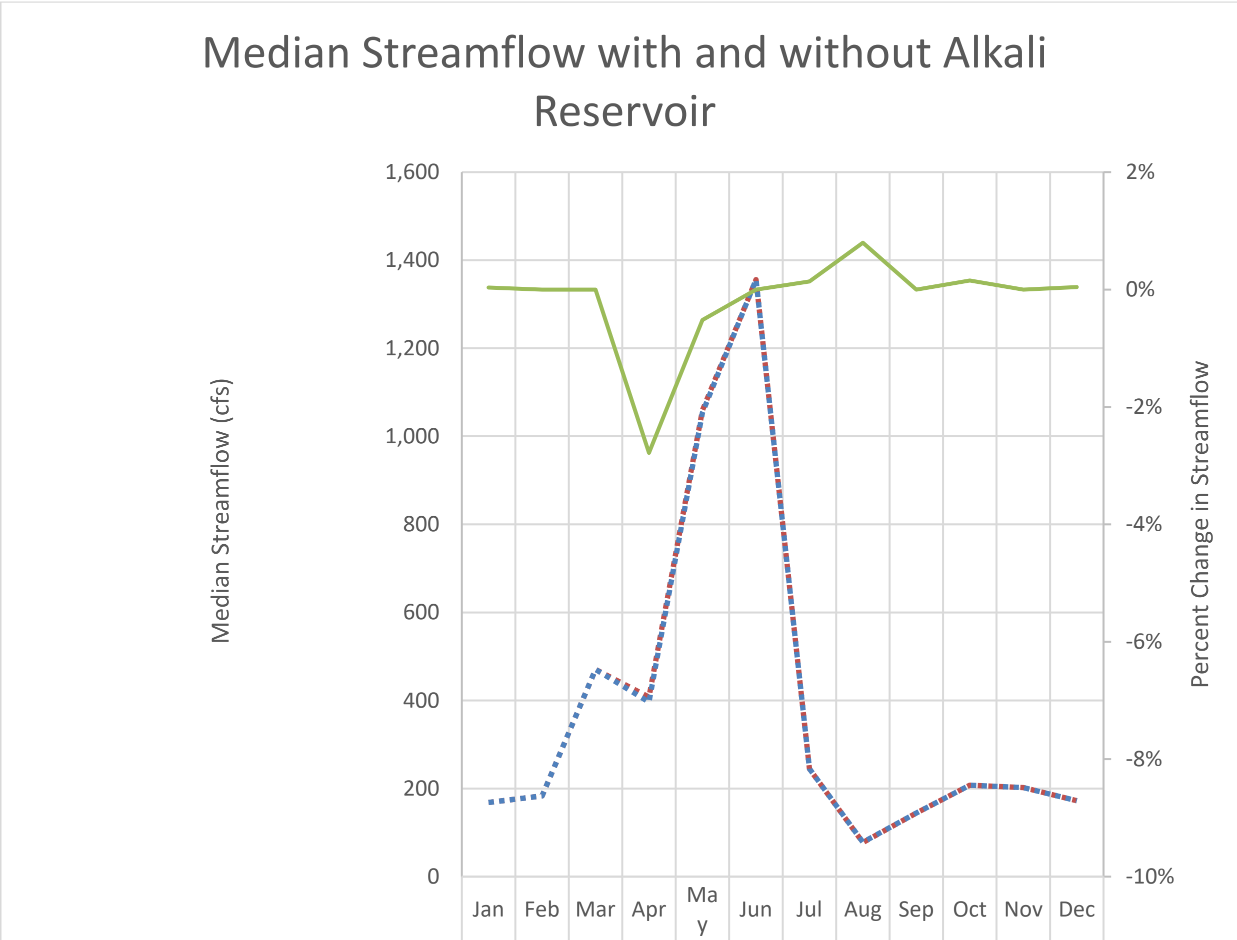
4C) Paint Rock Creek at the Confluence with the Nowood River



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	32	32	31	64	304	642	106	30	45	78	72	45
Normal Year - Proposed Action (without idle acres)	32	32	31	54	300	642	106	30	45	78	72	45
Percent Change	0%	0%	0%	-16%	-1%	0%	0%	0%	0%	0%	0%	0%

WENCK
Responsive partner.
Exceptional outcomes.

5) Nowood River below Paint Rock Creek confluence

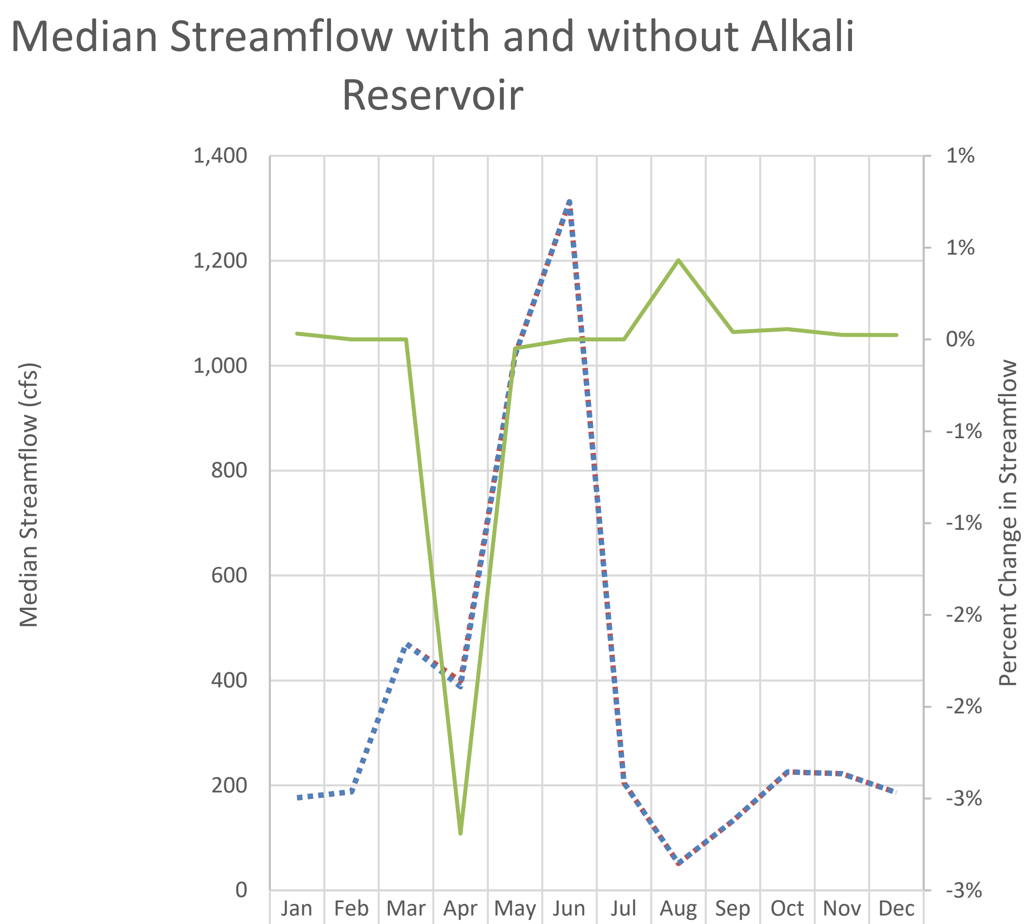


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	168	183	470	408	1059	1356	245	77	145	207	202	172
Normal Year - Proposed Action (without idle acres)	169	183	470	396	1053	1356	245	78	145	208	202	172
Percent Change	0%	0%	0%	-3%	-1%	0%	0%	1%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

Responsive partner.
Exceptional outcomes.

6) Nowood River at Confluence with Bighorn River

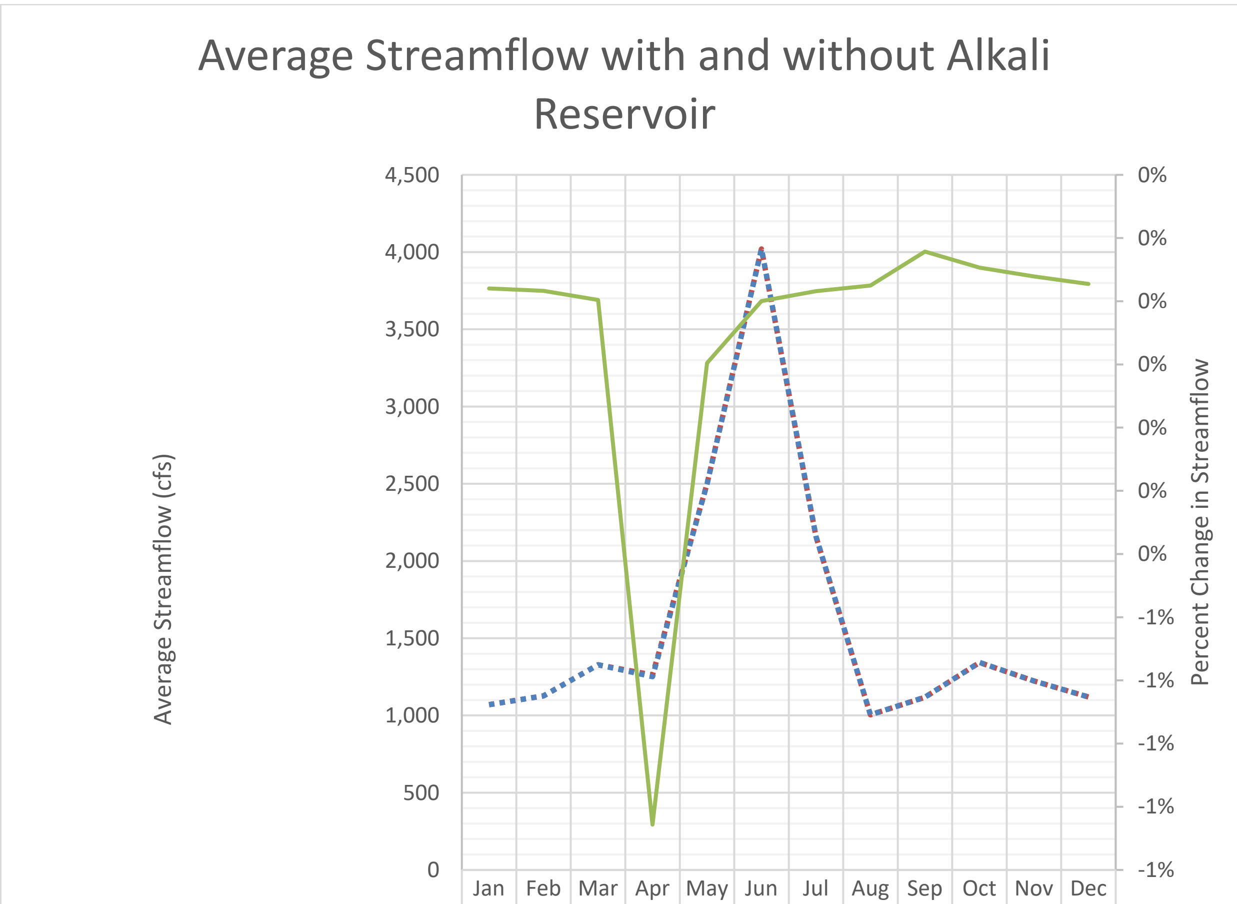


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	176	188	470	399	1020	1312	205	51	133	226	222	186
Normal Year - Proposed Action (without idle acres)	176	188	470	388	1020	1312	205	51	133	226	222	186
Percent Change	0%	0%	0%	-3%	0%	0%	0%	0%	0%	0%	0%	0%

Average Streamflow

Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (without idle acres)

7) Bighorn River below Confluence with Nowood River

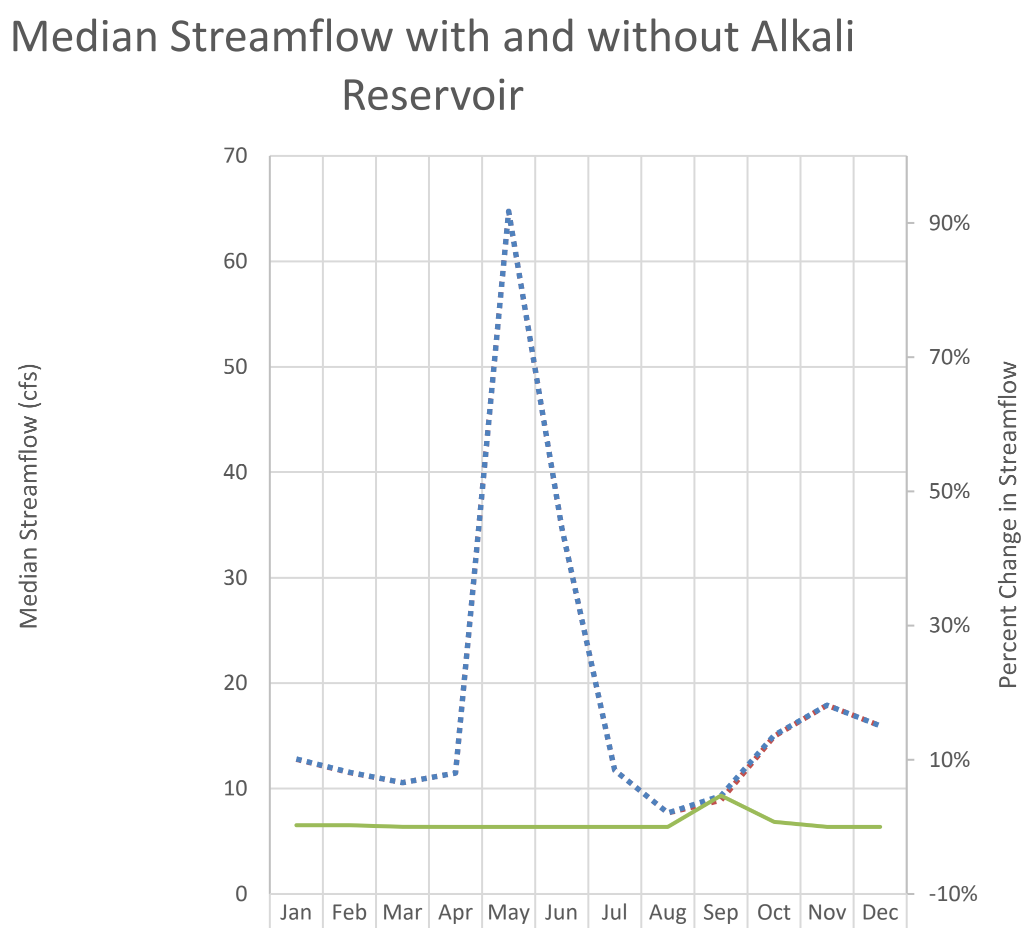


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	1,070	1,127	1,328	1,262	2,501	4,020	2,158	1,004	1,118	1,342	1,223	1,120
Normal Year - Proposed Action (without idle acres)	1,070	1,127	1,328	1,252	2,498	4,020	2,158	1,004	1,119	1,343	1,223	1,120
Percent Change	0%	0%	0%	-1%	0%	0%	0%	0%	0%	0%	0%	0%

Median Streamflow During a Dry Water Year

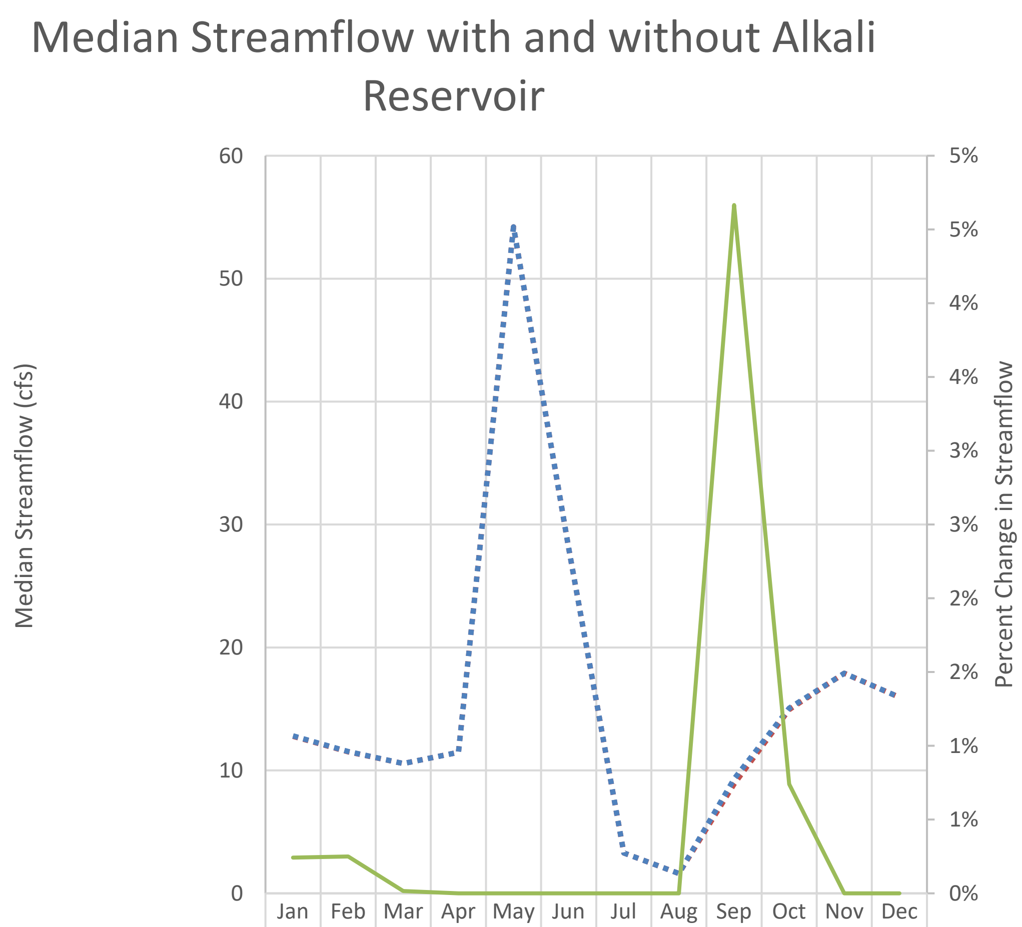
Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (without idle acres)

1A) Medicine Lodge Creek upstream of Anita Ditch



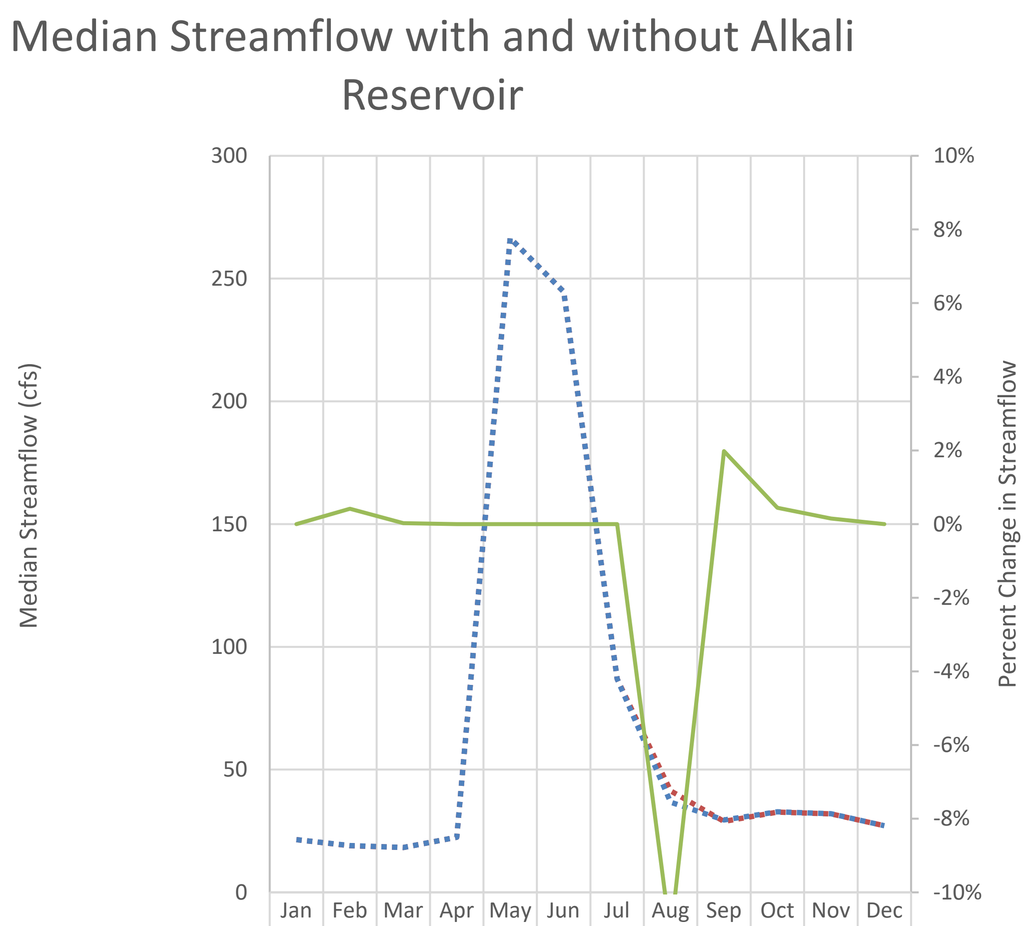
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	13	12	11	11	65	35	12	8	9	15	18	16
Dry Year - Proposed Action (without idle acres)	13	12	11	11	65	35	12	8	9	15	18	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	5%	1%	0%	0%

1B) Medicine Lodge Creek downstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	13	12	11	11	54	28	3	2	9	15	18	16
Dry Year - Proposed Action (without idle acres)	13	12	11	11	54	28	3	2	9	15	18	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	5%	1%	0%	0%

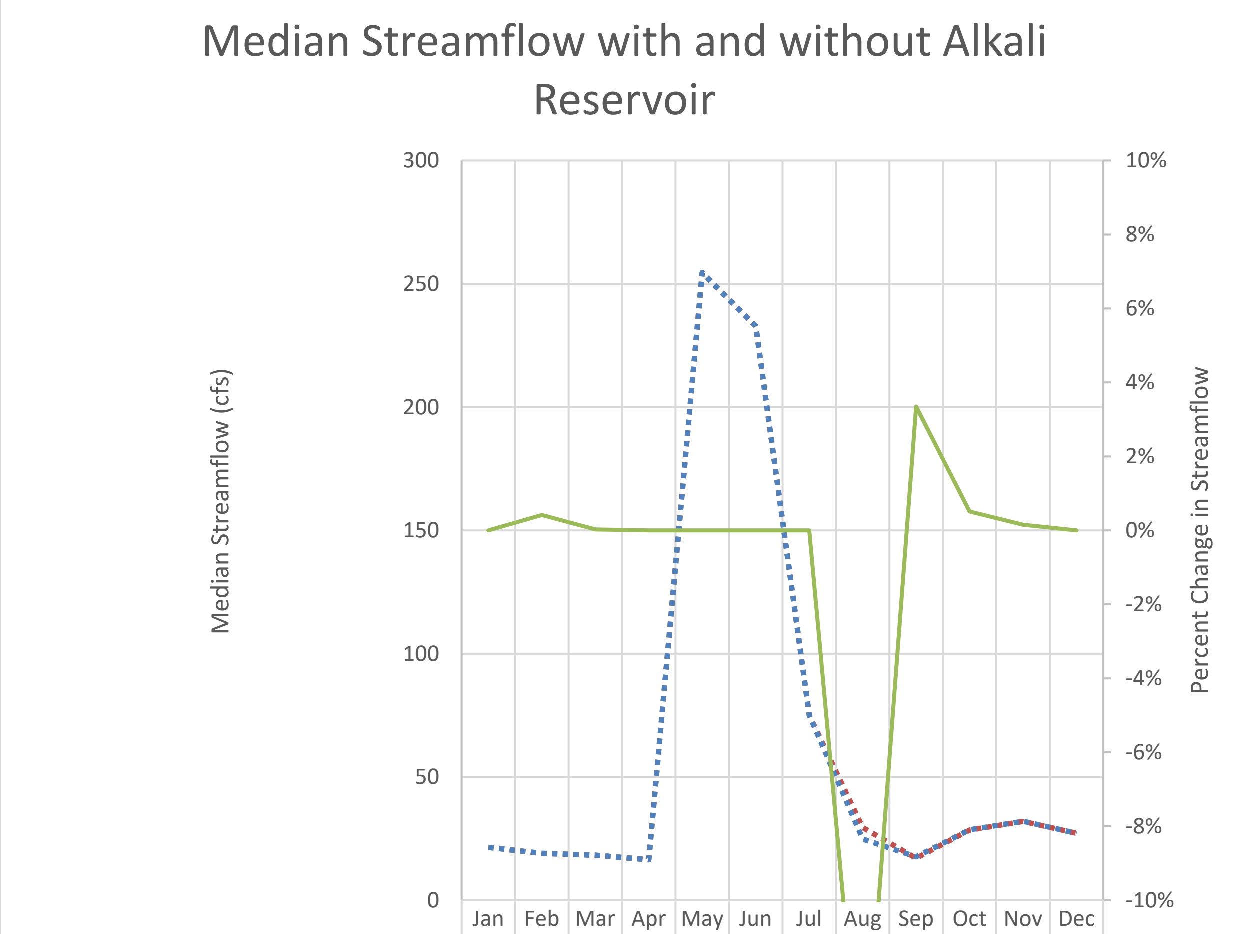
2A) Paint Rock Creek upstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	21	19	18	22	266	245	87	41	29	33	32	27
Dry Year - Proposed Action (without idle acres)	21	19	18	22	266	245	87	37	30	33	32	27
Percent Change	0%	0%	0%	0%	0%	0%	0%	-11%	2%	0%	0%	0%

WENCK
Responsive partner.
Exceptional outcomes.

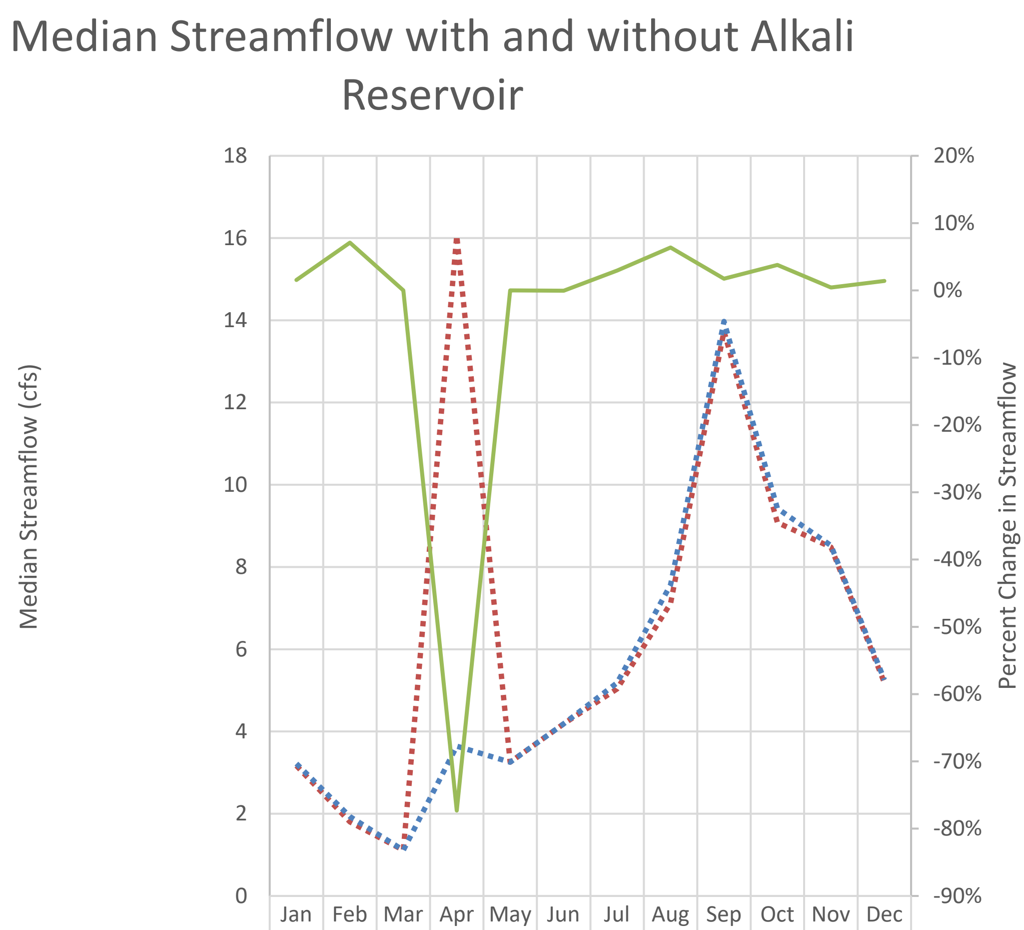
2B) Paint Rock Creek downstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	21	19	18	16	255	233	75	29	17	28	32	27
Dry Year - Proposed Action (without idle acres)	21	19	18	16	255	233	75	25	18	29	32	27
Percent Change	0%	0%	0%	0%	0%	0%	0%	-16%	3%	1%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Dry Water Year

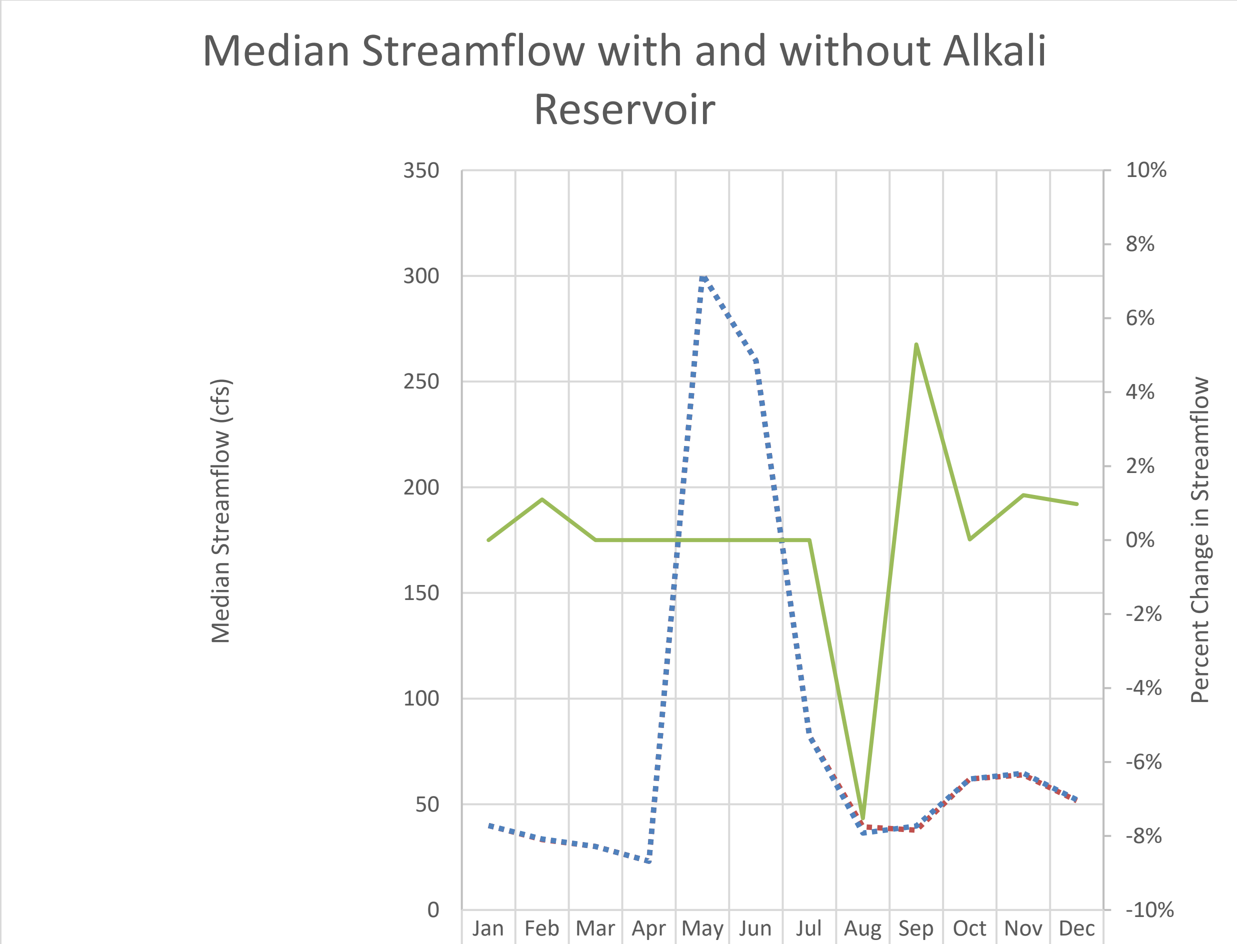
3) Alkali Creek downstream of Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	3	2	1	16	3	4	5	7	14	9	8	5
Dry Year - Proposed Action (without idle acres)	3	2	1	4	3	4	5	8	14	9	9	5
Percent Change	2%	7%	0%	-77%	0%	0%	3%	6%	2%	4%	0%	1%

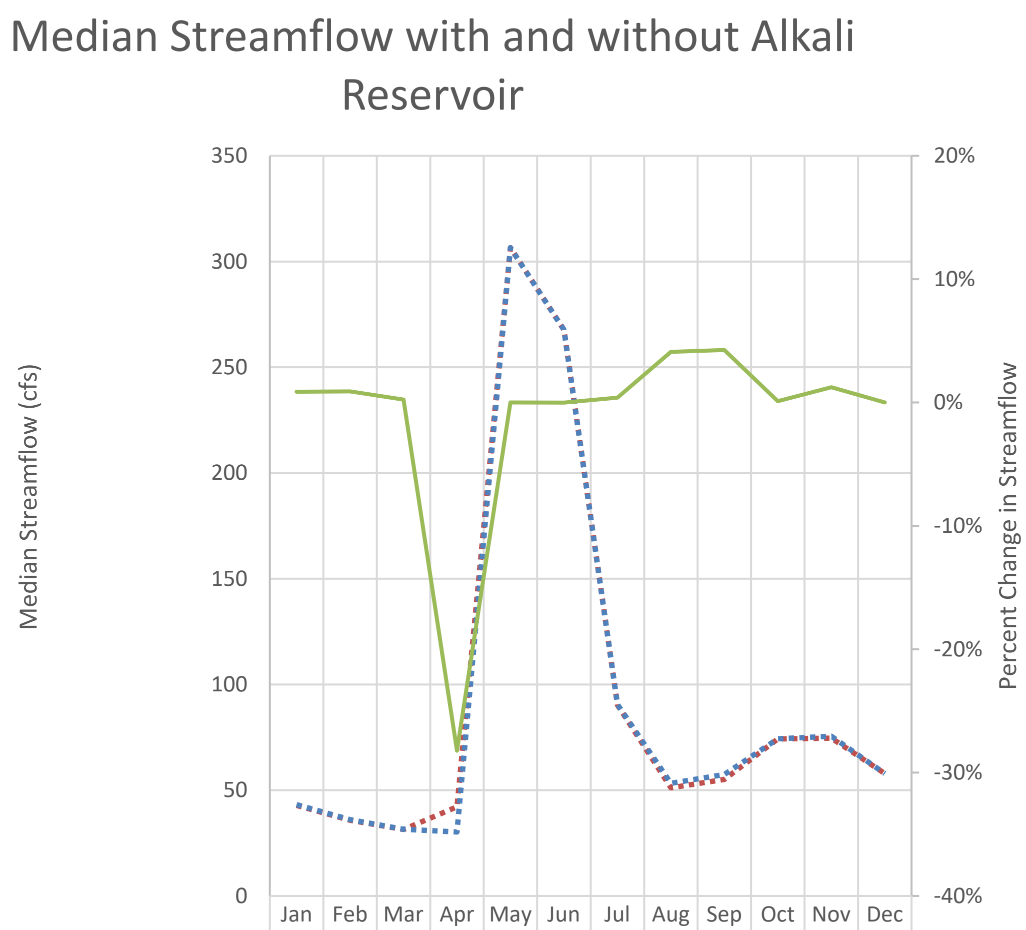
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Dry Water Year

4A) Paint Rock Creek upstream of Alkali Creek confluence



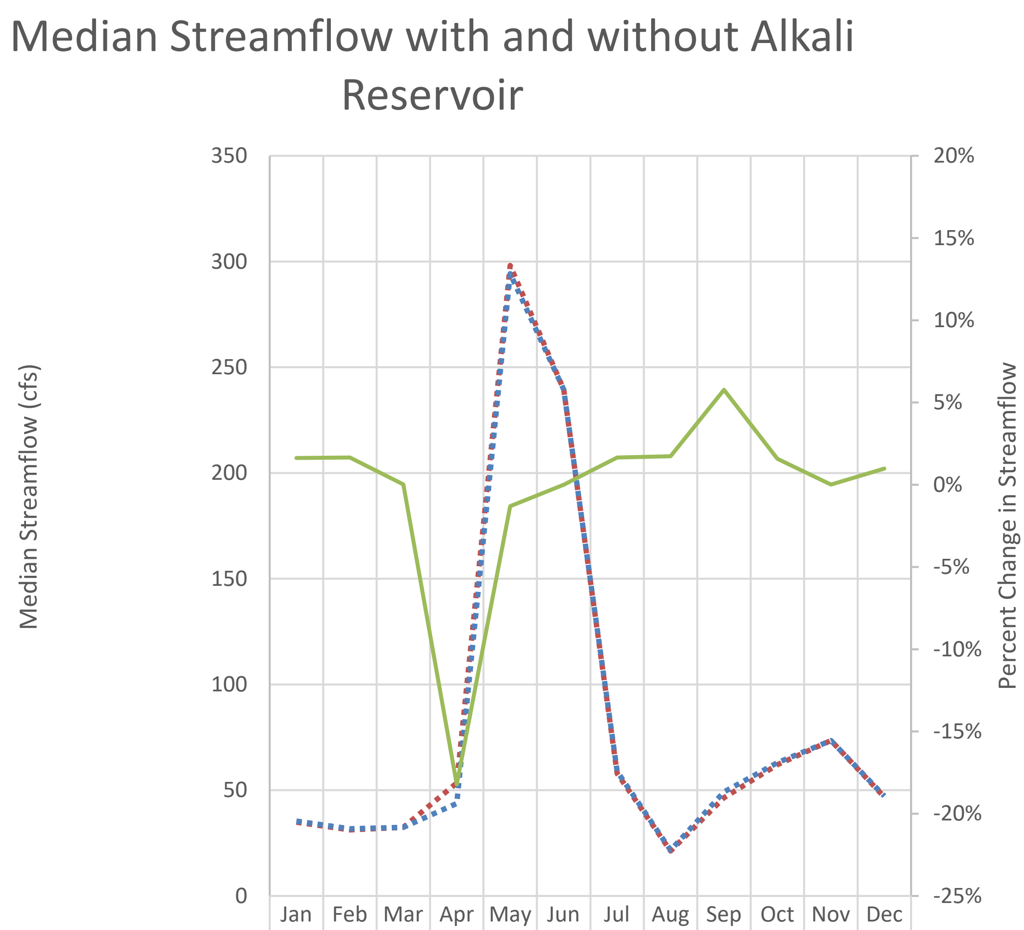
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	40	33	30	23	301	260	82	39	38	62	64	52
Dry Year - Proposed Action (without idle acres)	40	34	30	23	301	260	82	36	40	62	65	52
Percent Change	0%	1%	0%	0%	0%	0%	0%	-8%	5%	0%	1%	1%

4B) Paint Rock Creek downstream of Alkali Creek confluence



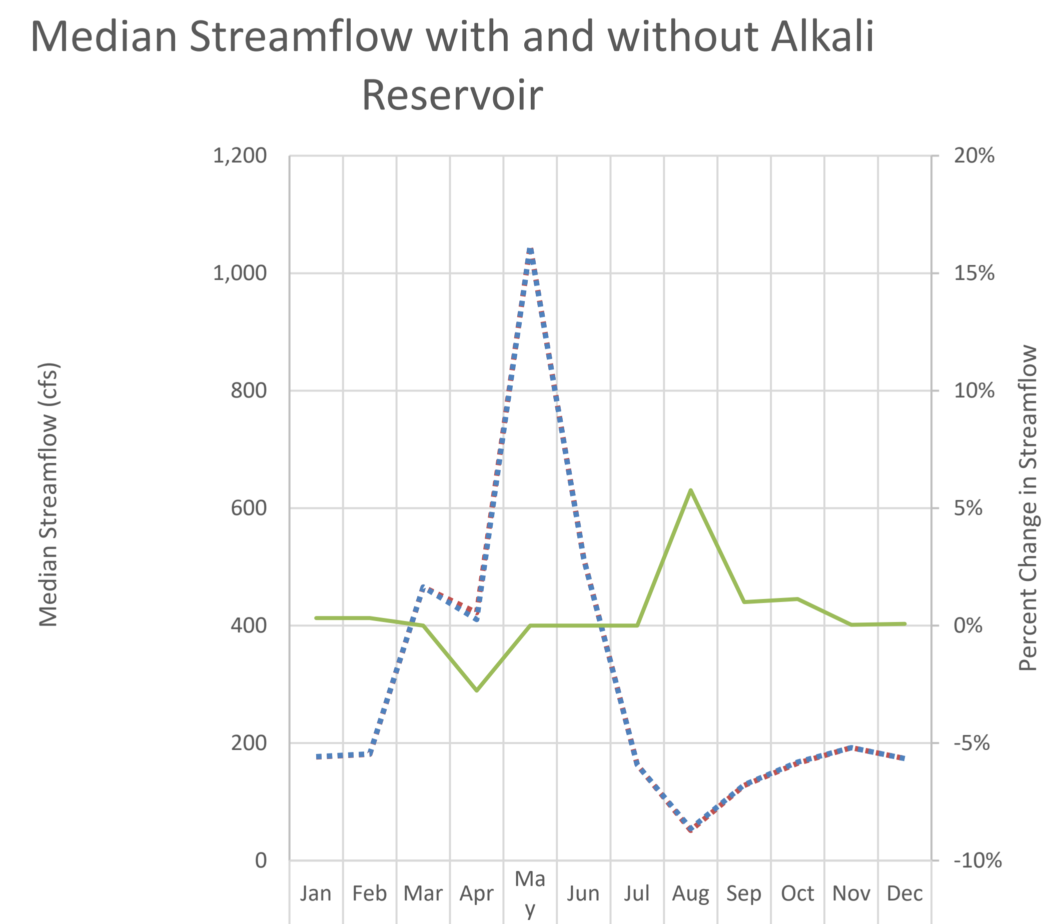
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	43	36	31	42	307	268	90	51	55	74	75	58
Dry Year - Proposed Action (without idle acres)	43	36	32	30	307	268	91	53	57	74	76	58
Percent Change	1%	1%	0%	-28%	0%	0%	0%	4%	4%	0%	1%	0%

4C) Paint Rock Creek at the Confluence with the Nowood River



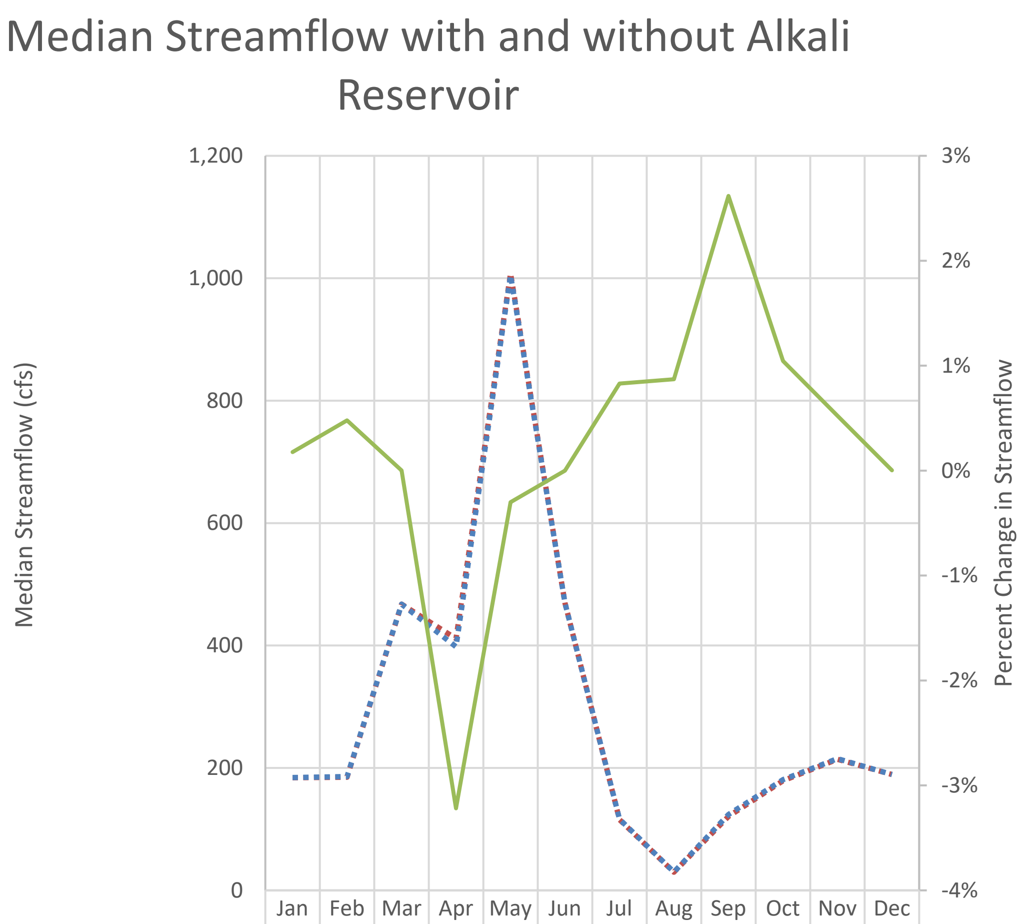
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	35	31	32	53	298	239	58	21	46	62	74	47
Dry Year - Proposed Action (without idle acres)	35	32	32	44	294	239	59	22	49	63	74	47
Percent Change	2%	2%	0%	-18%	-1%	0%	2%	2%	6%	2%	0%	1%

5) Nowood River below Paint Rock Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	177	181	466	422	1047	514	163	51	128	166	192	174
Dry Year - Proposed Action (without idle acres)	177	182	466	410	1047	514	163	54	129	168	192	174
Percent Change	0%	0%	0%	-3%	0%	0%	0%	6%	1%	1%	0%	0%

6) Nowood River at Confluence with Bighorn River

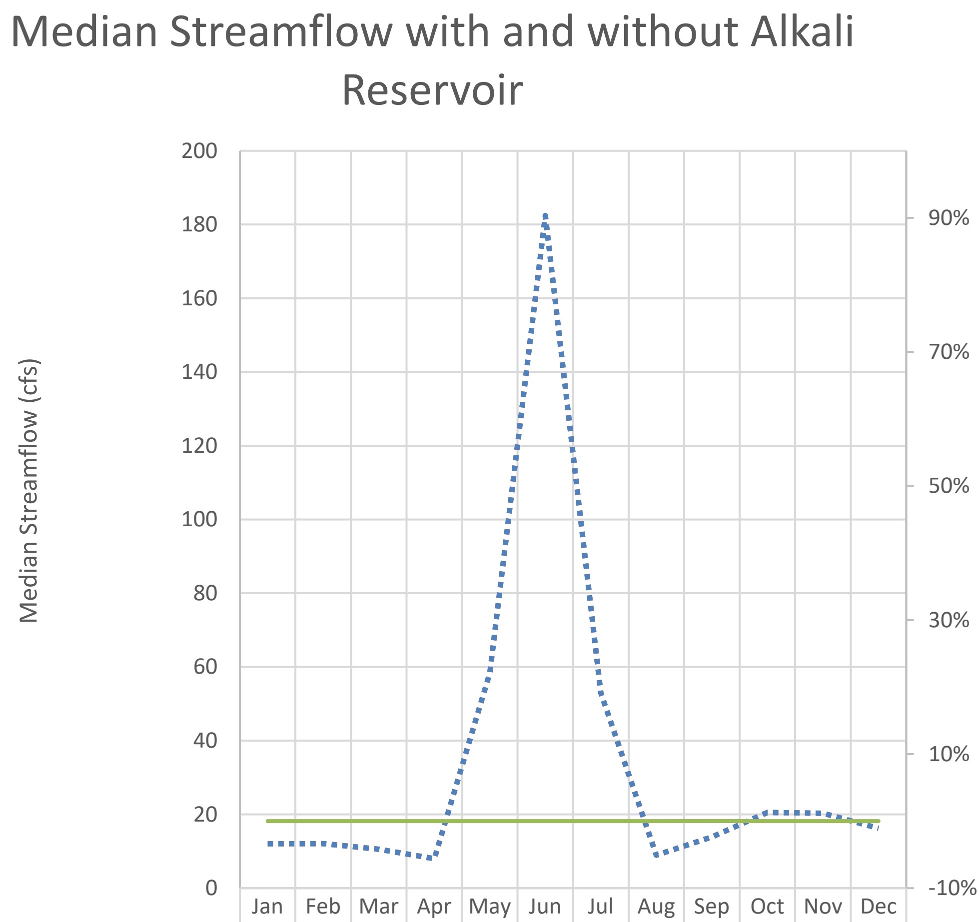


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	184	185	468	411	1008	470	115	30	121	179	214	189
Dry Year - Proposed Action (without idle acres)	184	186	468	398	1005	470	116	30	124	181	215	189
Percent Change	0%	0%	0%	-3%	0%	0%	1%	1%	3%	1%	1%	0%

Median Streamflow During a Wet Water Year

Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (without idle acres)

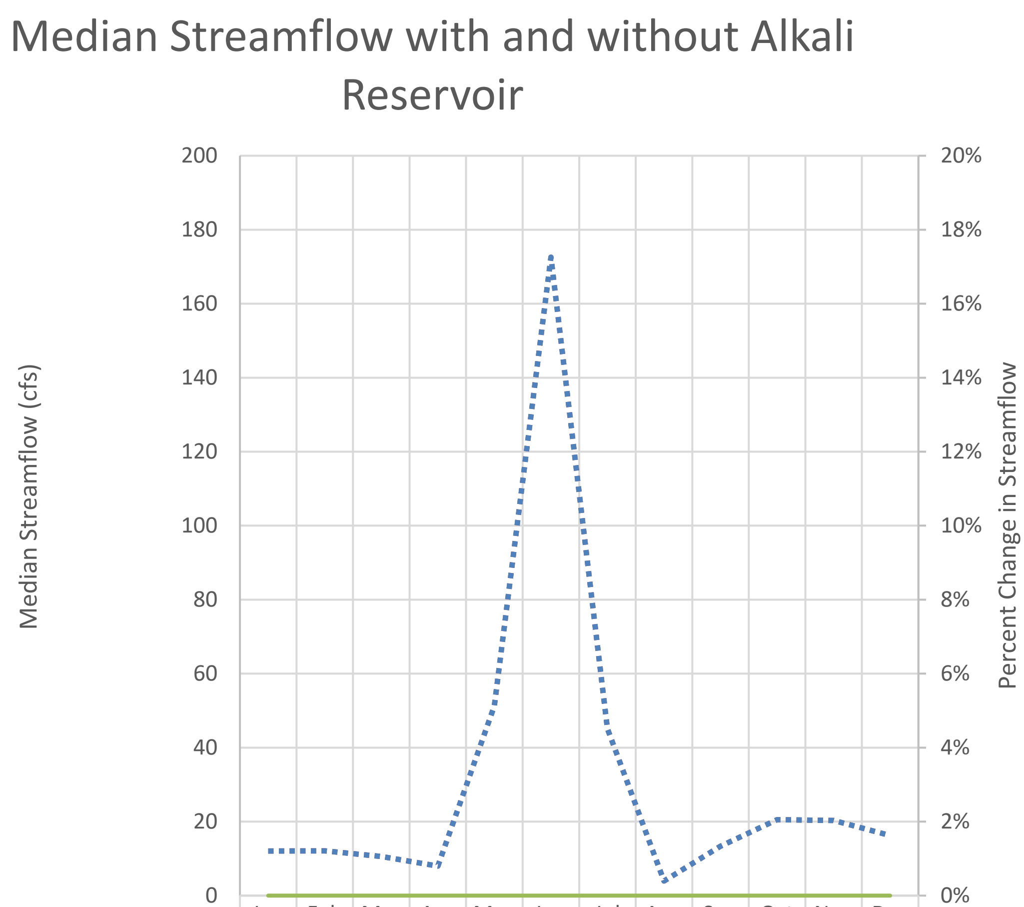
1A) Medicine Lodge Creek upstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	12	12	11	8	58	182	53	9	14	21	20	16
Wet Year - Proposed Action (without idle acres)	12	12	11	8	58	182	53	9	14	21	20	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Wet Water Year

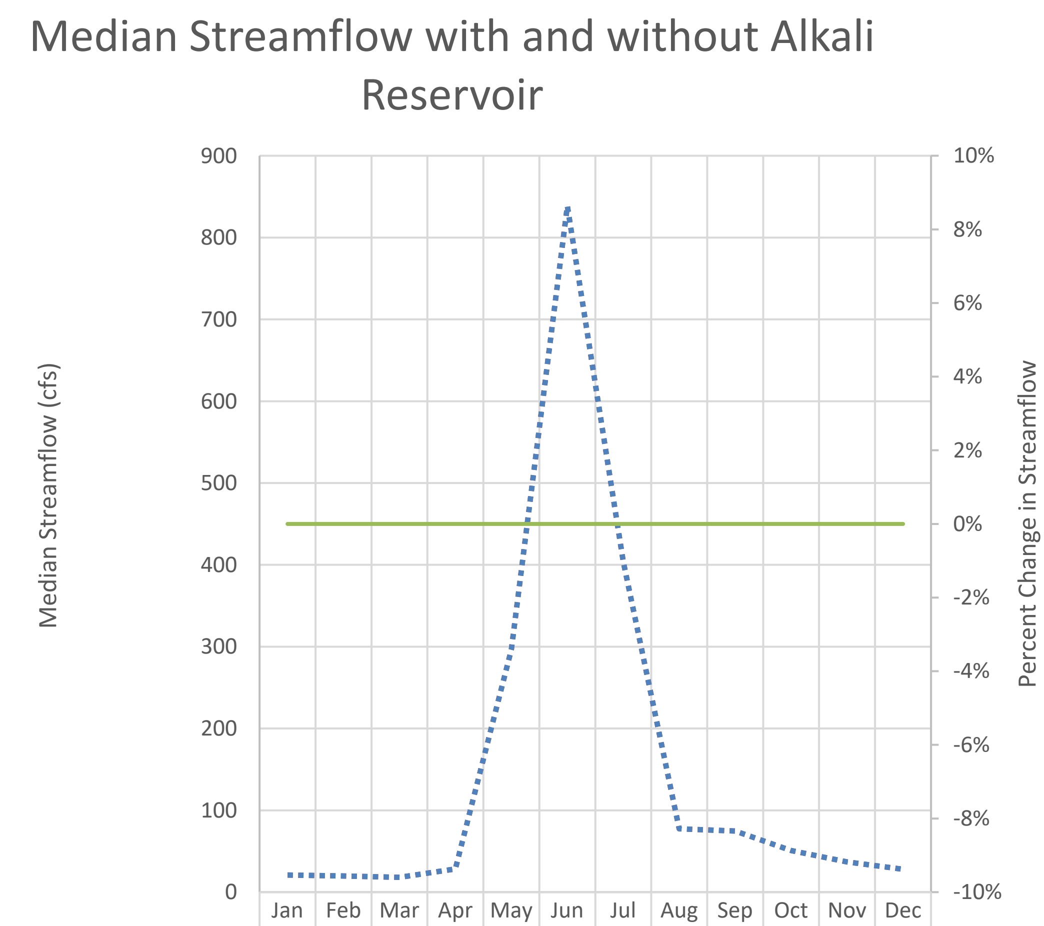
1B) Medicine Lodge Creek downstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	12	12	11	8	51	173	45	4	13	21	20	16
Wet Year - Proposed Action (without idle acres)	12	12	11	8	51	173	45	4	13	21	20	16
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Wet Water Year

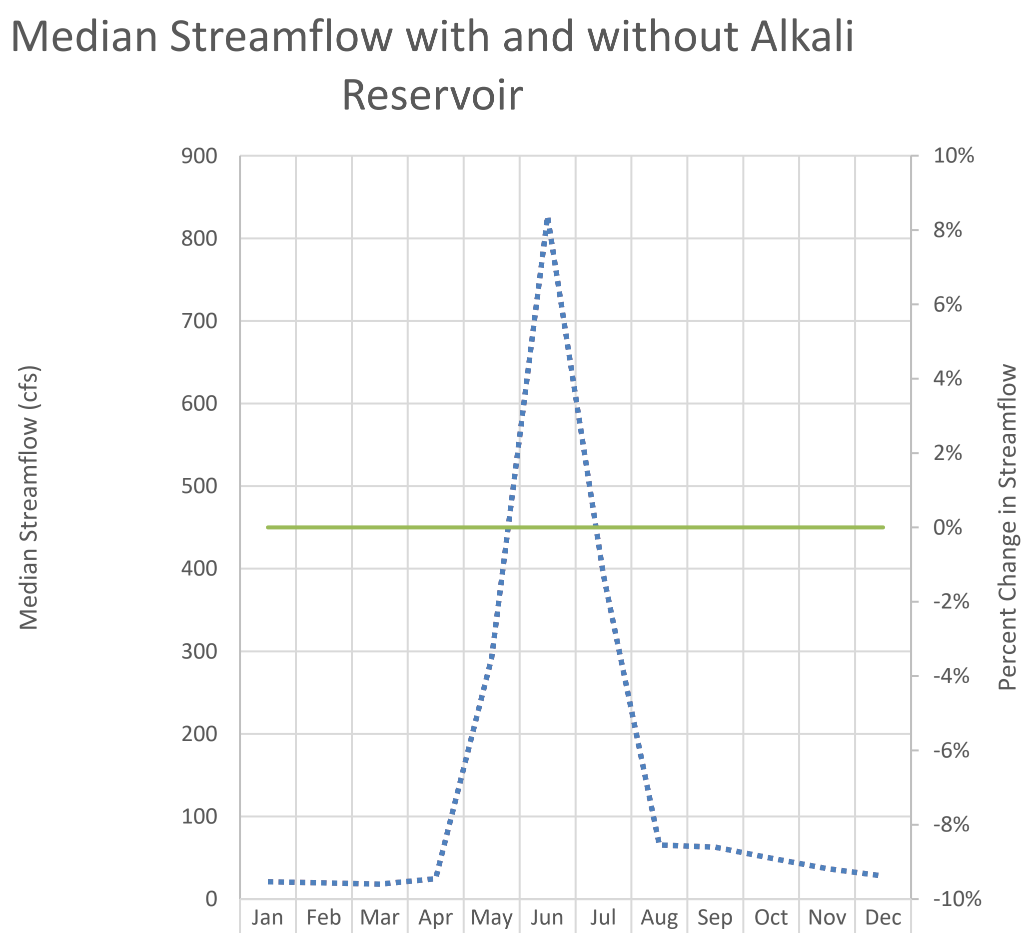
2A) Paint Rock Creek upstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	21	20	18	28	296	839	404	77	75	51	37	28
Wet Year - Proposed Action (without idle acres)	21	20	18	28	296	839	404	77	75	51	37	28
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Wet Water Year

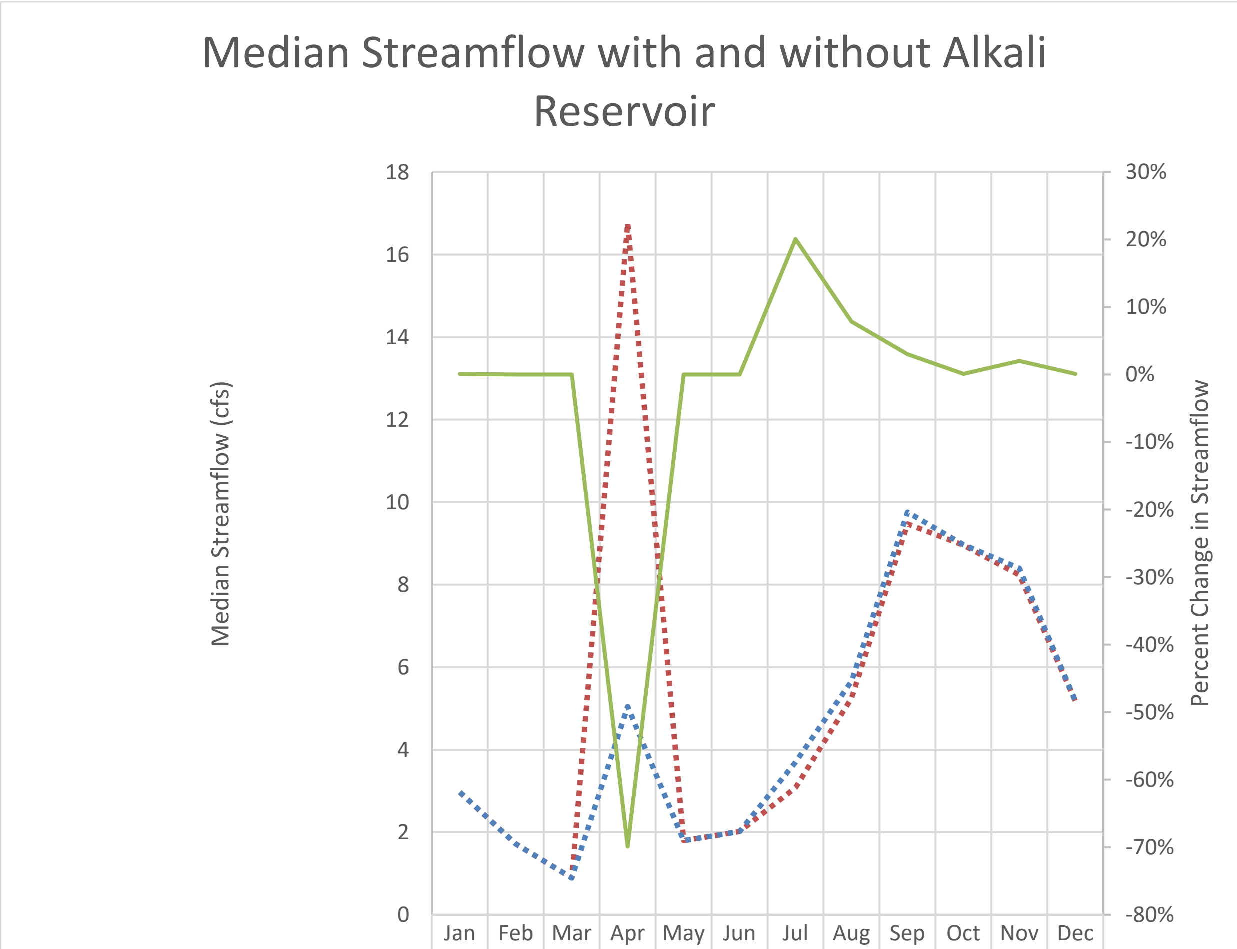
2B) Paint Rock Creek downstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	21	20	18	25	292	827	393	65	63	49	37	28
Wet Year - Proposed Action (without idle acres)	21	20	18	25	292	827	393	65	63	49	37	28
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Wet Water Year

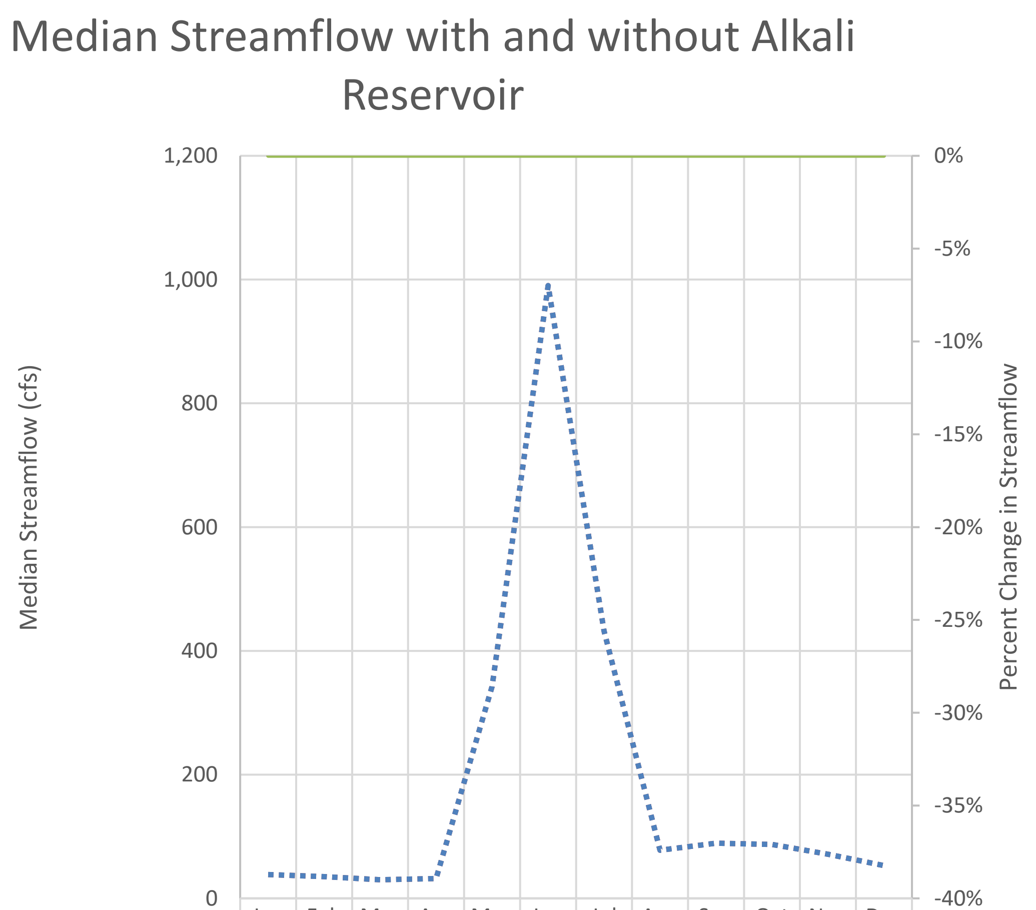
3) Alkali Creek downstream of Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	3	2	1	17	2	2	3	5	9	9	8	5
Wet Year - Proposed Action (without idle acres)	3	2	1	5	2	2	4	6	10	9	8	5
Percent Change	0%	0%	0%	-70%	0%	0%	20%	8%	3%	0%	2%	0%

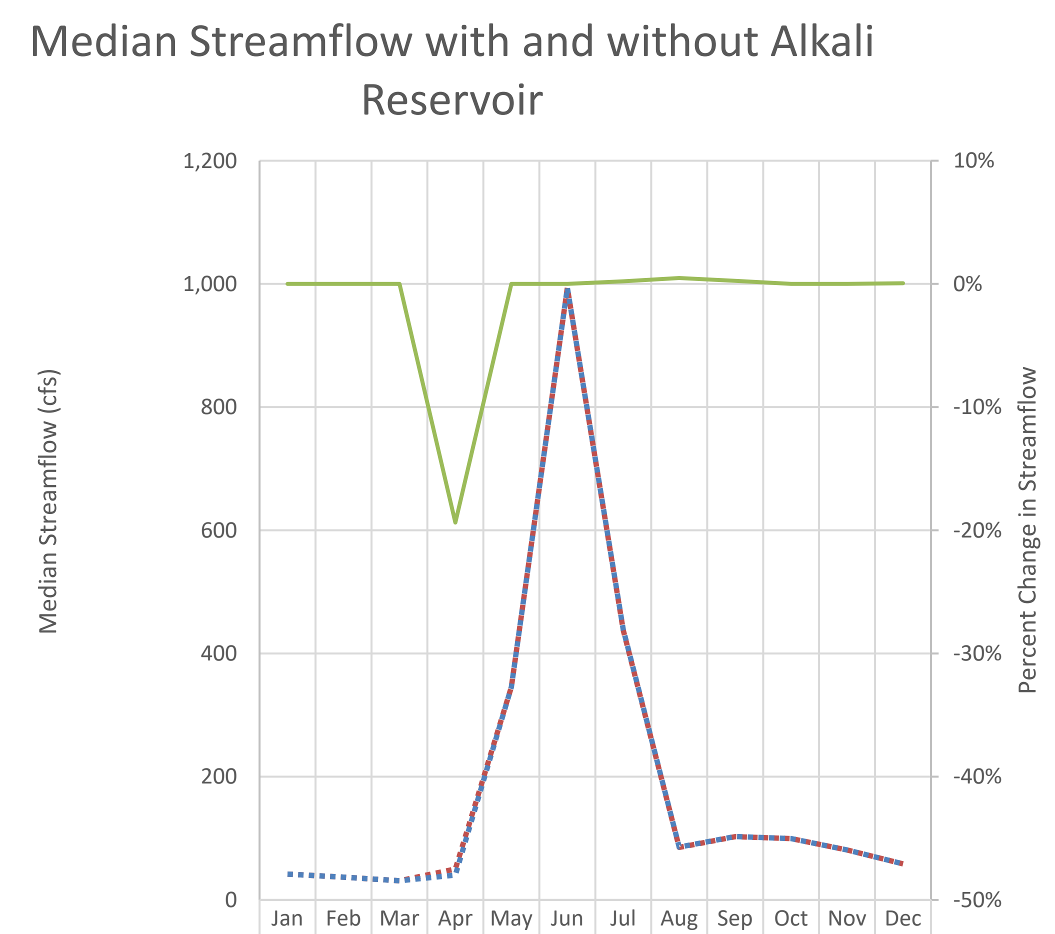
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Wet Water Year

4A) Paint Rock Creek upstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	38	35	30	32	343	990	432	78	89	87	71	53
Wet Year - Proposed Action (without idle acres)	38	35	30	32	343	990	432	78	89	87	71	53
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

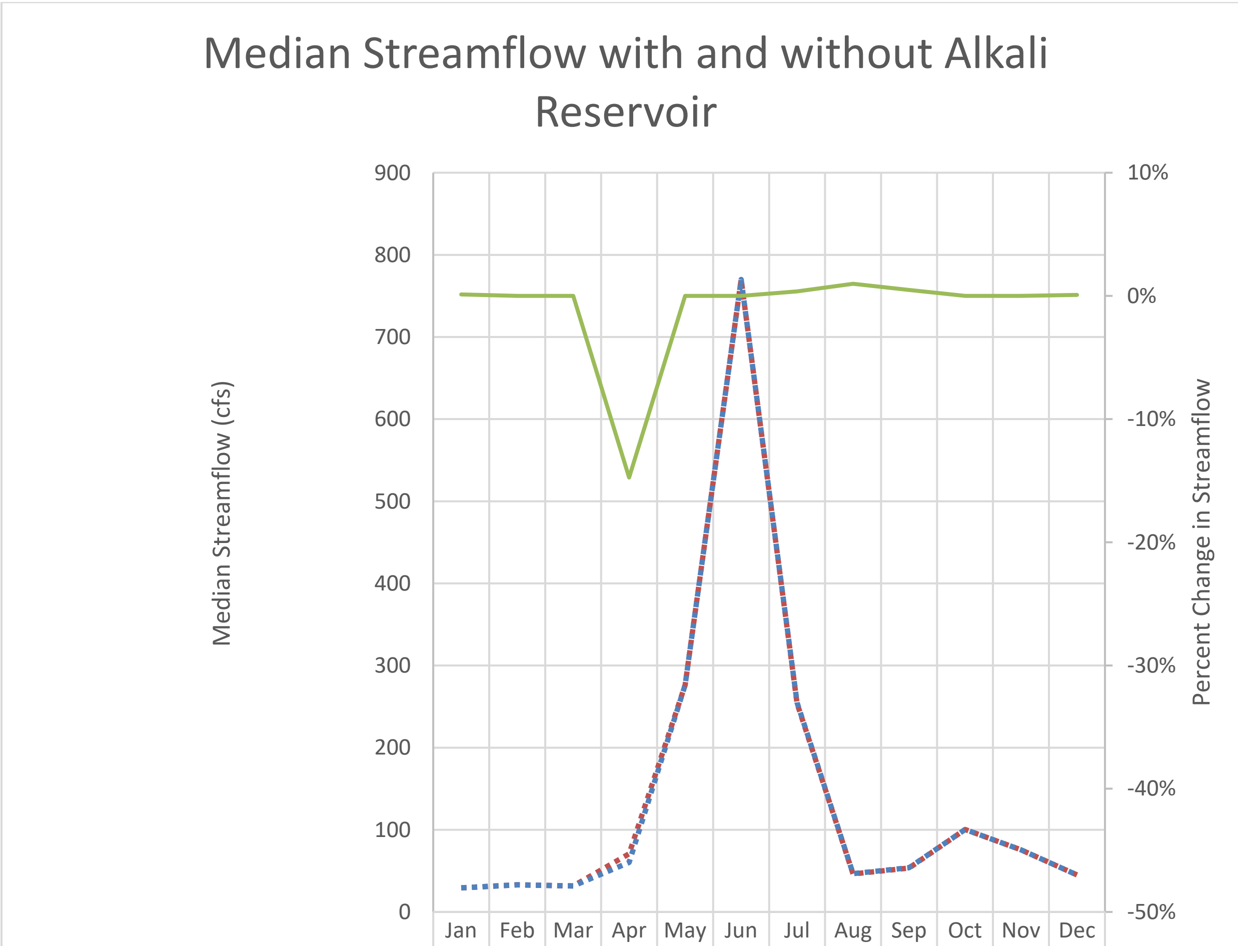
4B) Paint Rock Creek downstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	42	37	31	50	346	994	438	85	103	100	81	58
Wet Year - Proposed Action (without idle acres)	42	37	31	40	346	994	439	86	103	100	81	59
Percent Change	0%	0%	0%	-19%	0%	0%	0%	0%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Wet Water Year

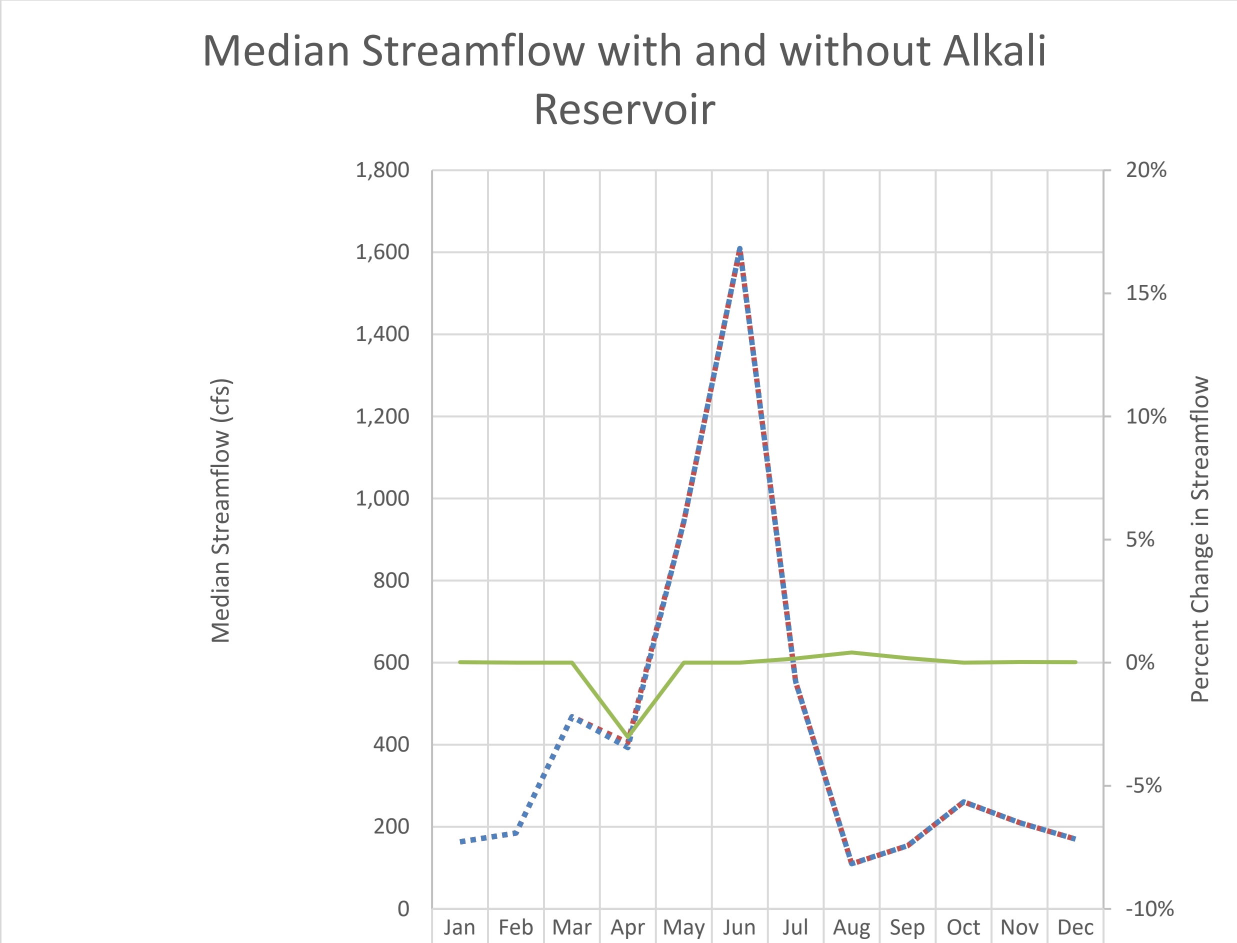
4C) Paint Rock Creek at the Confluence with the Nowood River



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	29	33	32	71	276	770	254	46	54	100	76	45
Wet Year - Proposed Action (without idle acres)	29	33	32	60	276	770	255	47	54	100	76	45
Percent Change	0%	0%	0%	-15%	0%	0%	0%	1%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Wet Water Year

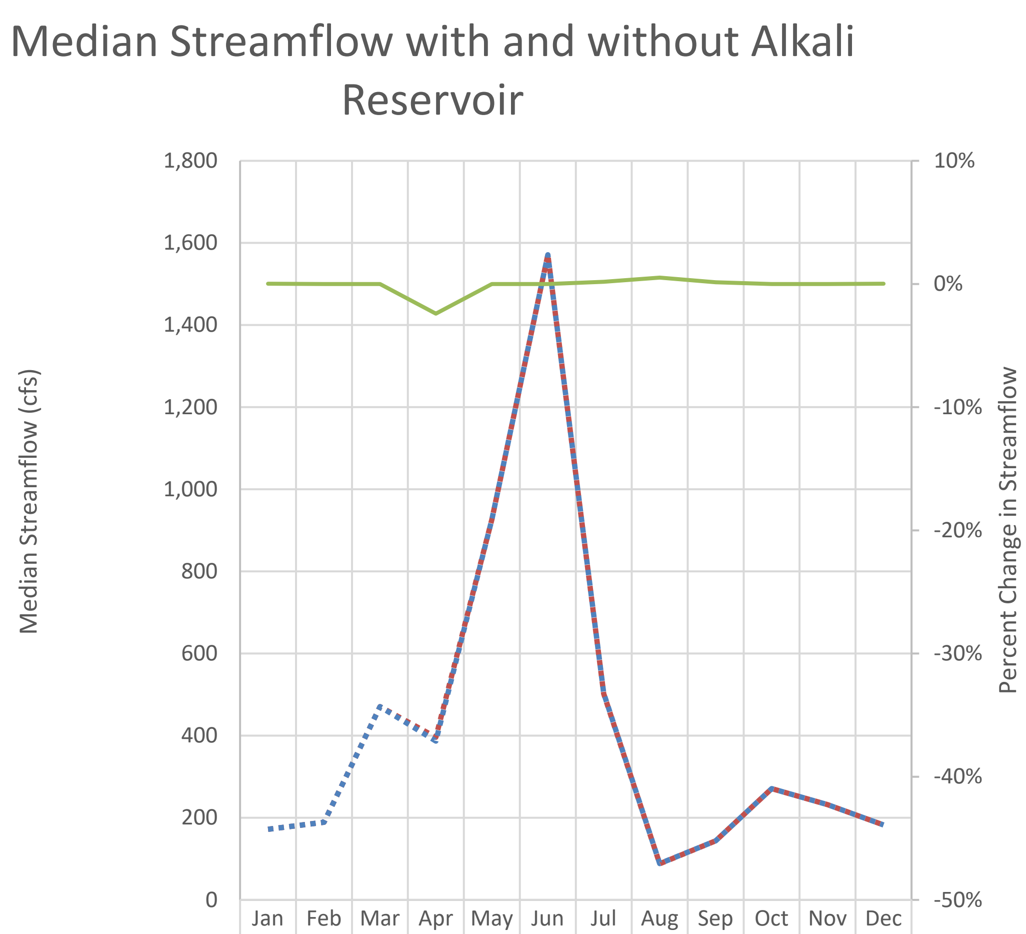
5) Nowood River below Paint Rock Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	163	185	468	405	944	1609	553	110	154	261	210	170
Wet Year - Proposed Action (without idle acres)	163	185	468	393	944	1609	554	110	154	261	210	170
Percent Change	0%	0%	0%	-3%	0%	0%	0%	0%	0%	0%	0%	0%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Wet Water Year

6) Nowood River at Confluence with Bighorn River

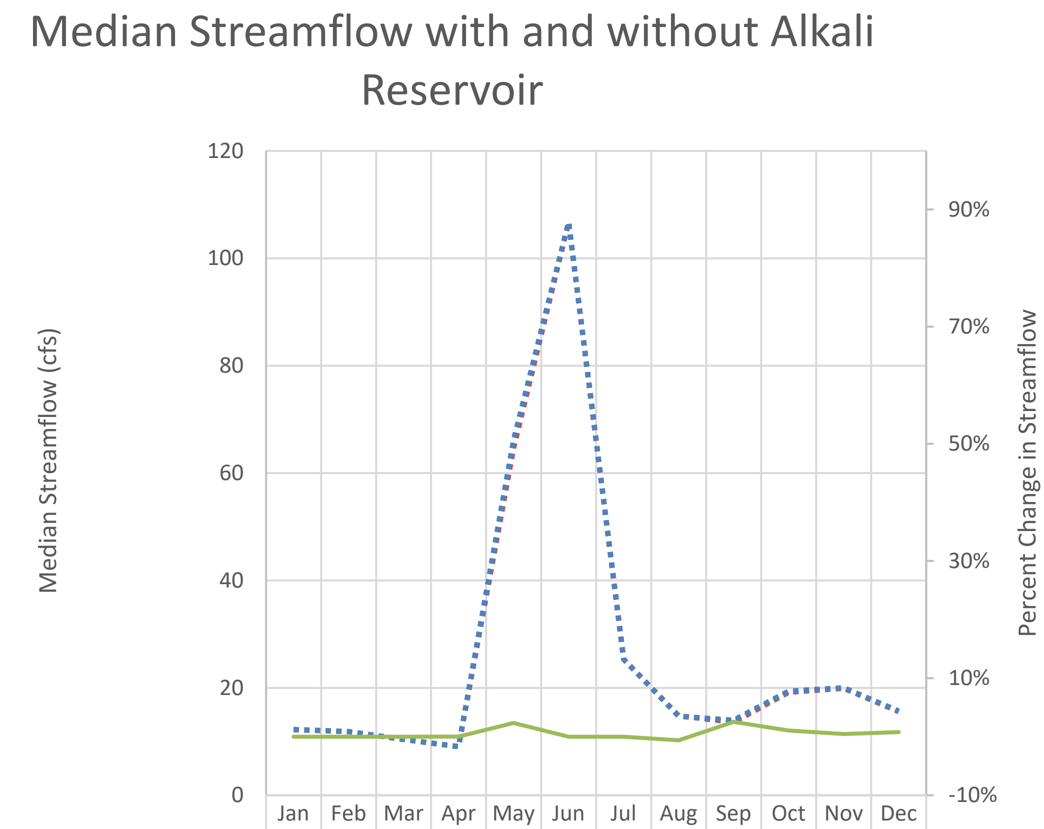


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	172	189	471	396	926	1571	502	88	144	271	232	182
Wet Year - Proposed Action (without idle acres)	172	189	471	387	926	1571	503	88	144	271	232	182
Percent Change	0%	0%	0%	-2%	0%	0%	0%	1%	0%	0%	0%	0%

Median Streamflow During a Normal Water Year

Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (without idle acres)

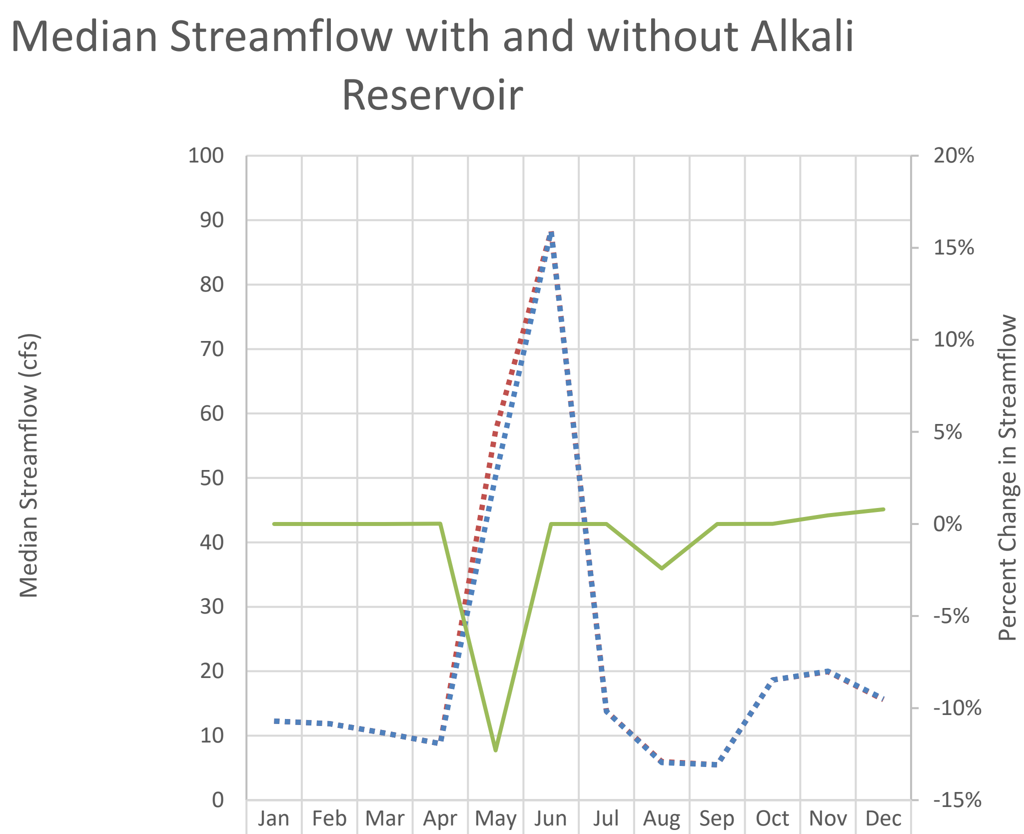
1A) Medicine Lodge Creek upstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	12	12	10	9	65	107	25	15	14	19	20	16
Normal Year - Proposed Action (with idle acres)	12	12	10	9	66	107	25	15	14	19	20	16
Percent Change	0%	0%	0%	0%	2%	0%	0%	-1%	3%	1%	0%	1%

WENCK
Responsive partner.
Exceptional outcomes.

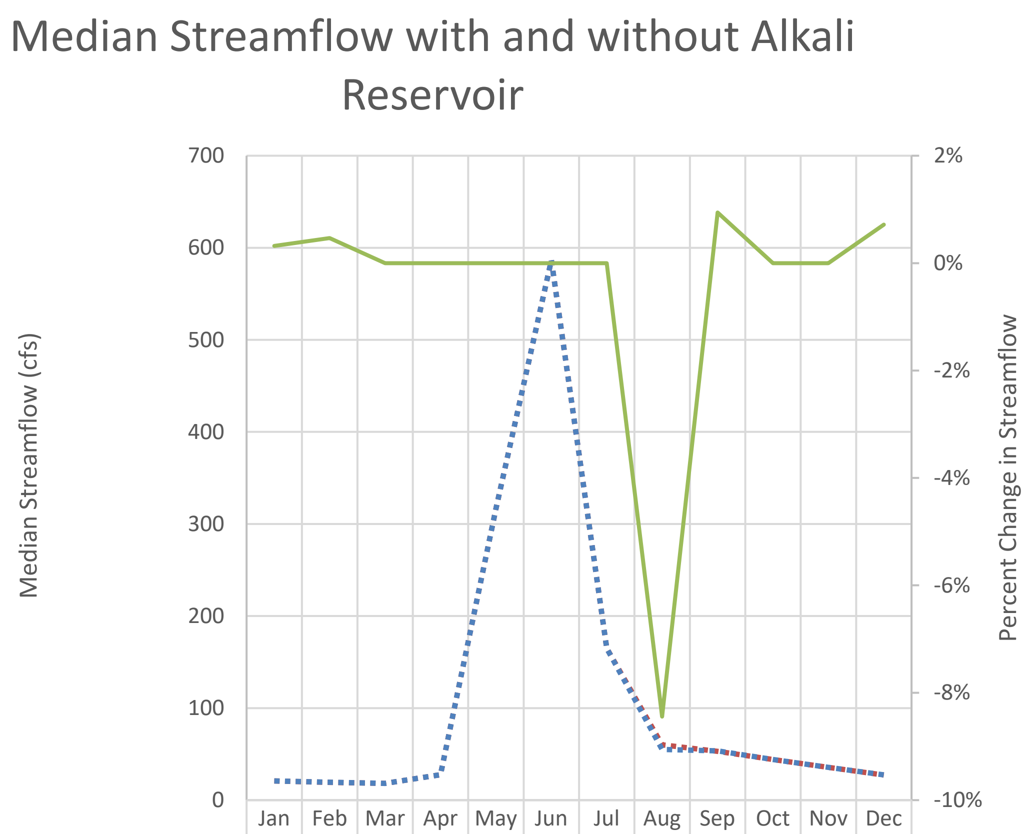
1B) Medicine Lodge Creek downstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	12	12	10	9	57	88	14	6	5	19	20	16
Normal Year - Proposed Action (with idle acres)	12	12	10	9	50	88	14	6	5	19	20	16
Percent Change	0%	0%	0%	0%	-12%	0%	0%	-2%	0%	0%	0%	1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

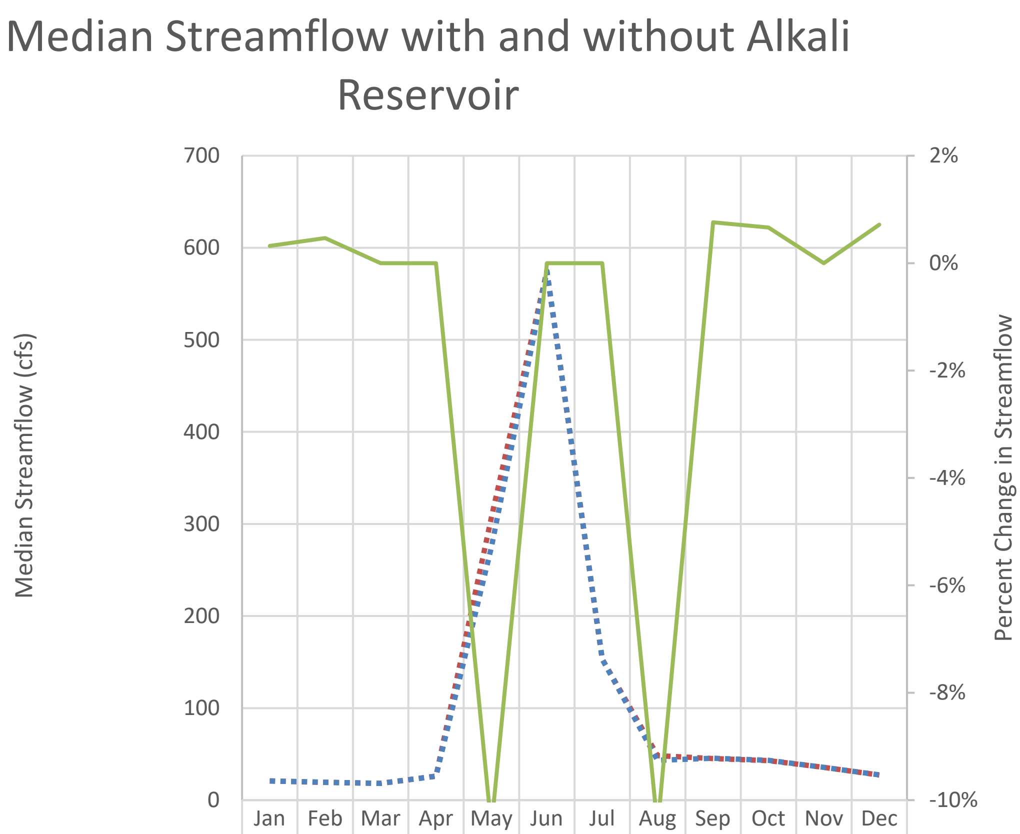
2A) Paint Rock Creek upstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	21	19	18	28	316	587	165	60	53	44	36	27
Normal Year - Proposed Action (with idle acres)	21	19	18	28	316	587	165	55	53	44	36	27
Percent Change	0%	0%	0%	0%	0%	0%	0%	-8%	1%	0%	0%	1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

2B) Paint Rock Creek downstream of Anita Supplemental Ditch

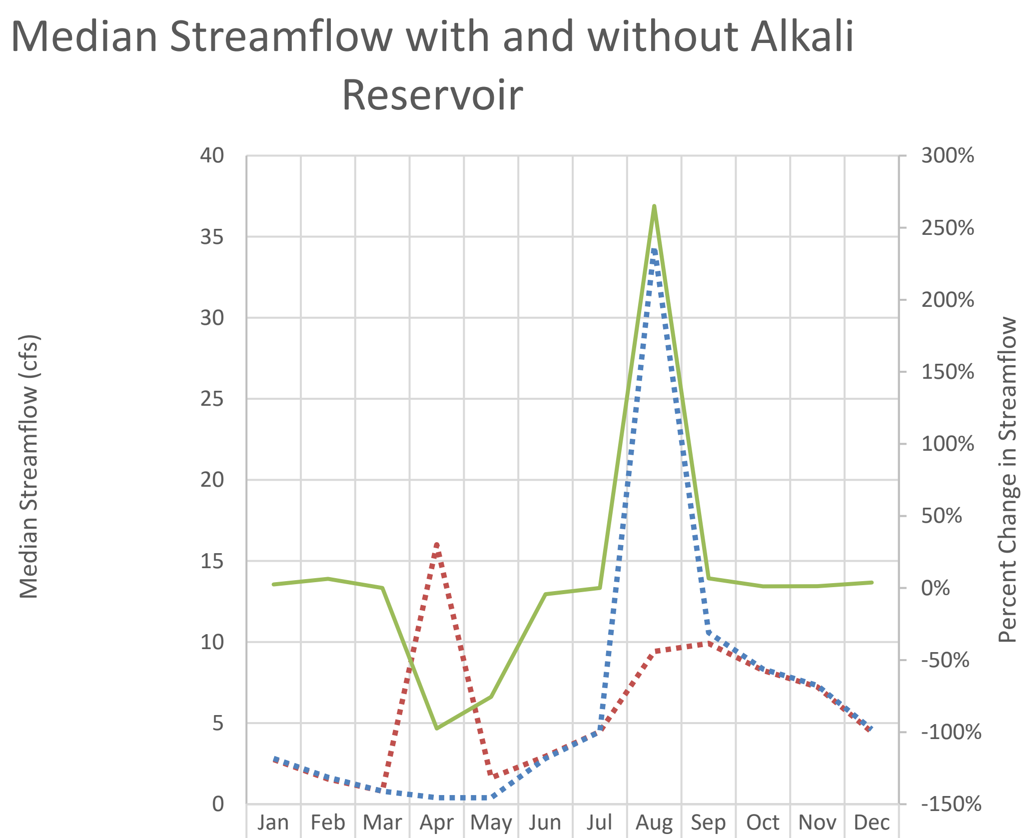


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	21	19	18	26	307	575	153	48	45	43	36	27
Normal Year - Proposed Action (with idle acres)	21	19	18	26	275	575	153	43	45	43	36	27
Percent Change	0%	0%	0%	0%	-11%	0%	0%	-11%	1%	1%	0%	1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

Responsive partner.
Exceptional outcomes.

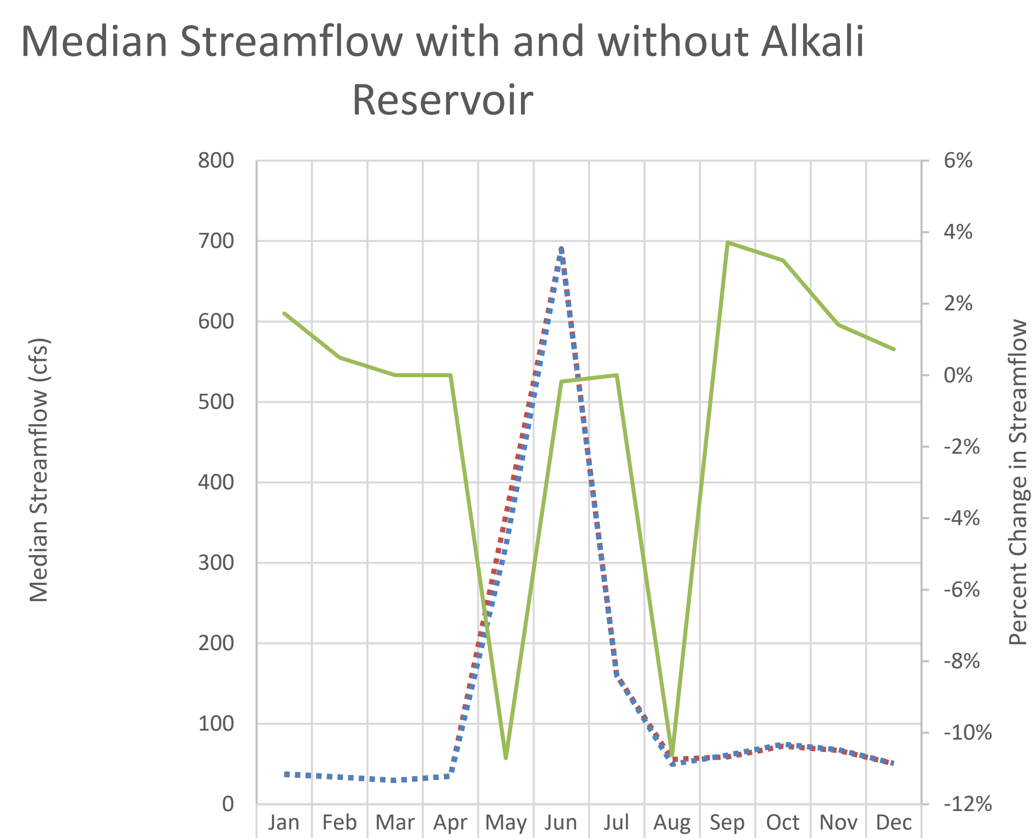
3) Alkali Creek downstream of Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	3	2	1	16	2	3	4	9	10	8	7	4
Normal Year - Proposed Action (with idle acres)	3	2	1	0	0	3	4	34	11	8	7	5
Percent Change	2%	6%	0%	-98%	-76%	-4%	0%	265%	7%	1%	1%	4%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

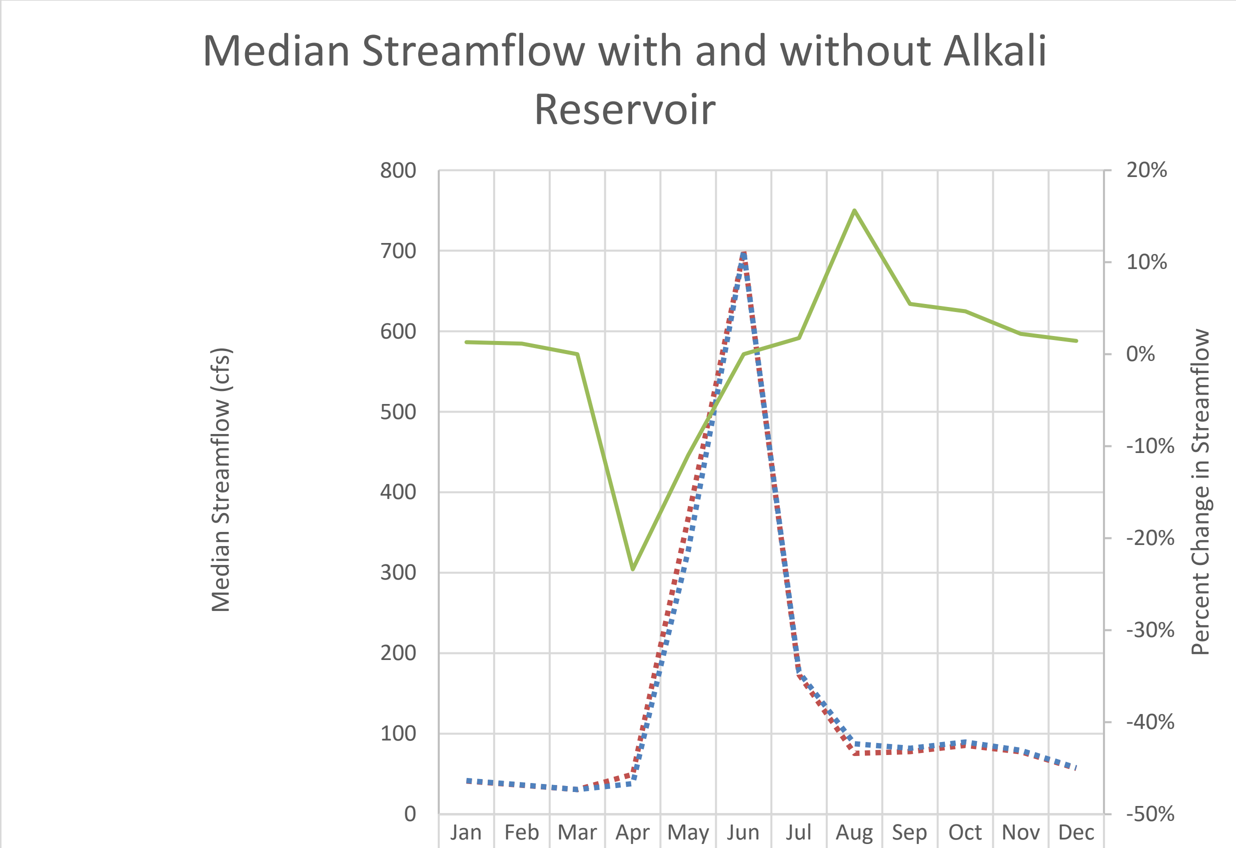
4A) Paint Rock Creek upstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	37	34	30	35	359	690	160	56	59	72	67	50
Normal Year - Proposed Action (with idle acres)	38	34	30	35	321	689	160	50	61	75	68	51
Percent Change	2%	0%	0%	0%	-11%	0%	0%	-11%	4%	3%	1%	1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

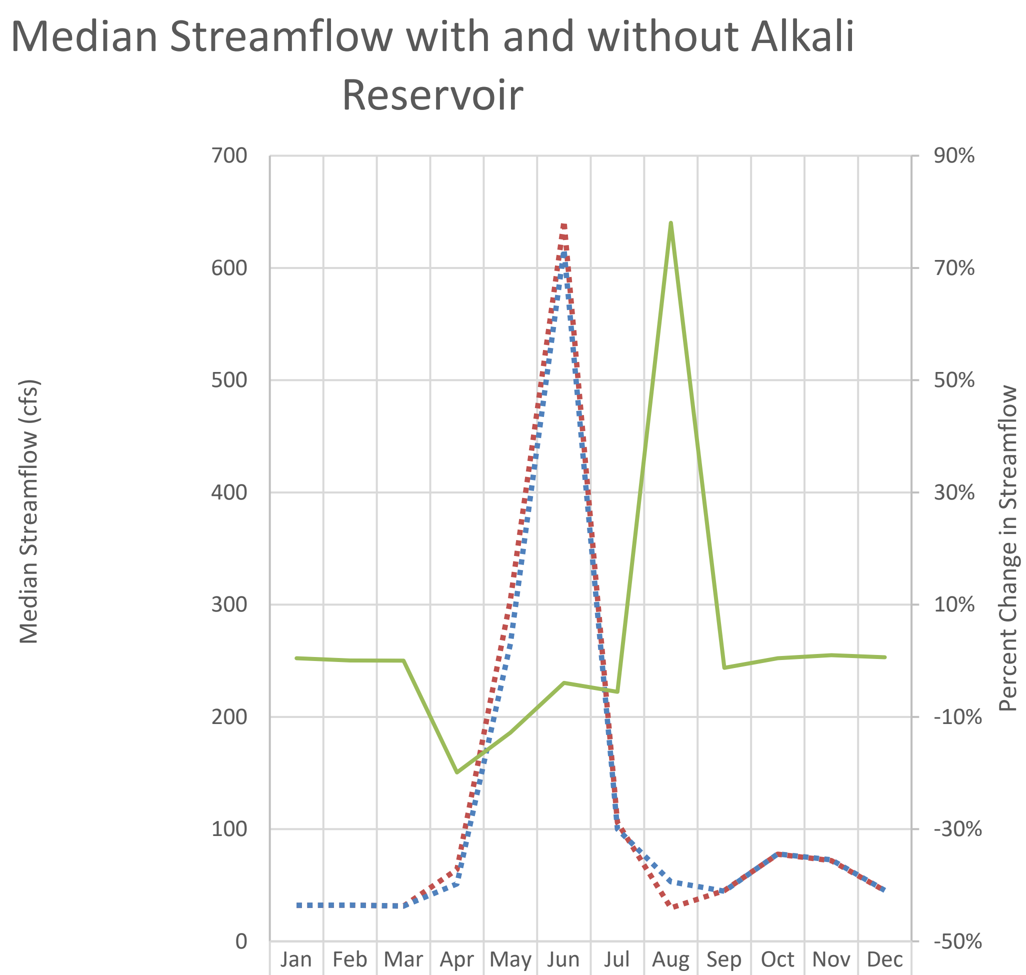
4B) Paint Rock Creek downstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	41	36	31	50	367	700	173	76	78	86	78	57
Normal Year - Proposed Action (with idle acres)	42	36	31	38	327	700	176	88	82	90	79	58
Percent Change	1%	1%	0%	-23%	-11%	0%	2%	16%	5%	5%	2%	1%

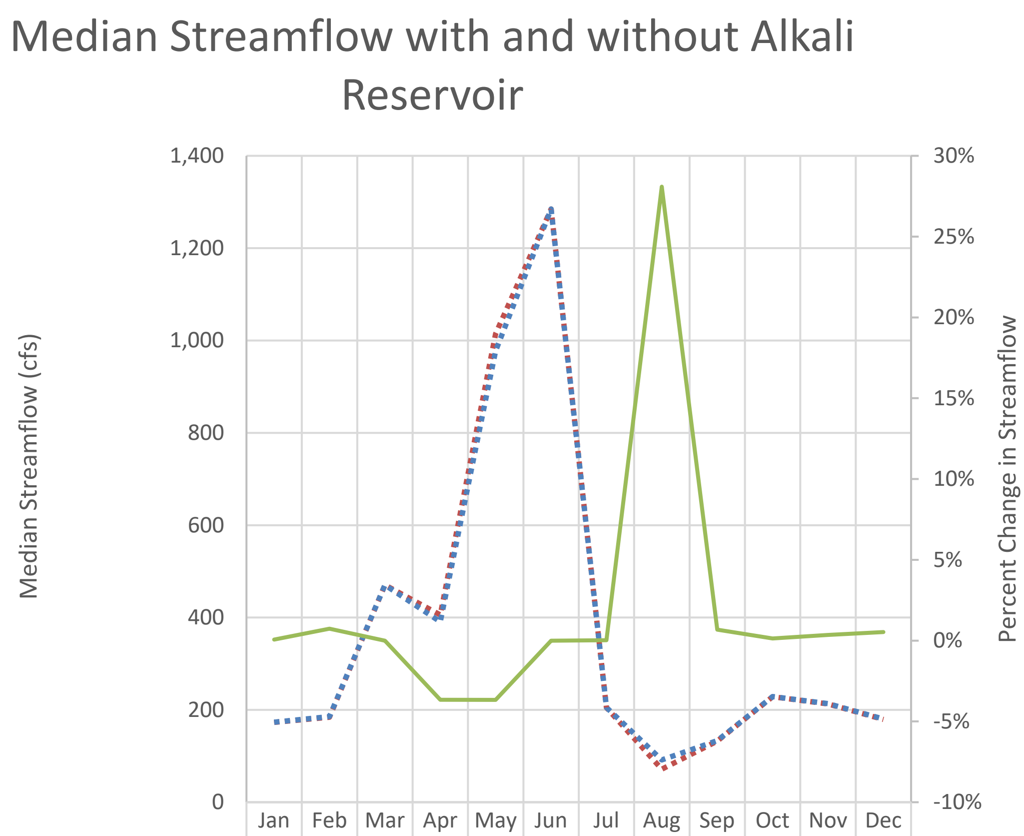
Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

4C) Paint Rock Creek at the Confluence with the Nowood River



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (without idle acres)	32	32	31	64	304	642	106	30	45	78	72	45
Normal Year - Proposed Action (with idle acres)	32	32	31	51	265	616	100	53	45	78	73	45
Percent Change	0%	0%	0%	-20%	-13%	-4%	-6%	78%	-1%	0%	1%	1%

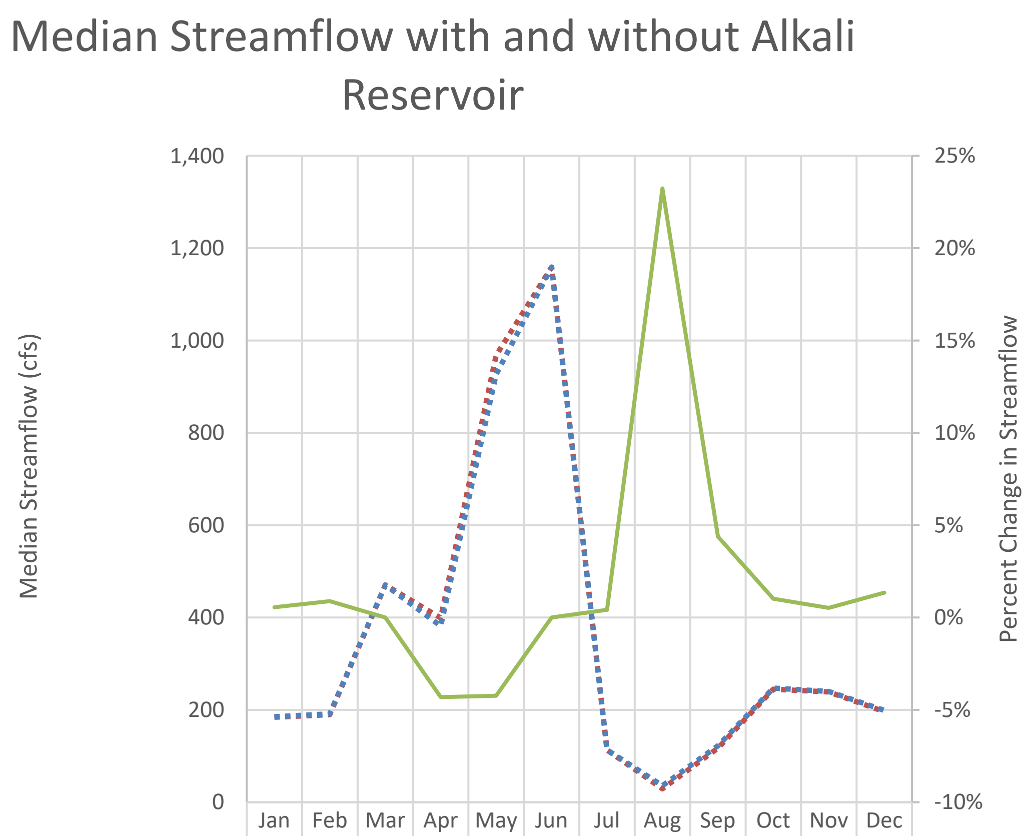
5) Nowood River below Paint Rock Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	173	184	470	406	1015	1285	205	72	132	228	213	179
Normal Year - Proposed Action (with idle acres)	173	186	470	391	977	1285	205	92	133	229	214	180
Percent Change	0%	1%	0%	-4%	-4%	0%	0%	28%	1%	0%	0%	1%

Median Streamflow
Alternative A – No Action (without idle acres) and
Alternative B - Proposed Action (without idle acres)
Normal Water Year

6) Nowood River at Confluence with Bighorn River

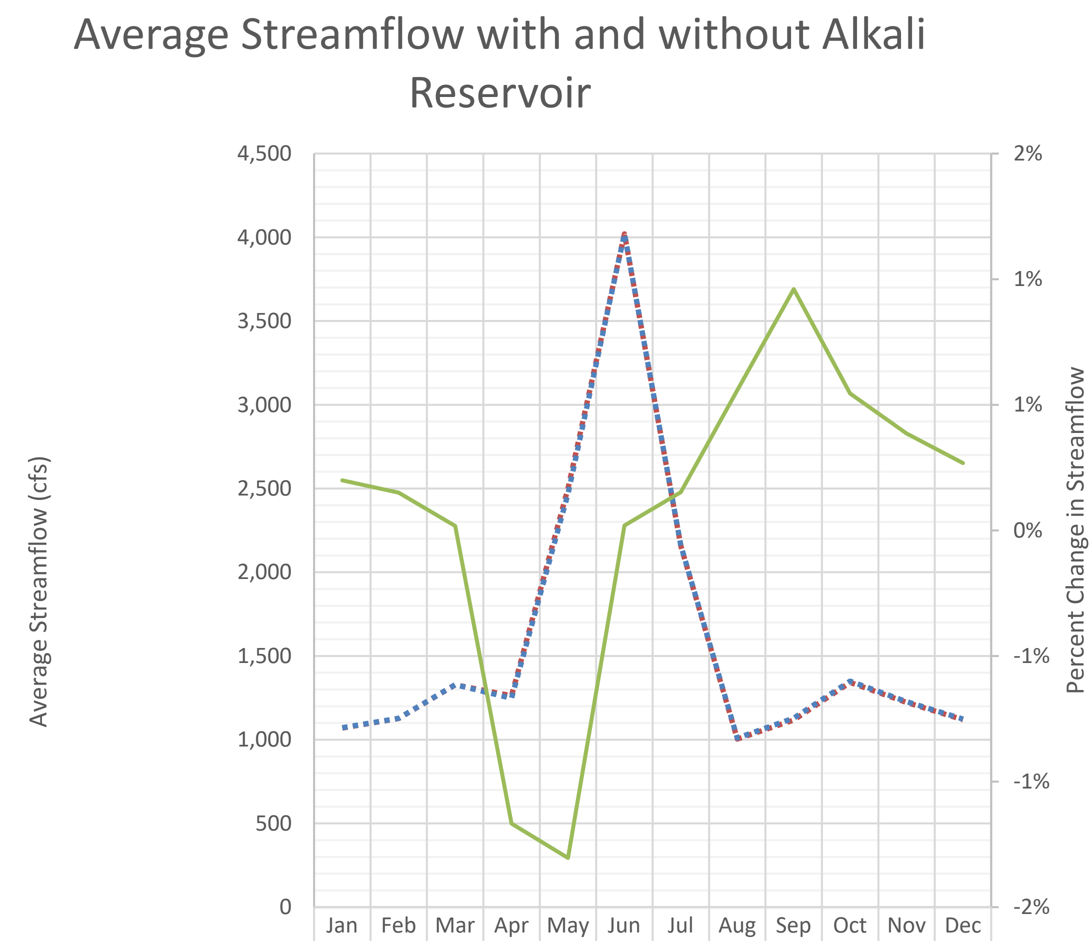


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	184	190	470	399	968	1159	113	29	117	245	239	196
Normal Year - Proposed Action (with idle acres)	185	191	470	382	927	1159	113	36	122	247	240	199
Percent Change	1%	1%	0%	-4%	-4%	0%	0%	23%	4%	1%	1%	1%

Average Streamflow

Alternative A – No Action (without idle acres) and Alternative B – Proposed Action (without idle acres)

7) Bighorn River below Confluence with Nowood River

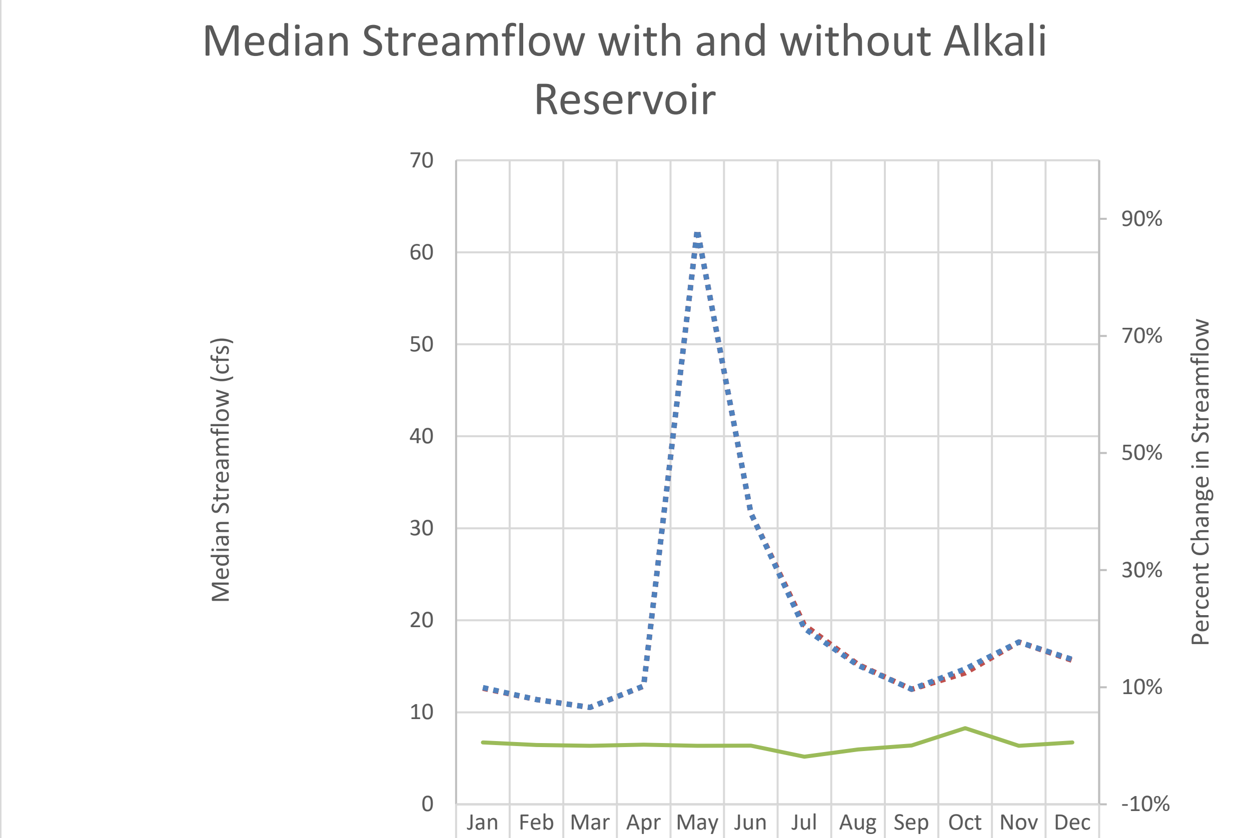


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Year - No Action (with idle acres)	1,070	1,127	1,328	1,262	2,501	4,020	2,158	1,004	1,118	1,342	1,223	1,120
Normal Year - Proposed Action (with idle acres)	1,072	1,128	1,328	1,248	2,468	4,021	2,161	1,010	1,129	1,350	1,228	1,123
Percent Change	0%	0%	0%	-1%	-1%	0%	0%	1%	1%	1%	0%	0%

Median Streamflow During a Dry Water Year

Alternative A – No Action (with idle acres) and Alternative B – Proposed Action (with idle acres)

1A) Medicine Lodge Creek upstream of Anita Ditch

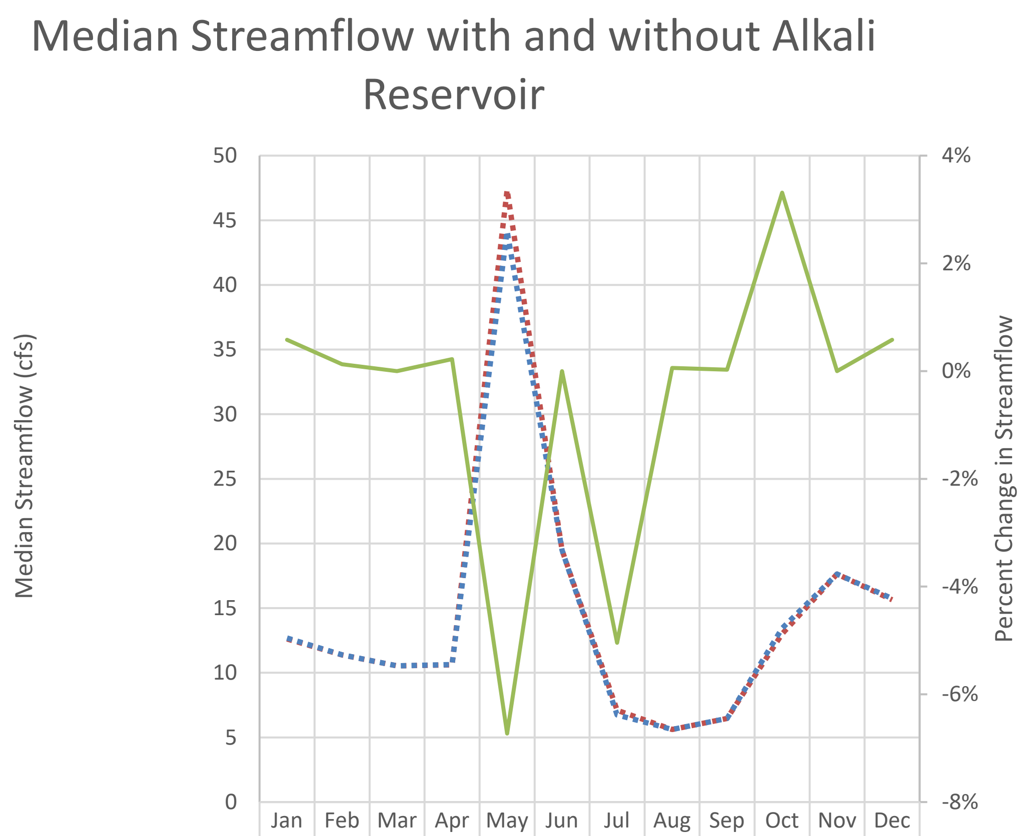


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	13	11	11	13	62	32	19	15	13	14	18	16
Dry Year - Proposed Action (with idle acres)	13	11	11	13	62	32	19	15	13	15	18	16
Percent Change	1%	0%	0%	0%	0%	0%	-2%	-1%	0%	3%	0%	1%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

WENCK
Responsive partner.
Exceptional outcomes.

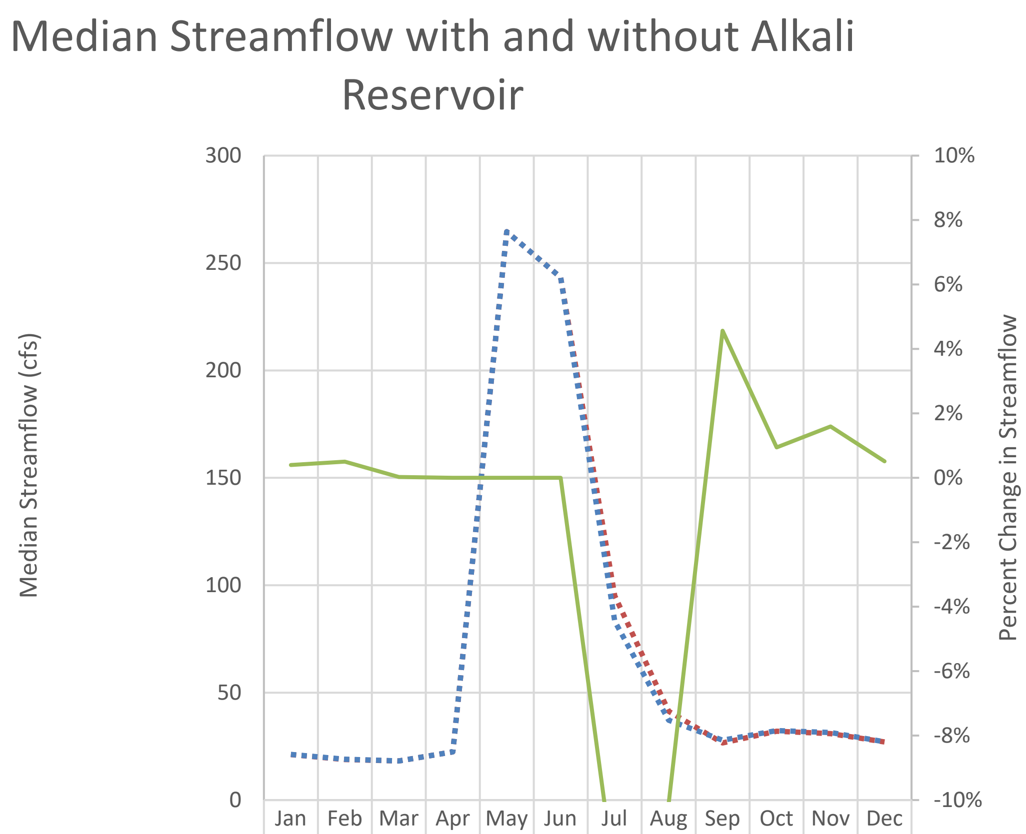
1B) Medicine Lodge Creek downstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	13	11	11	11	47	19	7	6	6	13	18	16
Dry Year - Proposed Action (with idle acres)	13	11	11	11	44	19	7	6	6	13	18	16
Percent Change	1%	0%	0%	0%	-7%	0%	-5%	0%	0%	3%	0%	1%

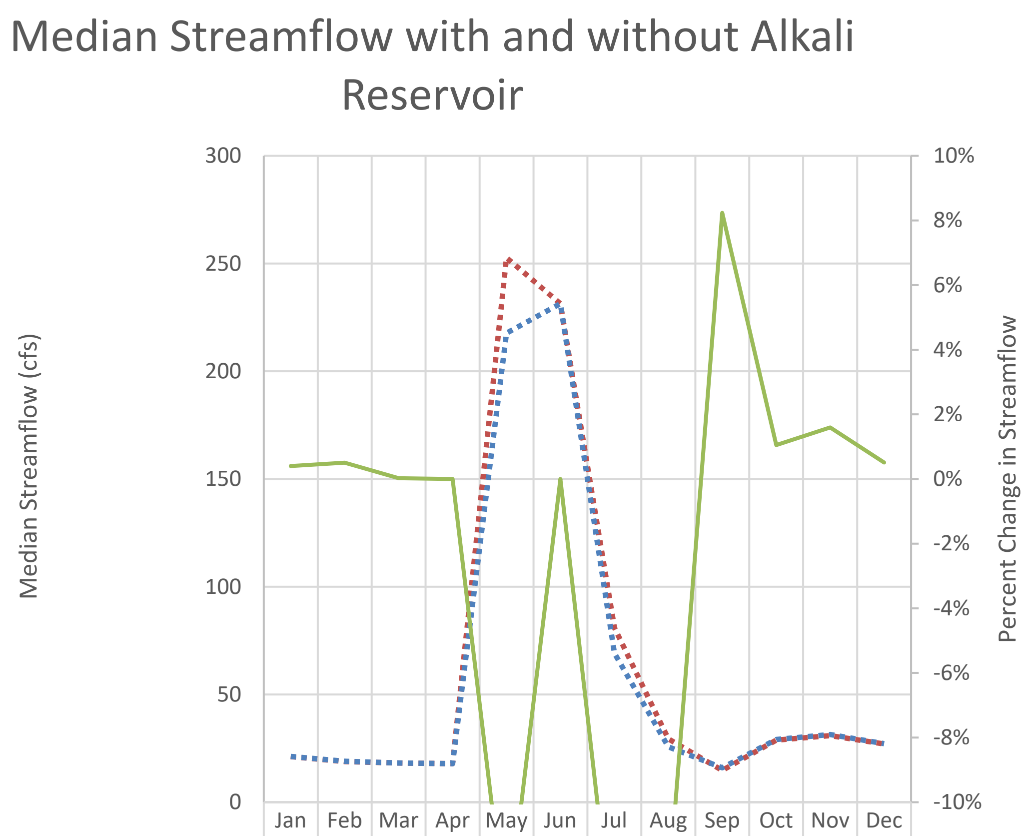
Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

2A) Paint Rock Creek upstream of Anita Supplemental Ditch



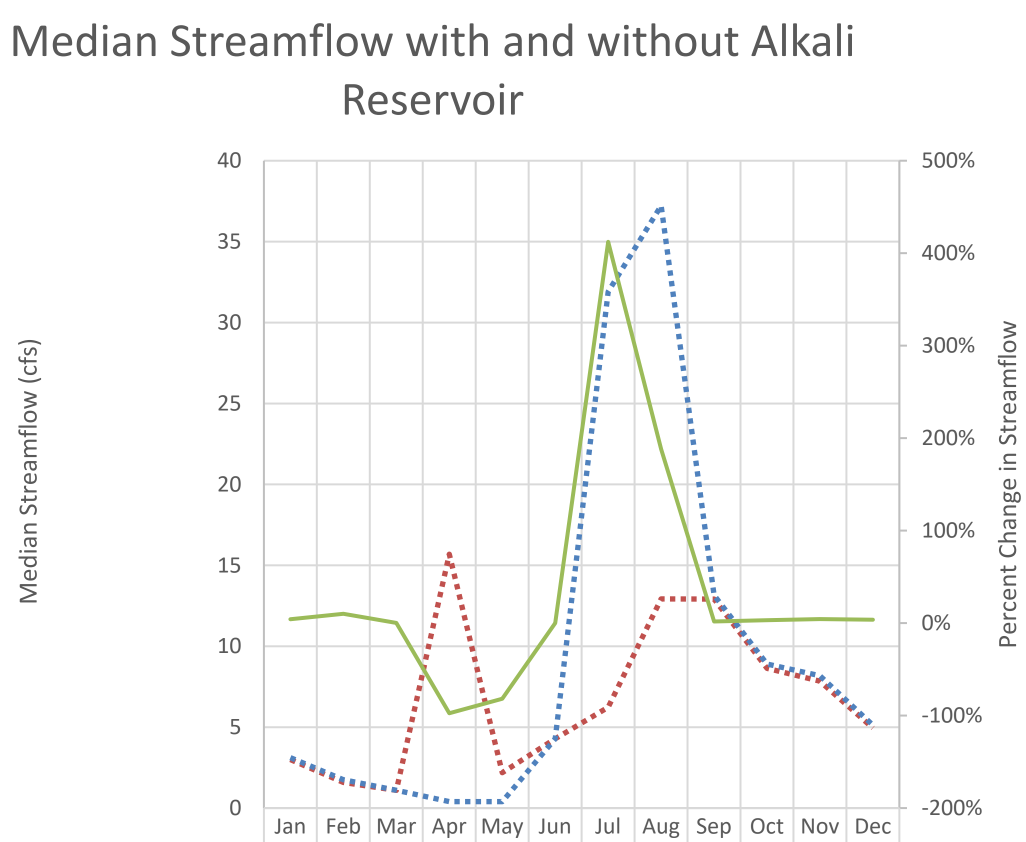
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	21	19	18	22	265	243	95	41	27	32	31	27
Dry Year - Proposed Action (with idle acres)	21	19	18	22	265	243	83	37	28	32	31	27
Percent Change	0%	1%	0%	0%	0%	0%	-12%	-10%	5%	1%	2%	1%

2B) Paint Rock Creek downstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	21	19	18	18	253	231	81	29	15	29	31	27
Dry Year - Proposed Action (with idle acres)	21	19	18	18	218	231	69	26	16	29	31	27
Percent Change	0%	1%	0%	0%	-14%	0%	-15%	-13%	8%	1%	2%	1%

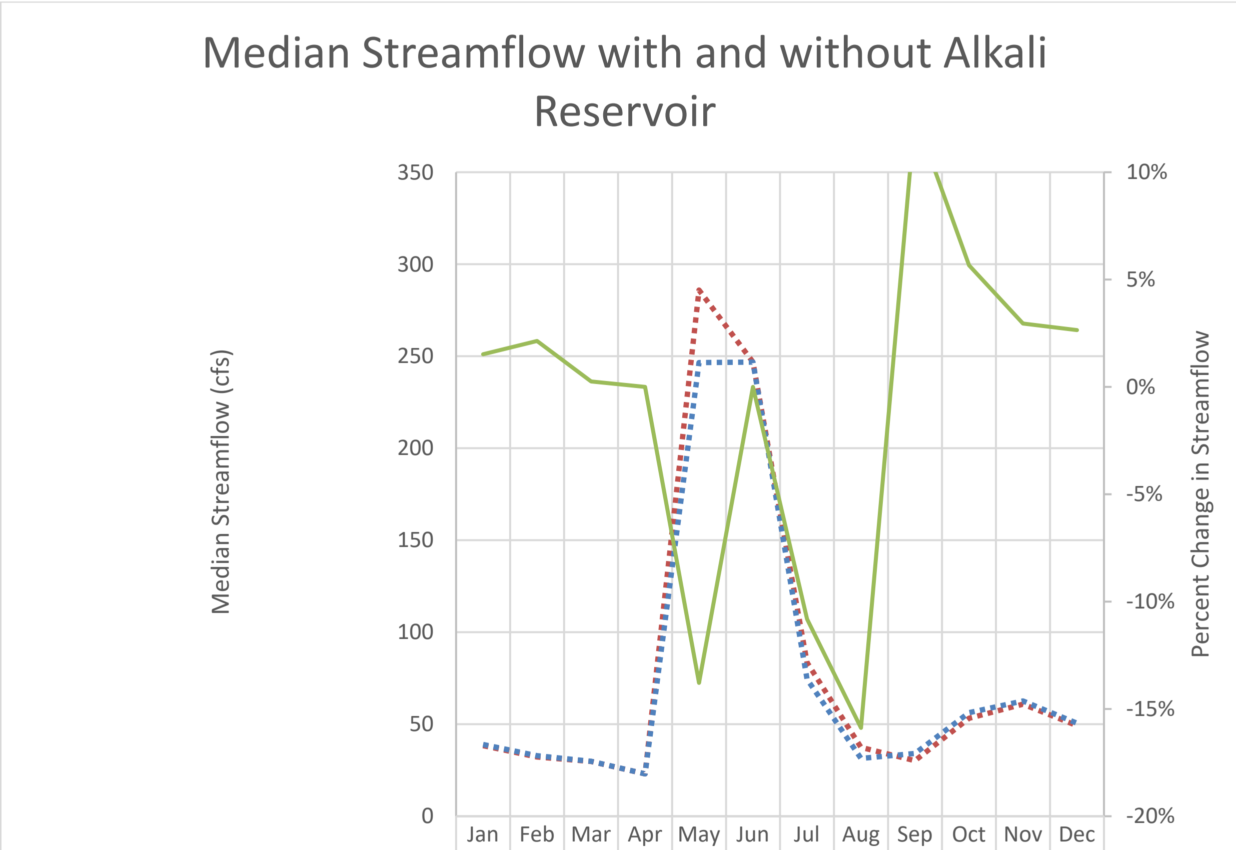
3) Alkali Creek downstream of Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	3	2	1	16	2	4	6	13	13	9	8	5
Dry Year - Proposed Action (with idle acres)	3	2	1	0	0	4	32	37	13	9	8	5
Percent Change	4%	10%	0%	-97%	-82%	0%	412%	188%	2%	3%	4%	4%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

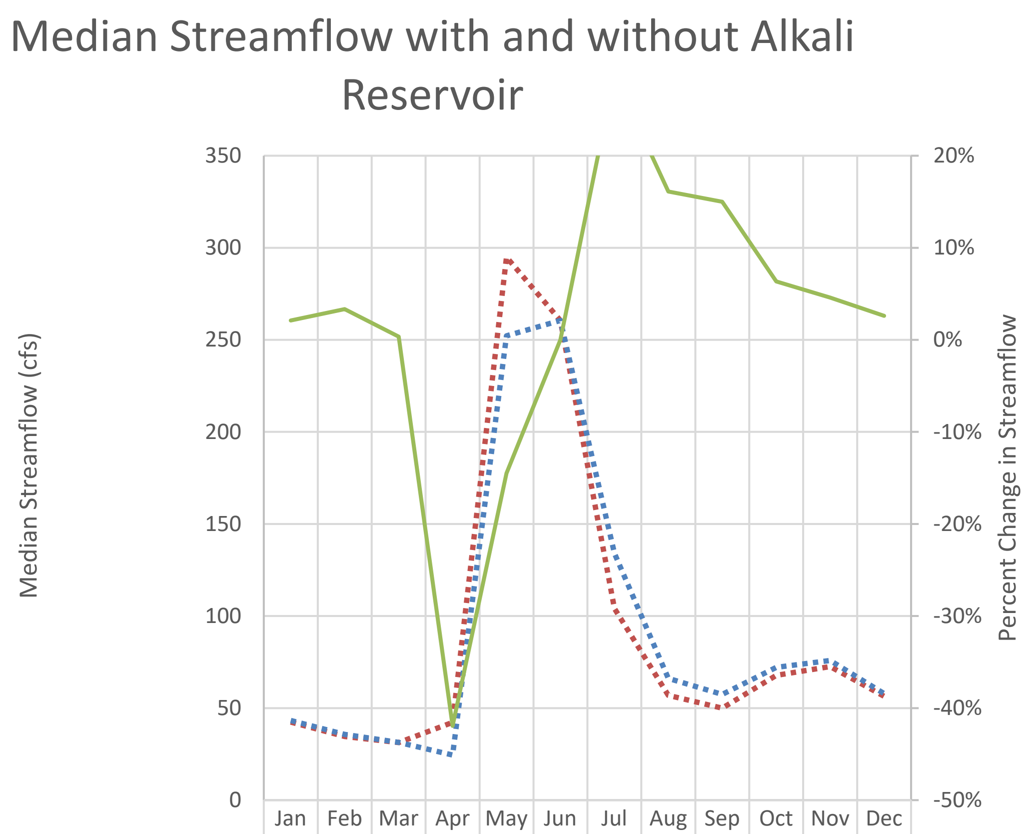
4A) Paint Rock Creek upstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	38	32	30	23	286	247	84	37	30	53	61	49
Dry Year - Proposed Action (with idle acres)	39	33	30	23	247	247	74	31	34	56	63	51
Percent Change	2%	2%	0%	0%	-14%	0%	-11%	-16%	13%	6%	3%	3%

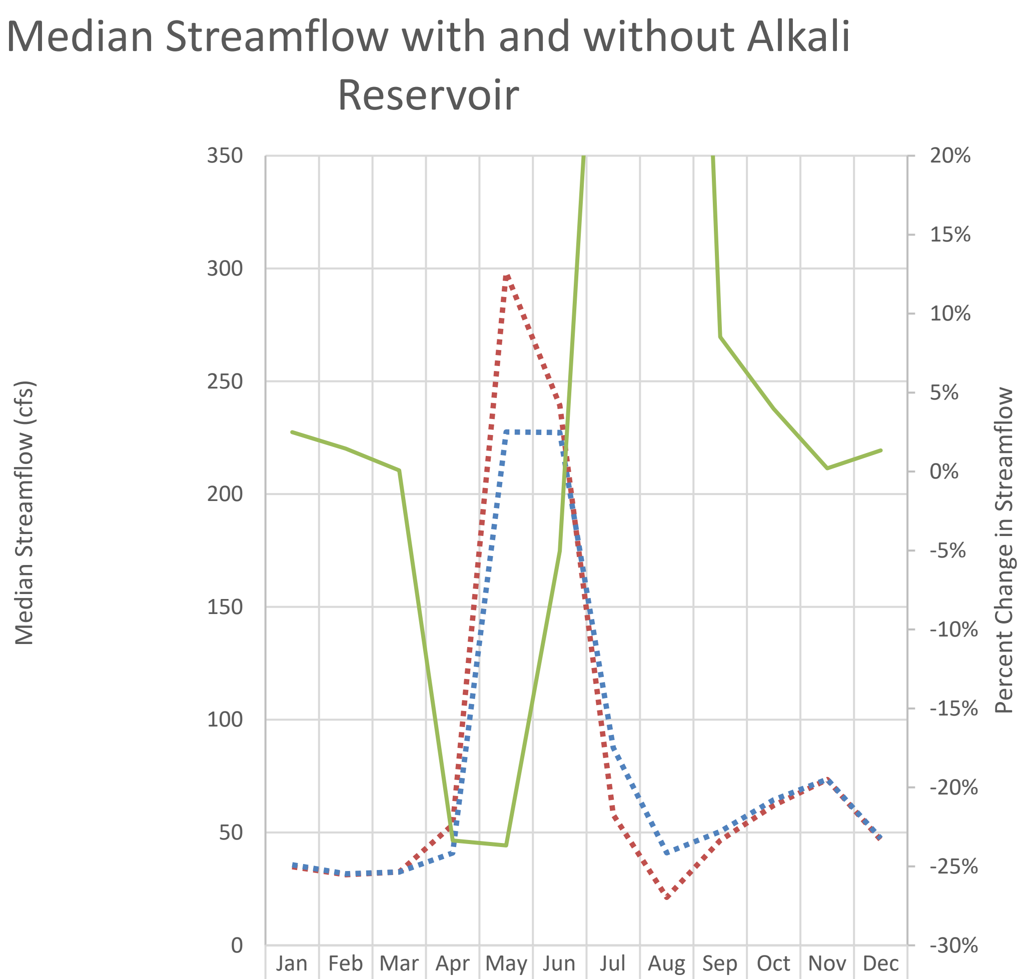
Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

4B) Paint Rock Creek downstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	42	35	31	42	295	261	104	57	50	68	73	56
Dry Year - Proposed Action (with idle acres)	43	36	31	25	252	261	134	66	57	72	76	58
Percent Change	2%	3%	0%	-42%	-14%	0%	29%	16%	15%	6%	5%	3%

4C) Paint Rock Creek at the Confluence with the Nowood River

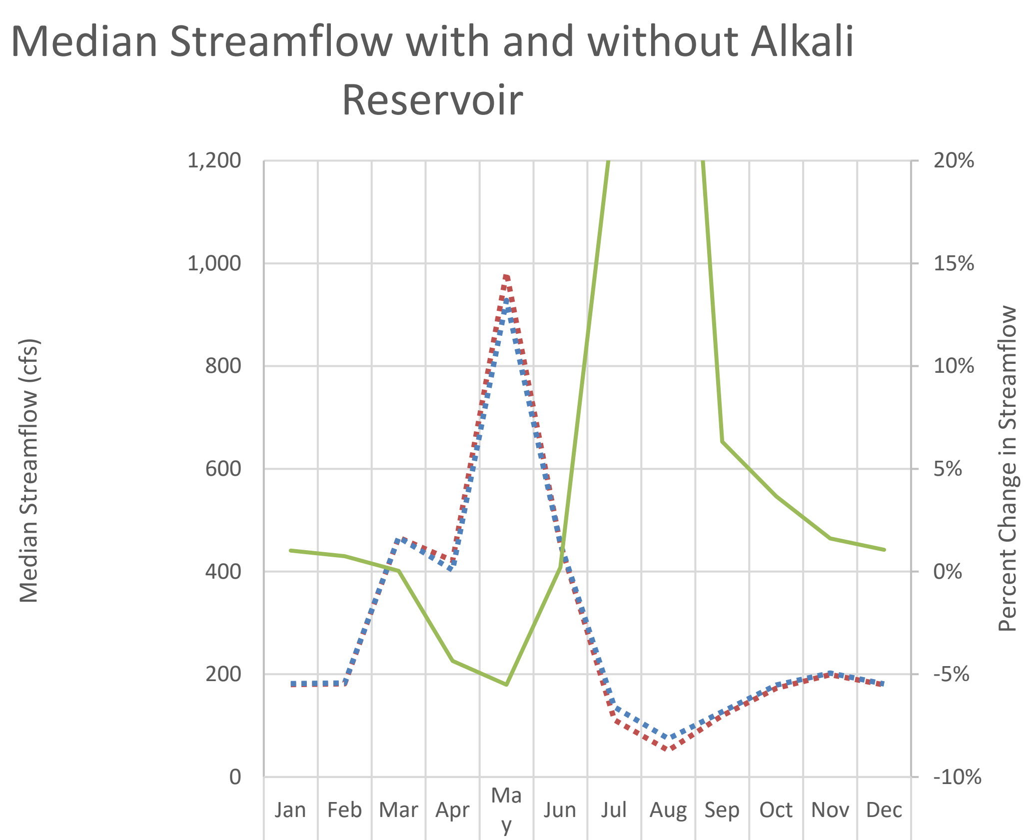


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (without idle acres)	35	31	32	53	298	239	58	21	46	62	74	47
Dry Year - Proposed Action (with idle acres)	36	32	33	41	228	227	88	41	50	65	74	47
Percent Change	2%	1%	0%	-23%	-24%	-5%	51%	93%	9%	4%	0%	1%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

WENCK
Responsive partner.
Exceptional outcomes.

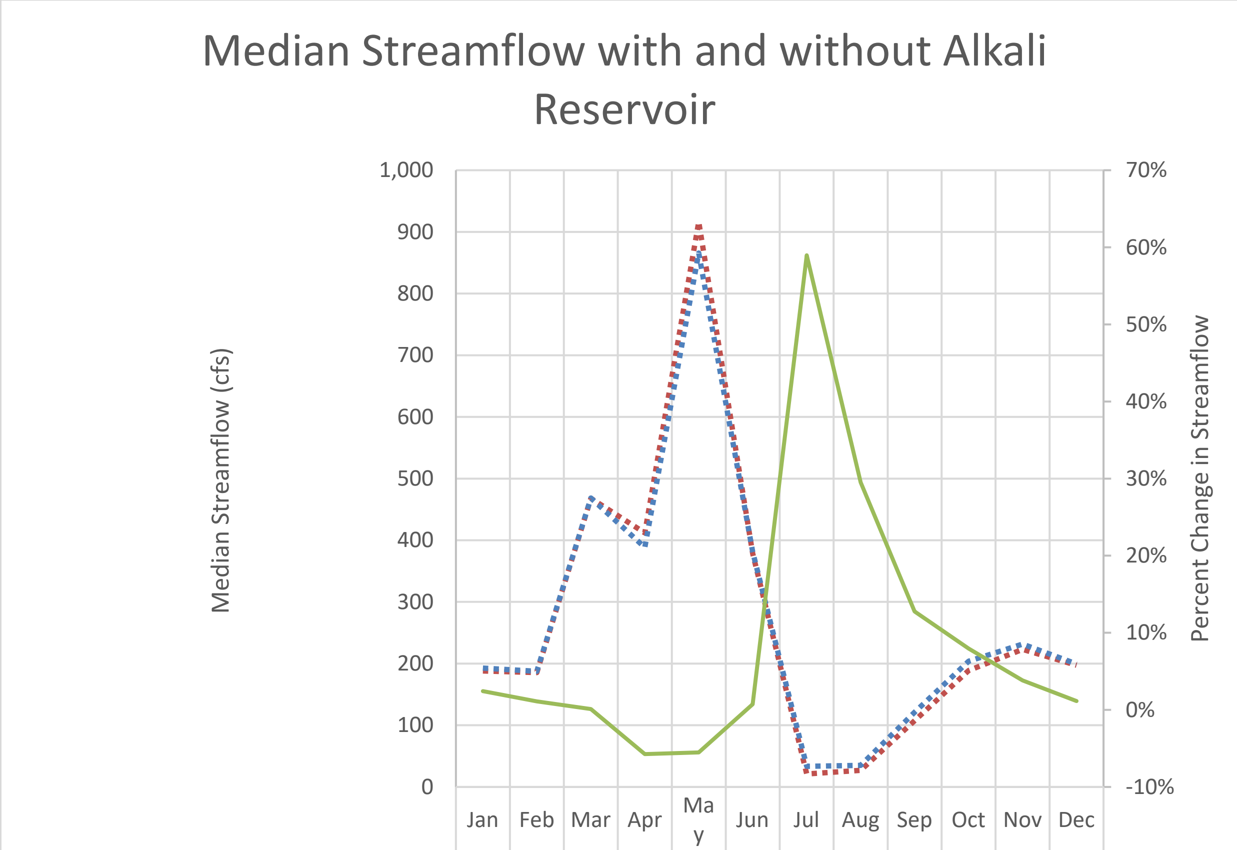
5) Nowood River below Paint Rock Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	180	182	466	421	982	454	111	52	120	173	199	179
Dry Year - Proposed Action (with idle acres)	182	183	466	403	928	454	136	75	127	179	202	181
Percent Change	1%	1%	0%	-4%	-6%	0%	23%	44%	6%	4%	2%	1%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Dry Water Year

6) Nowood River at Confluence with Bighorn River

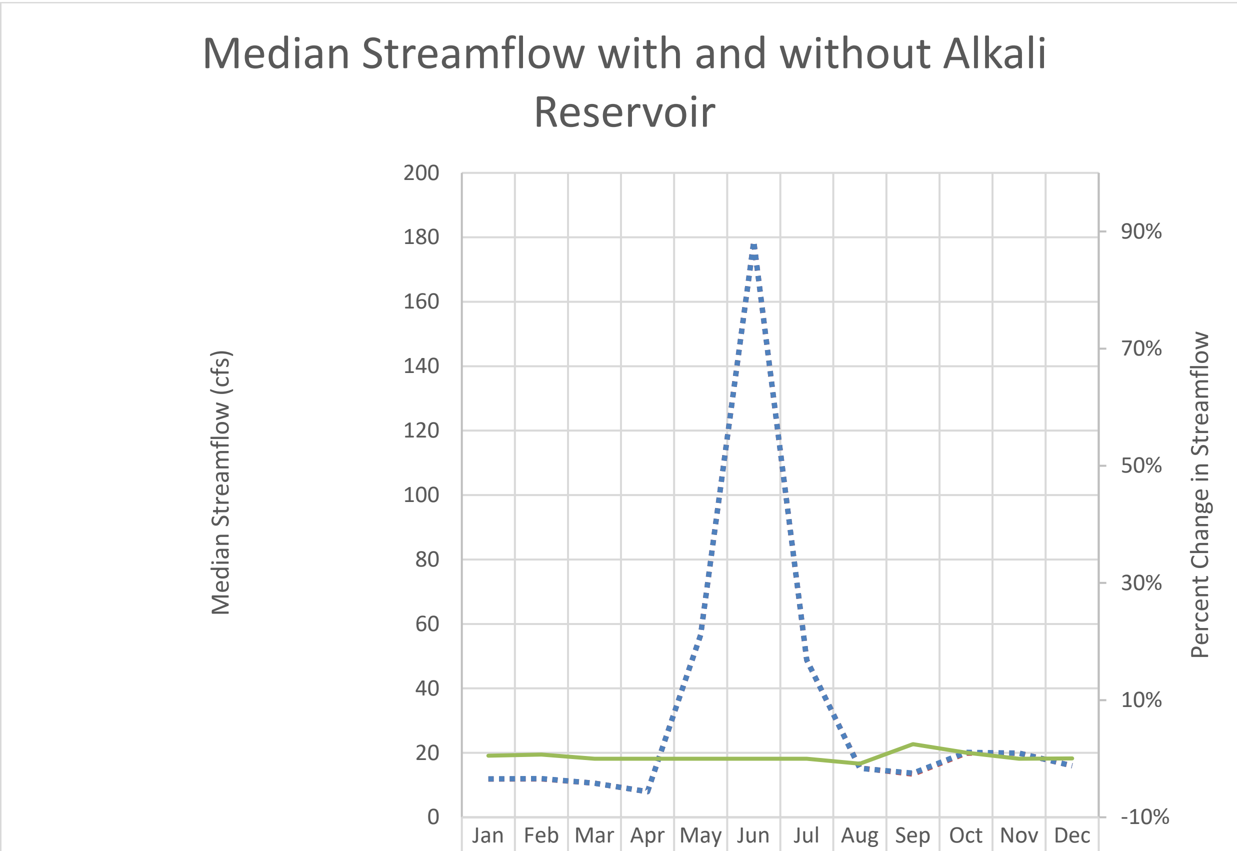


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry Year - No Action (with idle acres)	188	185	468	412	916	379	21	27	107	189	223	197
Dry Year - Proposed Action (with idle acres)	193	187	468	388	866	381	33	35	121	204	232	200
Percent Change	2%	1%	0%	-6%	-6%	1%	59%	30%	13%	8%	4%	1%

Median Streamflow During a Wet Weather Year

Alternative A – No Action (with idle acres) and Alternative B – Proposed Action (with idle acres)

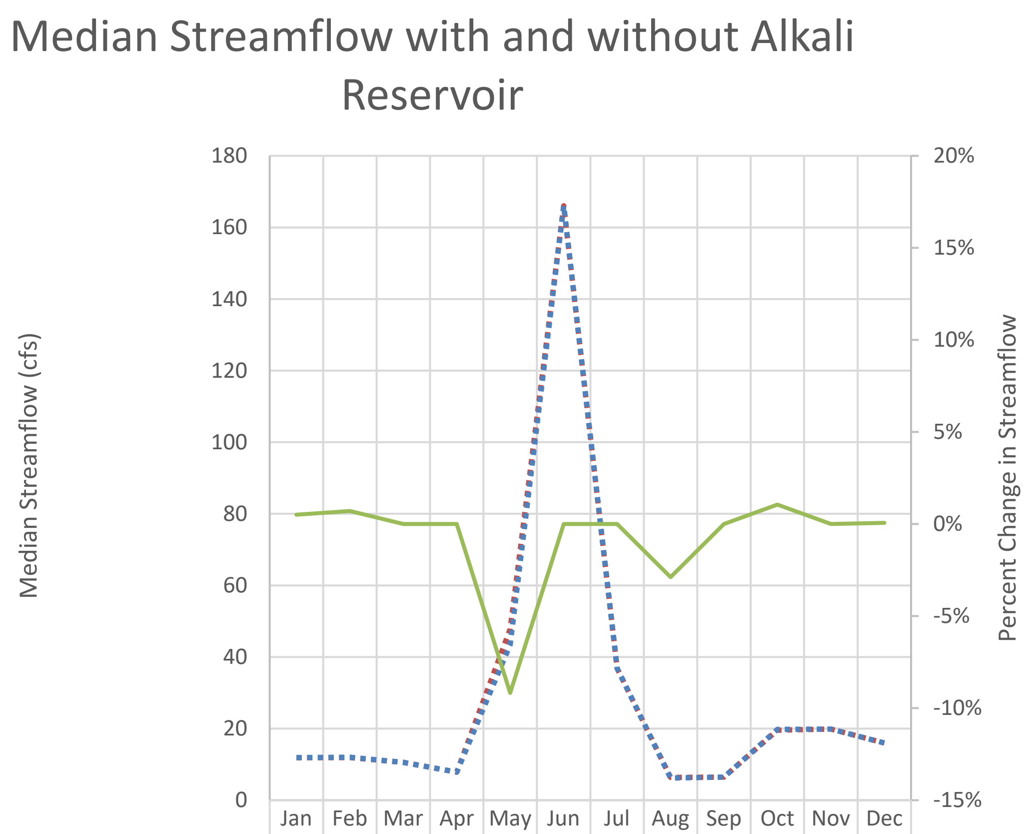
1A) Medicine Lodge Creek upstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	12	12	11	8	57	179	49	15	13	20	20	16
Wet Year - Proposed Action (with idle acres)	12	12	11	8	57	179	49	15	14	20	20	16
Percent Change	1%	1%	0%	0%	0%	0%	0%	-1%	2%	1%	0%	0%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

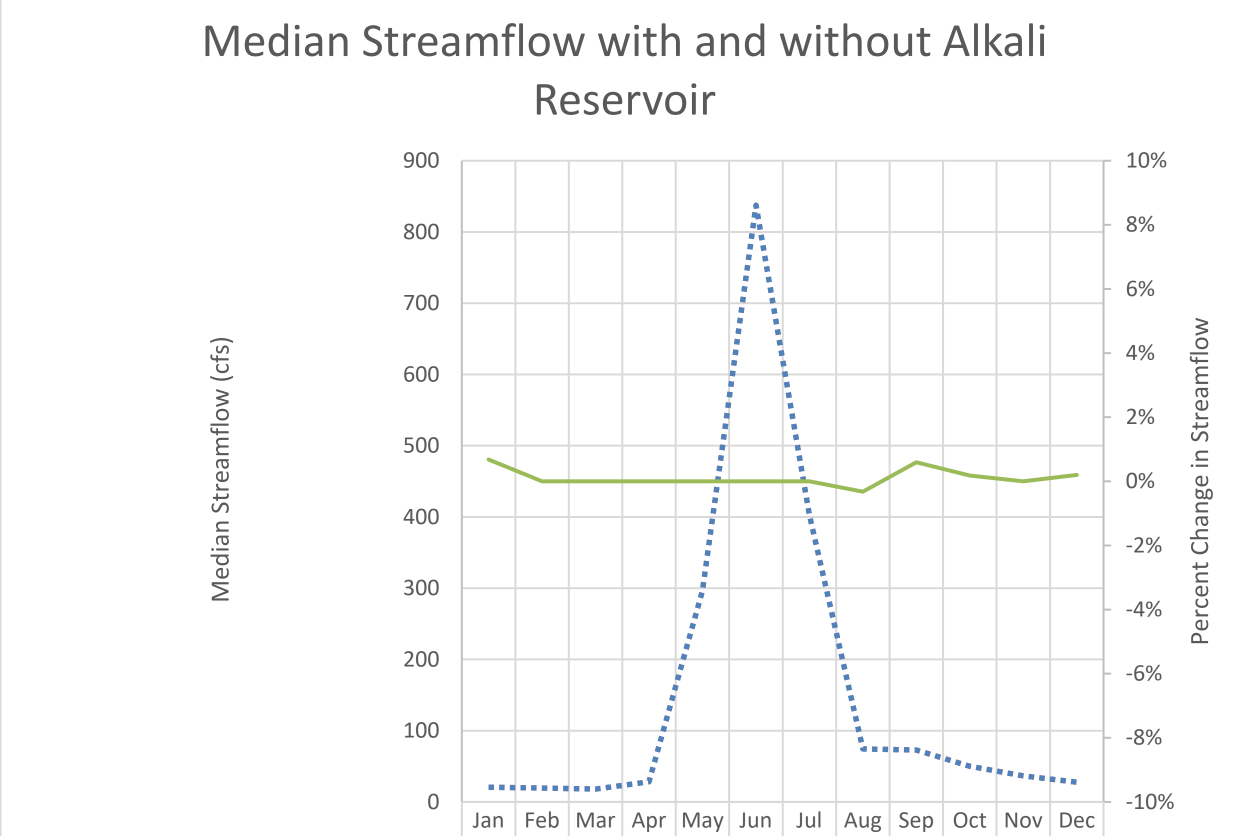
1B) Medicine Lodge Creek downstream of Anita Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	12	12	11	8	48	166	37	6	6	20	20	16
Wet Year - Proposed Action (with idle acres)	12	12	11	8	43	166	37	6	6	20	20	16
Percent Change	1%	1%	0%	0%	-9%	0%	0%	-3%	0%	1%	0%	0%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

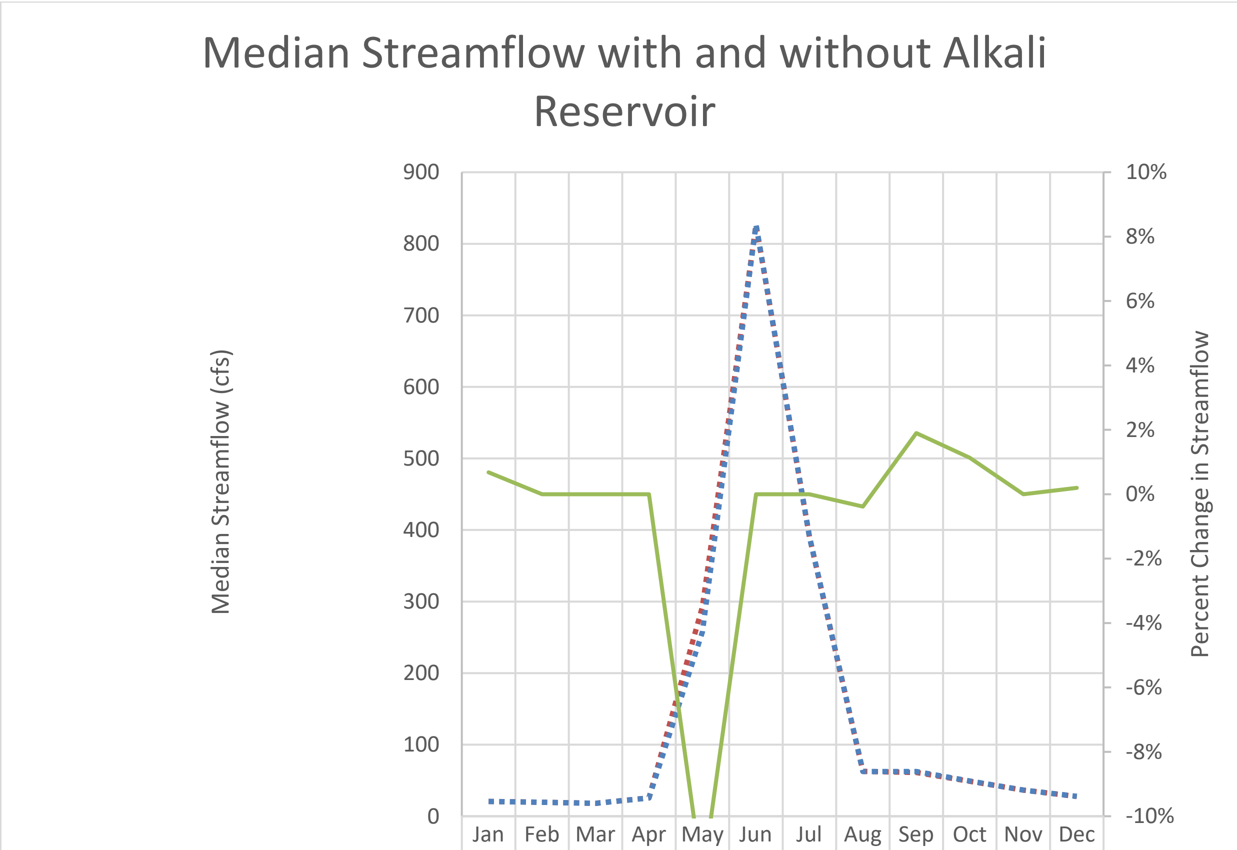
2A) Paint Rock Creek upstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	21	20	18	28	296	838	402	75	73	50	37	28
Wet Year - Proposed Action (with idle acres)	21	20	18	28	296	838	402	74	73	50	37	28
Percent Change	1%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

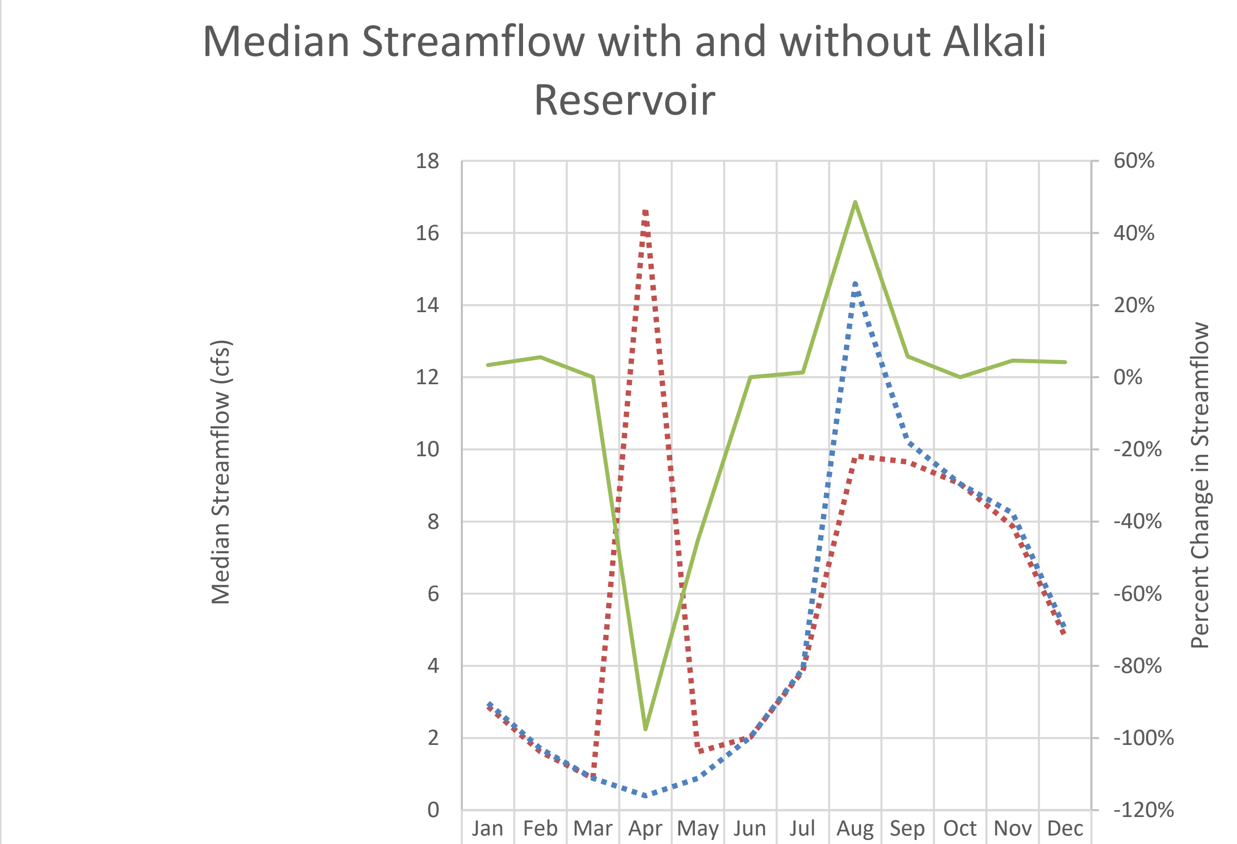
2B) Paint Rock Creek downstream of Anita Supplemental Ditch



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	21	20	18	26	293	827	391	63	61	49	37	28
Wet Year - Proposed Action (with idle acres)	21	20	18	26	258	827	391	62	62	49	37	28
Percent Change	1%	0%	0%	0%	-12%	0%	0%	0%	2%	1%	0%	0%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

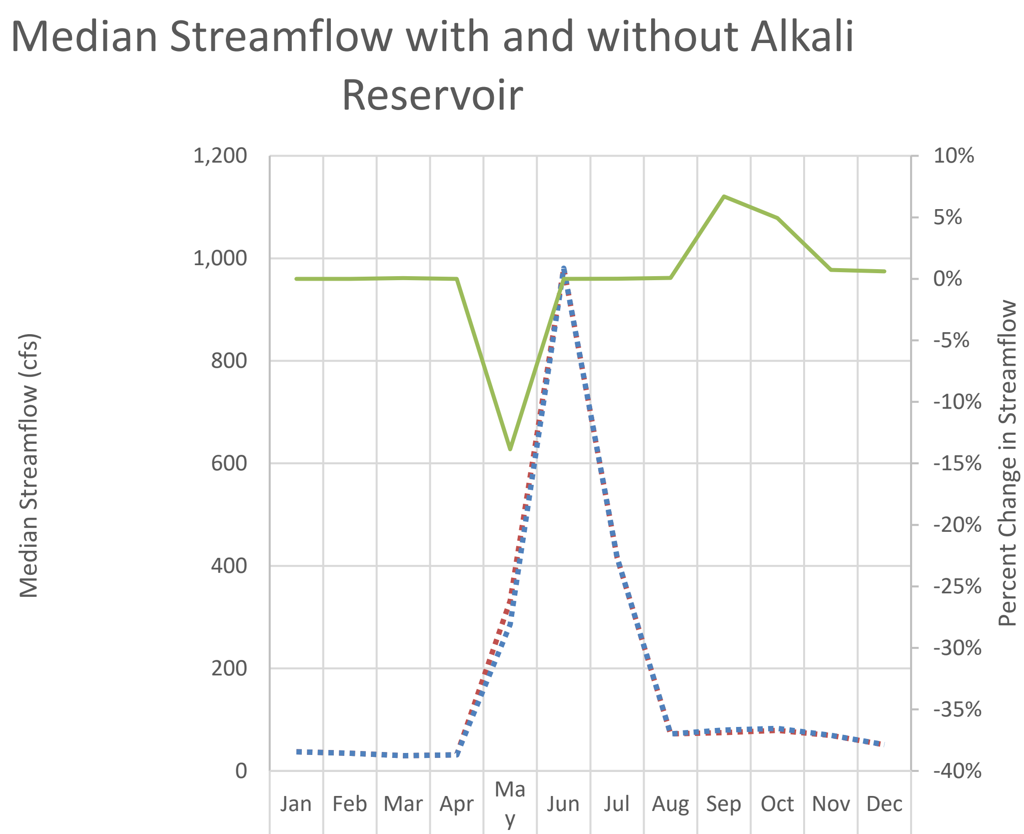
3) Alkali Creek downstream of Alkali Reservoir



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	3	2	1	17	2	2	4	10	10	9	8	5
Wet Year - Proposed Action (with idle acres)	3	2	1	0	1	2	4	15	10	9	8	5
Percent Change	3%	6%	0%	-98%	-45%	0%	1%	49%	6%	0%	5%	4%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

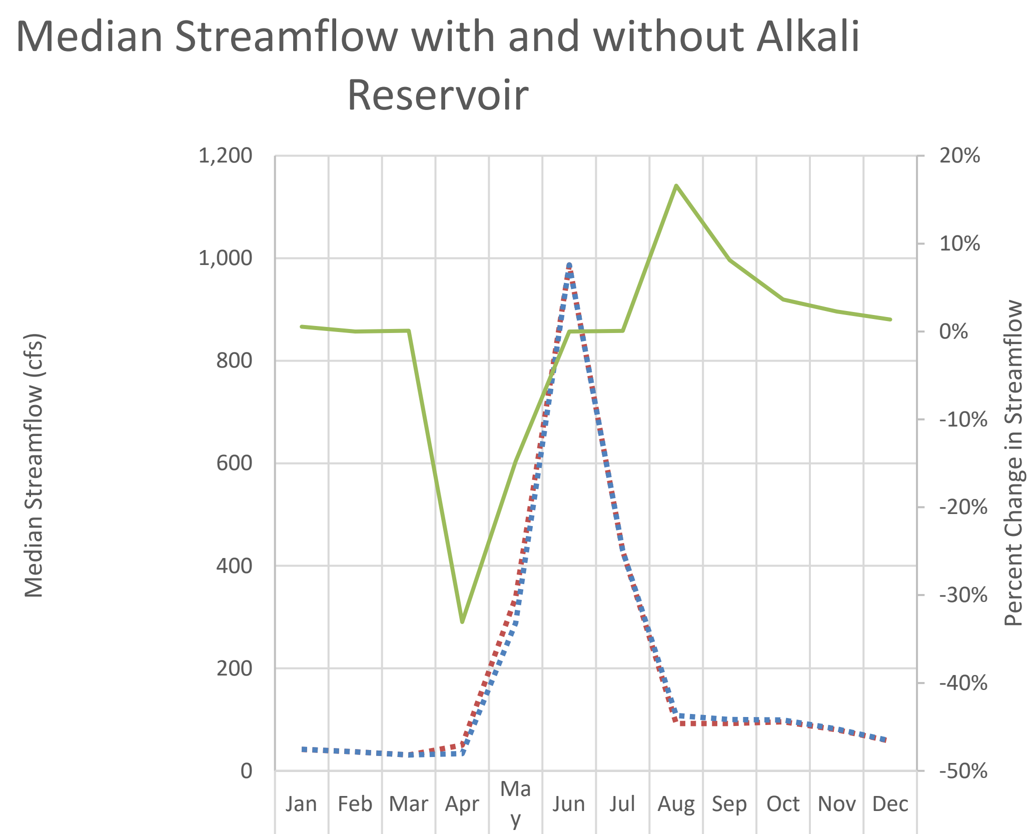
4A) Paint Rock Creek upstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	37	35	30	31	332	981	416	72	75	79	69	51
Wet Year - Proposed Action (with idle acres)	37	35	30	31	286	981	416	72	80	83	70	51
Percent Change	0%	0%	0%	0%	-14%	0%	0%	0%	7%	5%	1%	1%

Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

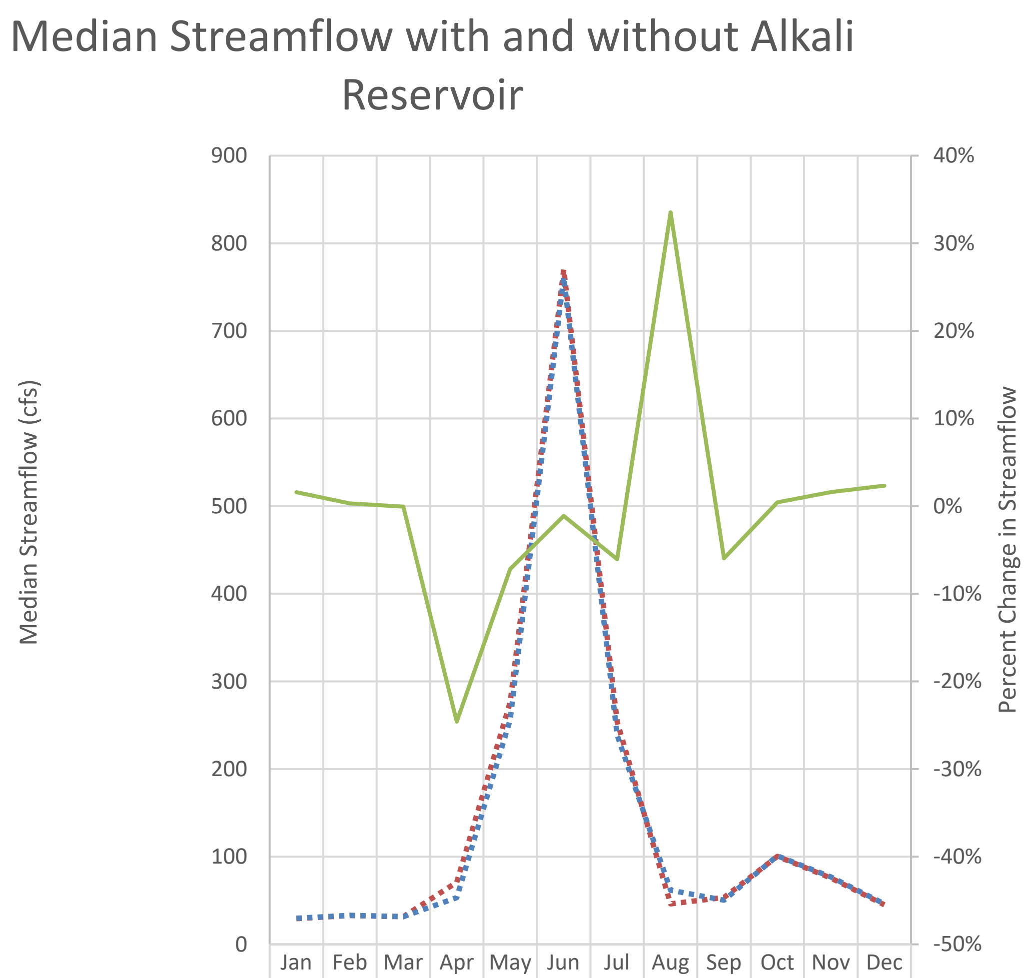
4B) Paint Rock Creek downstream of Alkali Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	42	37	31	50	338	987	429	92	92	96	80	58
Wet Year - Proposed Action (with idle acres)	42	37	31	34	288	987	429	108	100	99	82	59
Percent Change	1%	0%	0%	-33%	-15%	0%	0%	17%	8%	4%	2%	1%

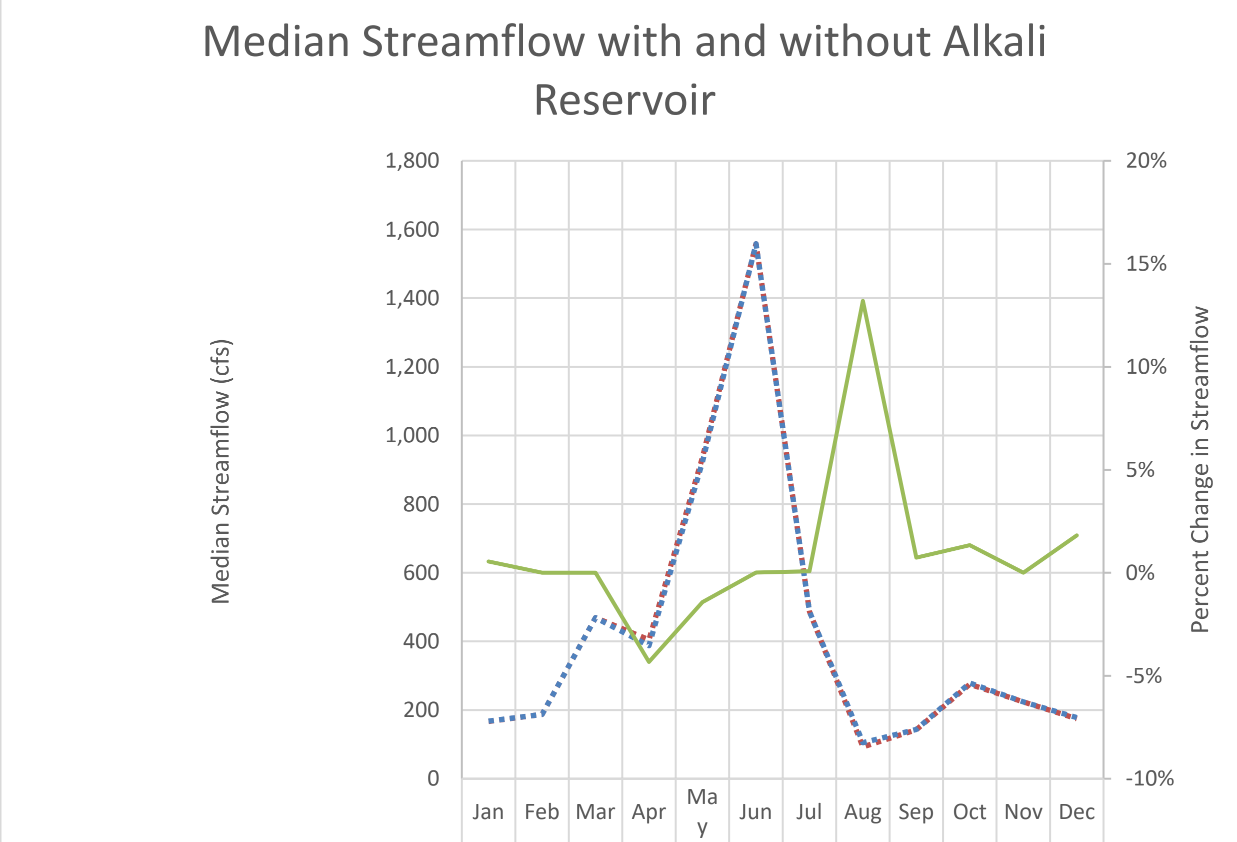
Median Streamflow
Alternative A – No Action (with idle acres) and
Alternative B - Proposed Action (with idle acres)
Wet Water Year

4C) Paint Rock Creek at the Confluence with the Nowood River



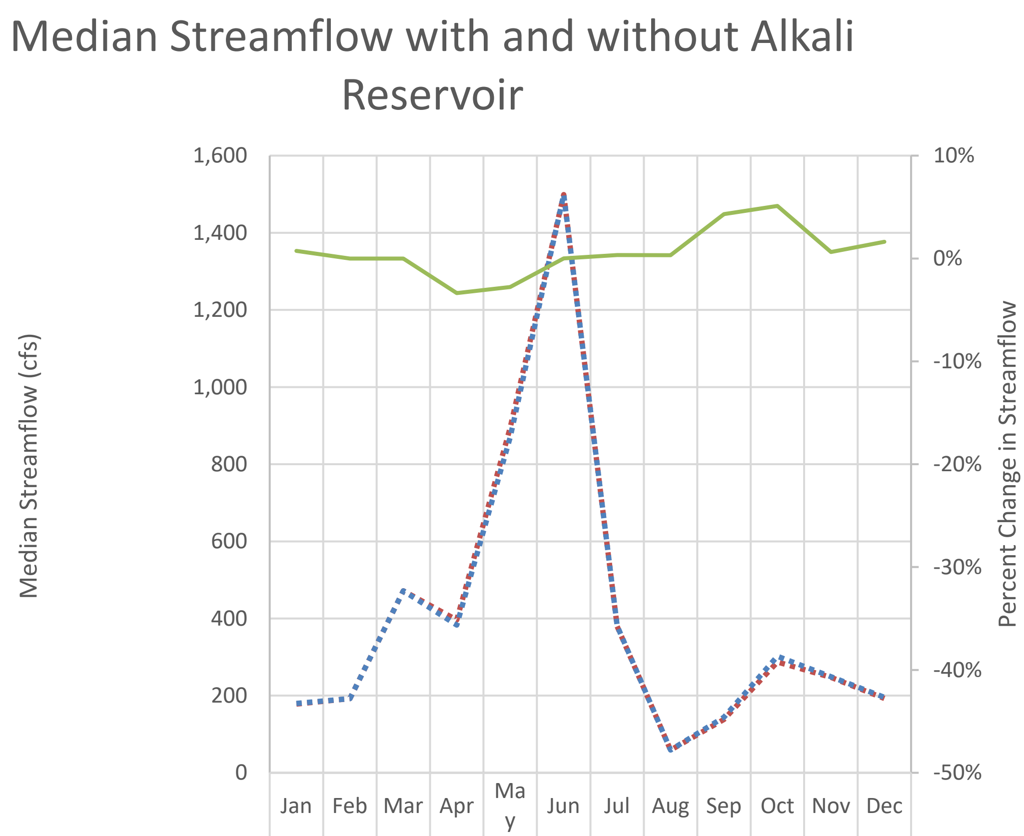
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (without idle acres)	29	33	32	71	276	770	254	46	54	100	76	45
Wet Year - Proposed Action (with idle acres)	30	33	32	53	256	762	239	62	50	101	77	46
Percent Change	2%	0%	0%	-25%	-7%	-1%	-6%	34%	-6%	0%	2%	2%

5) Nowood River below Paint Rock Creek confluence



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	167	187	469	405	936	1558	487	93	142	275	224	175
Wet Year - Proposed Action (with idle acres)	168	187	469	387	922	1558	488	105	143	279	224	178
Percent Change	1%	0%	0%	-4%	-1%	0%	0%	13%	1%	1%	0%	2%

6) Nowood River at Confluence with Bighorn River



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet Year - No Action (with idle acres)	178	192	472	396	895	1499	380	59	138	287	248	193
Wet Year - Proposed Action (with idle acres)	180	192	472	383	870	1499	381	59	144	302	249	196
Percent Change	1%	0%	0%	-3%	-3%	0%	0%	0%	4%	5%	1%	2%

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References

Trihydro Corporation. 2016. *Nowood River Storage, Level II Study, Phase II Summary Report*. Prepared for the Wyoming Water Development Commission. January 7, 2016.

Trihydro Corporation. 2016. *Nowood River Storage, Level II Study, Phase II Summary Report, Appendices*. Prepared for the Wyoming Water Development Commission. January 7, 2016.

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APPENDIX F

Responses to Comments on the Draft Environmental Impact Statement

Common Abbreviations

- EPA = Environmental Protection Agency, Region 8
- EIS = environmental impact statement
- CFR = Code of Federal Regulations
- NEPA = National Environmental Policy Act
- SEO = State Engineer's Office
- SWCA = SWCA Environmental Consultants
- USACE = U.S. Army Corps of Engineers, Wyoming Regulatory Office
- WCCD = Washakie County Conservation District
- WDA = Wyoming Department of Agriculture
- WDEQ = Wyoming Department of Environmental Quality
- WGFD = Wyoming Game and Fish Department
- WWDO = Wyoming Water Development Office
- WWP = Western Watersheds Project

Table F-1. Alternative Comments

Commenter	Comment ID	Comment	BLM Responses
WWP	009-3	The BLM instructed its consultant (SWCA) to screen potential alternatives according to a series of criteria, which include "Reliability/Yield: Is the reservoir storage site (singly or in combination) large enough to meet the need? Is there an adequate water supply to satisfy the purpose and need?" DEIS at 12. This explicitly excludes any alternative that does not involve the construction of a reservoir, and also renders the No Action alternative outside the scope of acceptable alternatives.	The 40 initial storage alternatives were evaluated by the WWDO and were later confirmed by SWCA using a different screening method (see Appendix C of the EIS). Additional alternatives were developed at a workshop, as described in Section 2.2 and Appendix C. Some of these additional alternatives do not involve the construction of a reservoir (e.g., three groundwater pumping alternatives, natural storage/beaver management, water conservation, and water leasing). More detail on these alternatives is provided in Appendix C. These non-storage alternatives were evaluated using the screening process used by SWCA for the 40 initial storage alternatives. The questions referenced are used to determine if the alternative can potentially meet the purpose and need by providing sufficient water to address late-season irrigation shortages. EISs must include a no action alternative (40 CFR 1502.14(d)). The No Federal Action alternative provides a baseline for comparison of environmental effects and does not respond to the purpose and need.
WWP	009-4	The alternative of having agricultural irrigators improve their water efficiency as a means of making up the water shortfall has not been considered. In the Bighorn Basin, many irrigators are still using 19th Century irrigation practices, with unlined canals, flood irrigation, and/or other methods that unnecessarily squander water to evaporation or runoff. Unlined canals (see DEIS at 115) increase the evaporative loss of diverted water, and also lose significant water underground to the surrounding soils. In addition, halting the flow of natural streams through impounding them also increases the surface area of water and further accelerates evaporative loss. Replacing existing open canals and channels with pipelines is an alternative likely to result in substantial water savings, potentially equal to or greater than the water that could be removed from an irrigation reservoir on Alkali Creek, to address the irrigation water needs during late-season without constructing a dam and reservoir. Also, the potential for simply withdrawing the water from a pipe intake in the Nowood River should be considered in detail. Also, what about having irrigators produce the desired water from underground aquifers, which entails little or no impacts to streams and wetlands? Under guidelines for Section 404(b)(1) of the Clean Water Act, only the least environmentally damaging alternative may be permitted, and these would seem to be much less damaging alternatives to produce the same irrigation water.	Water conservation and alluvial groundwater pumping alternatives were considered but eliminated from detailed analysis, as described in Section 2.2 and Appendix C of the EIS. The state of Wyoming has no regulatory or institutional mechanisms for requiring agricultural water conservation. A range of reasonable alternatives for this project was considered, enough to allow for a reasoned choice as required by NEPA. NEPA does not require the detailed analysis of all potential alternatives, nor does it require that a minimum number of alternatives be considered as "reasonable" or "practicable" for detailed analysis.
WWP	009-5	The cost of an alternative is an explicit criterion for alternative evaluation. DEIS at 12. The BLM has not produced cost estimates for the proposed Action as well as the various alternatives dismissed from detailed consideration. This is an important oversight. BLM also should state costs for all alternatives, both those considered in detail and those dismissed from consideration, so the public can see the differences.	The project cost criteria discussed on page 12, and the remaining criteria discussed in this section, were used to screen surface water storage site alternatives only. If needed, the cost criteria would have been used to screen alternatives only after the alternative passed the three previous screens: Screen 1. Purpose and Need & Reliability/Yield; Screen 2. Technological Feasibility; and Screen 3. Environmental Impacts. When considering the 40 reservoir sites, the cost screen was not needed as the previous screens were adequate to determine the "reasonable/practicable" alternatives. However, cost was also considered when evaluating other alternatives such as water conservation and alluvial groundwater pumping (see Appendix C). NEPA does not require an evaluation of costs for proposed actions and all alternatives, and it is not necessary in this case for BLM to make a reasoned choice. The 2016 CEQ guidance states that "NEPA does not require monetizing costs and benefits" (CEQ 2016). BLM does not customarily conduct a cost-benefit analysis in the context of a NEPA evaluation. Council on Environmental Quality (CEQ). 2016. Regulations for implementing the procedural provisions of the National Environmental Policy Act. Available at: https://ceq.doe.gov/ceq_regulations/regulations.html.
EPA	011-12	Because this project will require a CWA Section 404 permit, the alternatives screening criteria should be aligned with the Guidelines' practicability requirements and clearly stated and supported. The EIS should then describe how each potential alternative passes or fails those practicability screens.	The revised Appendix C clearly describes the practicability requirements and describes how each of the alternatives passes or fails the screens. If an alternative passed the first screen, the alternative was then evaluated in the second screen and so on. The alternatives that passed all five screens were considered "practicable."
EPA	011-13	The alternatives screening process appears to give equal weight to factors that are not treated equally under the Guidelines. For example, while impacts to seasonal range for game species may be one of the important secondary impacts to consider, impacts to aquatic resources are weighted more heavily under the Guidelines. Location within a national forest is also not an acceptable basis for eliminating an alternative from consideration.	Equal weight was not given to all the screening factors. The screening analysis in Appendix C has been revised to present this more clearly. Impacts to aquatic resources were considered to be more important than terrestrial impacts, but as previously discussed, there are terrestrial impacts that would be very difficult, if not impossible, to mitigate.
EPA	011-14	Many of the eliminated alternatives would affect fewer acres of wetlands than the ACRP; however, these smaller wetland effects are listed as a reason for eliminating these alternatives while the larger amount of wetland effects expected from the ACRP is listed as a reason for including this Proposed Action in the EIS analysis. For purposes of 404 permitting, only the least environmentally damaging practicable alternative (LEDPA) may be permitted under the Guidelines (40 CFR § 230.l0(a)). We recommend reconciling these discrepancies with a detailed practicability evaluation for any alternative with fewer effects to wetlands or other waters of the U.S.	The BLM's screening of storage alternatives was conducted to validate Trihydro's initial screening of the 40 alternative reservoir sites in the Level II study (2013). Based on the technical and environmental information presented in the Level II study, BLM was able to use a different screening approach and conduct an apples-to-apples comparison to confirm that the proposed Alkali Creek Reservoir was the best candidate to be included in the draft EIS for detailed analysis. The information provided in the EIS for the Alkali Creek Reservoir project was the result of additional, more detailed analysis completed for that alternative. The amount of impacted wetland acres changed from Trihydro's initial assessment to what was ultimately presented in the draft EIS. Similar changes would likely occur for other alternatives analyzed in more detail.

Commenter	Comment ID	Comment	BLM Responses
EPA	011-15	Operation and maintenance costs are listed as a reason for eliminating many alternatives, but such costs are not evaluated for the ACRP. The Guidelines focus on whether the cost of an alternative is within the range of similar projects or industry norms in a region rather than on whether costs are more than or less than another alternative. The Draft EIS does not evaluate the former aspects of cost. With regard to the Water Conservation Alternative, we note that center pivot sprinkler irrigation in this alternative can have lower annual operating costs than flood/furrow irrigation in the ACRP due to fewer field operations and lower pumping costs, and that the savings afforded by center pivot irrigation can produce benefits that exceed the additional investment cost.8 9 Given that cost is the basis for screening out these alternatives, we recommend including detailed documentation and evaluation of the cost of constructing, operating and maintaining the ACRP and any alternative which may have been dismissed from further analysis due to, in whole or in part, cost. Evaluating the costs of different types of piping 1°, as well as the cost of lining ditches vs. piping water, may be warranted.	Please see the response to WWP 009-5 under Alternatives Comments. Regarding operations and maintenance costs: Cost was not a consideration in the elimination of all the reservoir alternatives. Alternatives that require new diversions, pumping, and miles of new piping, canals, and tunnels would incur greater operations and maintenance costs than gravity systems that have much of the delivery infrastructure already in place. Pumping requires maintenance of equipment and ongoing electrical power costs. The WWDO has set the norms for agricultural water development projects in the state of Wyoming. Cost has not been a determining factor in the advancement or elimination of reservoir alternatives. Cost was considered a factor to eliminate the deep groundwater alternatives. Funding or requiring implementation of conservation practices is not within the institutional or regulatory mandate of the WWDO. Thus, there is no mechanism (other than encouraging voluntary conservation) for implementing conservation practices other than very limited funds available from the USDA or Wyoming Farm Loan Board programs. Conservation does not provide late-season, post-runoff irrigation water when stream flows are at their lowest. Cost is not, and never has been, a factor for eliminating conservation as an alternative to the ACRP.
EPA	011-16	Many alternatives are eliminated, in part, on the basis that they would require diversion from the Nowood River and piping/pumping/a tunnel or because they would provide insufficient water supply without constructing a new diversion. According to the Draft EIS, while piping from the Nowood River would result in additional costs, some of these alternative reservoirs (e.g., Cottonwood Creek Reservoir) would cost less to construct than the ACRP, helping to offset the cost of piping. If these alternatives are determined to be practicable under the Guidelines and would reduce impacts to aquatic resources compared to the ACRP (as it appears that some have the potential to do), it will be important to analyze them in detail.	Clarifying information has been included in Appendix C of the final EIS. The Cottonwood Creek Reservoir alternative was eliminated in Screen 2. Because of topography, soils, and geology, the reservoir would have significant constructability issues. Conveyance losses would be a factor. The reservoir would be unable to supply lands in the Paint Rock Creek drainage above the confluence with the Nowood River without another diversion from the Nowood River requiring pumping, piping, and a tunnel resulting in additional (but uncharacterized) aquatic effects. The Cottonwood Reservoir could only serve lands in the Paint Rock Creek drainage through exchange that the Alkali Creek Reservoir would serve directly.
EPA	011-17	Conveyance losses and lower storage capacity are indicated as reasons for eliminating several alternatives from detailed analysis. Additional information on conveyance losses is needed to understand this reasoning, and it is important to consider whether such alternatives could be combined with water conservation or other alternatives to reduce the stated need to a similar extent as the proposed project. No combinations of alternatives were evaluated in the Draft EIS. It appears that several alternatives may reduce impacts to aquatic resources compared to the ACRP, and potentially fulfill the need to a similar extent as the ACRP if at least two are combined. If it is possible to extend the area served by exchange to include the reach of Alkali Creek below the proposed project, alternatives that would only divert from the Nowood River could present opportunities to avoid impacts to water quality. We recommend evaluating whether these options are practicable under the Guidelines.	The Wyoming State Engineer’s Office has determined that conveyance losses on Wyoming streams are 1% per mile. This depends on the size of the stream, the topography and elevation, stream gradient, extent of alluvium, proximity to bedrock, the extent and health of the riparian ecosystem, the time of year, and many other factors. In the case of the ACRP, the distance from the confluence of the Nowood River and Paint Rock Creek upstream to the Town of Ten Sleep is 38.8 miles. Therefore, we assumed that any reservoir releasing flow into the Nowood River upstream of Ten Sleep would lose at least 38.8% of the water released from storage. Finally, there were no reservoir sites located in the Nowood basin above the confluence with Paint Rock Creek that could serve the needs of the Paint Rock Creek Basin above the confluence with the Nowood River without a diversion from the Nowood River. The needed diversion would be potentially more impactful to the aquatic environment and may affect fish species of concern (e.g., sauger, flathead minnows, burbot). Combinations of reservoirs were considered. These were rejected based upon water supply, logistics (location), geology (foundation flaws), combined environmental impacts (aquatic and terrestrial), or the combined cost of two or more alternatives.
EPA	011-18	The effects of the ACRP on sage grouse habitat is minimized by calculating the percent of habitat affected. These calculations are not made for other alternatives that were screened out of the Draft EIS, in part, on effects to sage grouse habitat.	This comment is noted. However, in addition to aquatic impacts, some of the alternatives that were eliminated in the environmental screening process had greater impacts to sage-grouse habitat than ACRP.
EPA	011-19	Several alternatives are eliminated, in part, due to impacts to fisheries and special status species; however, the Draft EIS identifies that these resources also occur in the streams that would be adversely affected by ACRP including: Species of Greatest Conservation Need, State of Wyoming Red Ribbon fisheries habitat, crucial habitat priority areas, and aquatic conservation areas defined to protect riparian corridors and habitat for native fish, amphibians, turtles, and mollusks. We recommend resolving these discrepancies.	In the draft EIS, Environmental Effects was the fourth of six hierarchical screens applied to potential alternatives. All contributing factors for dropping alternatives from detailed analysis in the draft EIS were included in Table C-1 in a combined and bulleted list. The list incorrectly implied that all screening criteria were equal in weight and neglected to explicitly indicate at which screen an alternative was dropped and for what reason. At the Environmental Effects screen, alternatives may have dropped out for a number of reasons, including potential impacts to aquatic species. The revised Appendix C in the final EIS clarifies the hierarchical screening that was applied.

Table F-2. Cumulative Effects Comments

Commenter	Comment ID	Comment	BLM Responses
WDA	006-2	The BLM later discusses potential dam failure and potential adverse impacts of failure (Section 4.8.2; pg. 154), yet never makes a connection between statements in 4.8.1 (pg.153) and the project itself. If the intent of Section 4.8.1 is to illustrate the ongoing and potential future actions that could be impacted by a dam failure this is not being clearly conveyed. If this Is the intent, the BLM should qualify all statements with "In the event of dam failure ... " or similar. We suggest the BLM review 40 CFR 1508.7 definitions and appropriately tailor the discussion within the analysis	The list of contributing cumulative actions provided in Section 4.8.1 is not a list of cumulative effects. It is a list of individual actions that when added together may contribute to cumulative public health and safety effects. A contributing cumulative action is not the same as a cumulative effect. The cumulative effects analysis looks at whether the Proposed Action and Modified Proposed Action would add incrementally to other contributing actions to create cumulative effects on a particular resource. Therefore, the intent of Section 4.8.1 is not to illustrate ongoing and future actions that could be impacted by dam failure, but to provide a list of past, present, and reasonably foreseeable actions that when added together with any incremental effect from the Proposed Action or Modified Proposed Action would be considered a cumulative impact. The first two paragraphs in Section 4.8.2 describe potential contributing cumulative actions from the Proposed Action and Modified Proposed Action (hazardous material releases and dam failure). The third paragraph evaluates whether potential hazardous material releases and dam failure would add incrementally to other contributing actions in the analysis area to create a cumulative impact.
WWP	009-12	The cumulative effects analysis is inadequate because it does not consider the cumulative effects of current irrigation withdrawals and water level changes with the added changes to be approved as a result of the Alkali Creek Reservoir project. The CIAA properly includes the project area downstream to the confluence of the Nowood and Bighorn Rivers (DEIS at 148), but also should include all waters downstream from the Anita Ditch and Anita Supplemental Ditch and all reservoir outlets associated with irrigation water storage and diversions in the affected watersheds, to account for the cumulative impacts of this diversion. Unfortunately, the BLM then fails to venture any cumulate impacts analysis of past and proposed water withdrawals and additions on the streams within this boundary	The cumulative effects analysis does consider past and present irrigation withdrawals qualitatively as described in Section 4.1.2.1. These are included as “agricultural uses such as farming and ranching” in the list of past and present actions. This sentence has been modified to read “agricultural uses such as farming and ranching (e.g., water withdrawals).” For surface water, the CIAA includes water downstream of Anita Ditch and Anita Supplemental Ditch (this consists of Medicine Lodge Creek and Paint Rock Creek below the point of diversions). Any reservoir outlets would also be incorporated because the CIAA includes stream reaches from the point where water is diverted from Alkali Creek (which would consist of the reservoir) and downstream. The cumulative effects of the Proposed Action and Modified Proposed Action on streams are discussed in Section 4.15.2.2. Section 4.15.2.2 has been edited to better incorporate contributing cumulative actions.
WWP	009-13	See DEIS at 158. Similarly, surface water quality fails to take into account past impacts on water quality from pre-existing irrigation, roads, agricultural land uses, and other human impacts. DEIS at 158. The BLM should also quantify the relative contributions of livestock grazing versus septic systems, which would seem to be a relatively minor contributor to *E. coli* contamination given the sparse residential development in the area.	Surface water quality does take into account past impacts on water quality as described in Section 4.15.3.1 (“farming and ranching activities”). Quantification of the relative *E. coli* contributions of livestock grazing versus septic systems is outside the scope of this analysis because the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the proposed action and alternatives, when combined with past, present, and reasonably foreseeable actions, on a particular resource. The CEQ’s 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that “CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions.” In addition, CEQ regulations “do not require agencies to catalogue or exhaustively list and analyze all individual past actions.” Sections 4.15.1.2 and 4.15.3.2 have been edited to better incorporate contributing cumulative actions for surface water and water quality.
WWP	009-14	The irrigation withdrawals, acreage of irrigated lands, and historic impacts of irrigation within these stretches of waterway should be available, and historic, pre-irrigation photographs as well as accounts and records of streamflows and patterns should be available to BLM. It is necessary to undertake this historical research as part of the cumulative impacts analysis to determine the extent to which stream and river flow patterns deviate from pre-settlement, natural patterns, so that the additive alterations resulting from the construction and operation of the Alkali Creek Reservoir can be evaluated in the context of cumulative impacts on waterways, fisheries, and land uses.	Under NEPA, the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the proposed action and alternatives, when combined with past and present actions, on a particular resource. The CEQ’s 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that “CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions.” In addition, CEQ regulations “do not require agencies to catalogue or exhaustively list and analyze all individual past actions.” Historical research on the extent that stream flow patterns deviate from pre-settlement patterns is therefore outside the scope of this analysis and not necessary for the BLM to make a reasoned choice between alternatives.
WWP	009-16	The direct effects on wetlands (including springs) are not evaluated in the context of a cumulative effects analysis, because the BLM has made no attempt to evaluate the extent to which wetlands along Alkali Creek, Paint Rock Creek, Medicine Lodge Creek, and the Nowood River have already been impacted or eliminated as a result of past irrigation practices, farming and ranching, land conversion, or construction of roads, pipelines, and overhead or buried telephone or power lines. DEIS at 160.	Under NEPA, the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the proposed action and alternatives, when combined with past and present actions, on a particular resource. The CEQ’s 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that “CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions.” In addition, CEQ regulations “do not require agencies to catalogue or exhaustively list and analyze all individual past actions.” The in-depth analysis suggested is not necessary because the USACE will require compensatory mitigation for permanent wetlands losses caused by the project. As a result, cumulative effects to wetlands would be limited under the Proposed Action and Modified Proposed Action. With regards to past actions, farming and ranching, land conversion, and construction of roads, pipelines and power lines are likely to have had minimal effects to either naturally occurring or irrigation–induced wetlands. Generally, the effect of irrigation has likely been neutral or beneficial to wetlands in the area.

Commenter	Comment ID	Comment	BLM Responses
WWP	009-21	The Cumulative Impacts Analysis Area (CIAA) for the project is absurdly restricted to "the project area with a 0.25-mile buffer." DEIS at 151. This is entirely inappropriate. The effects of irrigation on land use extend throughout the entire Paint Rock, Medicine Lodge, Alkali Creek, and Nowood watersheds. This is therefore the appropriate CIAA for the project on land use. Past conversion of native habitats to irrigated pasture or tilled croplands for hay, alfalfa, or human food crops has resulted in major impacts to native wildlife, in addition to the obvious impact that stream dewatering and changes in flow patterns stemming from irrigation have resulted in major losses of aquatic habitat and biodiversity over the century-plus history of irrigated agriculture in the Bighorn Basin. The instant project will result in additional irrigation of thousands of acres, and this conversion of habitats must be fully evaluated, both directly and cumulatively with all the other habitat losses within these watersheds that result from the conversion of native plant communities to irrigated pasture or cropland. What are the current land and habitat statuses of the thousands of acres into which irrigation will expand as a result of this project? What will the impacts of converting these habitats to irrigated croplands or pastures be on the native wildlife that may depend on them for habitat?	The CIAA for land use was not modified because the 0.25-mile buffer is established in the Worland RMP for recreation sites. In addition, the cumulative effects analysis looks at the incremental impact of the land use changes caused by the Proposed Action or Modified Proposed Action. These land use changes (conversion of a riparian area to a dam and a reservoir) occur within the project area; the 0.25-mile buffer incorporates peripheral land uses and any potential conflicts or edge effects where there may be an incremental impact. The cumulative effects of the project on surface water and wildlife habitat are discussed in Section 4.15.1 and 4.18, respectively. More detail on past human activities in the wildlife CIAA has been added to Section 4.18.1. Habitat loss is discussed as a direct impact of the Proposed Action and the Modified Proposed Action in Sections 3.18.4.2.1 and 3.18.4.3.1, respectively. BLM notes that currently idle but permitted irrigable acres may go back into production independent of the proposed reservoir. However, it is reasonable to assume that a reliable water supply may also encourage some of the idle but permitted irrigable lands to go into production. It is not known with any certainty how many acres may be put into production following completion of the proposed project; this acreage cannot be quantified and associated with habitat loss at this time.
WWP	009-25	BLM must consider all of the impacts of past human activities in the CIAA on big game and raptor populations, and on the populations of all Sensitive Species (state or BLM), in order to credibly conduct a cumulative effects analysis that places the impacts of the Alkali Cree Reservoir impacts in meaningful context. BLM must also provide distribution and population trends for BLM and state-listed Sensitive Species, which is important baseline information. Instead of undertaking a cumulative effects analysis, BLM merely lists the additive effects of the project, without considering the degree to which these add to pre-existing effects from foregoing projects and pre-existing human structures, land uses, and activities. DEIS at 161. This is flatly inadequate.	Under NEPA, the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the proposed action and alternatives, when combined with past and present actions, on a particular resource. The CEQ's 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that "CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions." In addition, CEQ regulations "do not require agencies to catalogue or exhaustively list and analyze all individual past actions." Provision of distribution and populations trends is therefore outside the scope of this analysis. In addition, distribution and population trend data for special status species are not available for the CIAA. Section 4.18.2 has been modified to better incorporate contributing cumulative actions.
WWP	009-32	There is a dearth of information on distribution of fishes, aquatic invertebrates, and other species of special concern. This is a baseline information failure. There also is no cumulative effects analysis that considers how past irrigation projects and their ongoing consequences will interact with the impacts of the proposed reservoir, making it impossible for the reader (or the agency) to determine whether this particular reservoir with be "the straw that breaks the camel's back" for a particular species or group of species.	Section 3.18.2 contains detailed information on terrestrial wildlife (including BLM sensitive species), aquatic wildlife, fish, amphibians, macroinvertebrates, and special-status aquatic species. The references cited in this section provide more in-depth detail, if needed. Available published information and unpublished file information provided by WGFD was used in describing aquatic biological resources within the project area. Past irrigation effects on aquatic biological resources are discussed in the No Action Alternative in Section 3.18.4.1.2. Section 4.18.2 has been modified to better incorporate contributing cumulative actions.

Table F-3. Proposed Action Comments

Commenter	Comment ID	Comment	BLM Responses
WGFD	007-6	Page 67 -Reference to the guaranteed minimum fishery pool should include clarification of how such guarantee would be provided and under what conditions it might be released. We recommend that the minimum fishery pool be provided by its own water right separate from the consumptively used portion of the reservoir with a priority date of one-minute senior to other rights in the reservoir. We also recommend including language that the minimum fishery pool may only be released with mutual agreement of the Wyoming Game and Fish Department, project sponsors, and the Water Development Commission.	The minimum pool would be provided as part of Alternatives B and C. WWDO anticipates that the water right application would allocate the bottom 1,998 acre-feet of the volume for one of the following uses: fish propagation, environmental, or recreation (or a combination thereof); and the top 5,996 acre-feet for irrigation use. This would be handled in one application with the same priority date on all designated uses. Clarifying language has been added to Section 2.4.2.1.
WGFD	007-11	Page 113, first row -Temperature changes in summer and winter will be significantly different than stream temperatures at present and likely lead to change in the species composition and abundance. The analysis needs to consider the reservoir's effects on winter temperatures if a flow release is provided to maintain the downstream fishery. If water is released from near the top of the reservoir pool, negligible temperature changes should occur and would be beneficial. Summer releases will almost certainly be cooler than present stream temperatures and lead to a shift in fish and aquatic insect species composition.	A multilevel outlet, which would allow control of release temperatures, is part of the preliminary designs. Current inflows during winter months may be unnaturally warm considering a portion of the majority of winter flow comes from overflow of a stock tank that is supplied by an artesian well located upstream of the proposed reservoir. Clarifying language was added to Section 2.4.2.2.1 and 3.18.4.2.2 and Table 3.15-3. Water temperature will be addressed as part of the proposed adaptive management approach discussed in Section 3.15.6. The multilevel outlet would be one of the potential corrective actions to adaptively manage for unacceptable changes in water temperature.
WGFD	007-12	Page 113, row eight -If winter releases are made from the bottom of the reservoir, considerable bank erosion could occur from repeated ice formation and break-up process each winter. Releasing cooler water in the winter from near the surface would minimize the potential for this negative effect.	A multilevel outlet, which would allow control of release temperatures to address ice formation concerns, is part of the preliminary designs. Current inflows during winter months may be unnaturally warm considering a portion of the winter flow comes from overflow of a stock tank that is supplied by an artesian well located upstream of the proposed reservoir. The proposed adaptive management approach would address any channel stability issues that may result from operations and future management of the ACRP. Clarifying language was added to Section 2.4.2.2.1.

Commenter	Comment ID	Comment	BLM Responses
WGFD	007-13	3.15.6 Mitigation Measures -In addition to monitoring, financial and water resources should be established, either in a dedicated fund or bond, to provide needed changes to operation of the project and minimize impacts that may be determined necessary per adaptive management strategies employed for the project. Without adequate resources, monitoring alone will not adequately mitigate identified impacts.	A dedicated fund or bond would be established to address needed operational changes to minimize impacts detected by monitoring or surveys.
WWDO	008-1	The Wyoming Game and Fish Department has expressed interest in managing the recreational uses and associated facilities at the reservoir. Rather than limiting reservoir use to non-motorized boats and recreation, perhaps it would be more appropriate to require the ACR Proponent to consult with the WGFD Habitat and Access Branch for final recommendations.	Section 2.4.2.1 indicates that the WGFD and the BLM have expressed interest in managing the recreational uses and associated facilities at the reservoir. Because it is not known for certain that the WGFD will manage recreational uses and associated facilities at the reservoir, it does not make sense to have a mitigation measure requiring the proponent to consult with the WGFD Habitat and Access Branch to minimize noise. The mitigation measure as stated in Section 3.6.6 is a potential option to mitigate noise impacts; it may not necessarily be selected by the BLM in the Record of Decision.
WWDO	008-2	Would a more defined time period for assessments and surveys be appropriate, rather than "for the life of the project"? It is likely that the need for additional stream stabilization measures and their implementation would occur within the first 10 years following ACR completion.	BLM agrees, and the text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
WWDO	008-3	It is important to note the trend in the ACR service area is that currently idle, but permitted irrigable acres (3,150 acres) are going back into production. This is due in part to change in ownership and improvements in technology. Permitted acres that have a valid water right for irrigation have the current ability to divert water from the stream for beneficial use. Therefore, the changing conditions (stream flow) associated with these lands going into production are independent of the Proposed Action and its associated environmental effects.	BLM agrees that currently idle but permitted irrigable acres may go back into production independent of the proposed reservoir. However, it is reasonable to assume that a reliable water supply may also encourage some of the idle but permitted irrigable lands to go into production. Because there is no way to demonstrate a causal link between the reservoir and idle lands, the analysis includes both possibilities. This was done in an attempt to better determine the actual contribution of the Proposed Action on modeled stream flows. Clarifying language was added to Sections 2.4.1, 3.15.4.1, 3.15.4.2.1, 3.16.4.1, 3.16.4.2, 3.18.4.1.2, and 3.18.4.2.2.
WWP	009-27	In addition, additional irrigation fields of significant acreage (see above) will result from this impoundment project; to what extent will these be disked or plowed, entailing surface disturbance? These additional acres of plowed or disked irrigated land that fall within the PHMA DDCT area must be added to the surface disturbance for the project.	BLM notes that currently idle but permitted irrigable acres may go back into production independent of the proposed reservoir. However, it is reasonable to assume that a reliable water supply may also encourage some of the idle but permitted irrigable lands to go into production. It is not known with any certainty how many acres may be put into production following completion of the proposed project. With that said, most of the 3,150 acres of idle lands are outside of the Sage Grouse Core Area. Those idle lands that do fall within the Core Area largely fall within acres already counted under existing disturbances. There are approximately 550 acres within Core Area (v. 4) and 534 acres within the Project DDCT boundary. Of the 534 acres, 523 acres fall within the Statewide Disturbance file. This means project-related disturbance within the DDCT boundary would be approximately 11 acres. This information was added to Section 3.18.4.2.1.

Table F-4. Purpose and Need Comments

Commenter	Comment ID	Comment	BLM Responses
WGFD	007-1	Uncertainties associated with the range of flows that may be diverted and the speculative nature of water management, necessitate that the project operational criteria contained in the Final Environmental Impact Statement (FEIS) should be made a part of the U.S Corp of Engineers (USCOE) 404 permit. We recommend the BLM work with the Wyoming Water Development Commission to have this feature embraced by the 404 permit. In the absence of such regulatory guidance, there is little certainty about how the project will be operated once it is completed and thus what impacts may occur to fish, wildlife, and their habitats.	The BLM will work with the WWDO and the USACE through NEPA and the 404 permitting processes to provide guidance regarding reservoir operation. The project includes a conservation pool and bypass of base flow in Alkali Creek through the reservoir to maintain current downstream conditions. The bypass would not affect the conservation pool. These measures will be implemented through coordination with appropriate state agencies (e.g., WWDO, WDEQ, WGFD). Clarifying language has been added to Section 2.4.2.1.
WWP	009-1	This is an illegally limited range of alternatives, designed to limit the specific outcome of the alternative selected to the agency's preference to approve a dam in this location.	CEQ's Forty Most Asked Questions Concerning CEQ's NEPA Regulations guidance indicates that for a proposal with a large number of alternatives, only a reasonable number of examples covering the full spectrum of alternatives must be analyzed and compared. What constitutes a reasonable range of alternatives "depends on the nature of the proposal and the facts in each case." The range of alternatives considered for this project covers the full spectrum of alternatives and allows for a reasoned choice as required by NEPA. NEPA does not require the analysis of all potential alternatives. A total of 53 alternatives, including water storage and other alternatives, were considered.

Commenter	Comment ID	Comment	BLM Responses
EPA	011-11	The Draft EIS references a personal communication with the project proponent as the source for the project need but does not include information about how the need for a 7,994 acre-feet reservoir was determined. Given the project's significant effects to aquatic resources, we recommend that a technical support document be made available to provide documentation in support of the final quantified need. The quantified need is important for identifying potential reasonable and practicable alternatives to the Proposed Action.	Because of advances in modeling that have occurred since the Savory Reservoir EIS, the shortage estimates were determined using StateMod. The following text has been added to Section 1.2 (Background) of the final EIS for further clarification: For these shortages or need evaluations, a historic consumptive use analysis and a surface water allocation model representation of the Nowood River watershed were developed. Currently irrigated lands were determined from aerial photography, and currently idle but permitted lands were determined from Wyoming State Engineer's Office records and subsequent analysis with the hydrographer-commissioners involved in the day-to-day regulation of water in the watershed. In addition, data management tools StateDMI and TSTool were used to develop input files and analyze model results. An irrigation shortage is the difference between irrigation demand and irrigation supply. An irrigation demand is the required amount of water that a crop needs beyond what it receives from precipitation. This value is calculated and is a function of a variety of parameters including climate conditions, crop types and acreages, and soil parameters. The irrigation supply is the amount of water delivered to the crop and is simulated based on stream flow records, ditch capacities, system efficiencies, return flows, reservoir capacities and evaporation, and water rights.
USACE	012-01	There are no statements within the Draft EIS that substantiates the need for the range of 2,360 to 6,030 A/F of irrigation water. The document simply states that is the outcome of the StateMOD model. USACE recommends inserting a statement in one or all of the following locations of the document; Executive Summary, within "Purpose & Need for the Action" section on page i; Section 1.2(Background), last paragraph of page 1; Section 1.3.2, after the USACE purpose & need statement. Example text provided below is from the High Savory Reservoir EIS. The applicable pages from that document are attached. Can WWDO come up with a similar summary statement with some of the math used to calculate the shortages? "The normal appropriation of water for irrigation as per Wyoming Water Law is one (1) cubic foot of water per second (cfs) for every 70 acres permitted. Wyoming statutes allow for the diversion of one (1) additional cfs during times when sufficient flow exists to meet all other water rights. After investigating the minimum amount of water that should be applied on a supplemental basis to supply crop needs during the late-season, WWDC established a minimum of 0.5 cfs per 70 acres. Supplemental water would be provided for a two-month (61-day) period, between July 15 and September 15. The rate converts to 0.864 AF of water per acre of irrigated land. An analysis of 1983 infrared aerial photography indicated approximately 73 percent of the lands in the Wyoming portion of the basin with Wyoming water rights were actually irrigated. Applying this percentage to the lands in the Colorado portion of the basin yields a total of 17,460 acres of land in the Little Snake River basin that is actually irrigated under Wyoming water rights permits. Based on 0.864 AF of water per acre of irrigated land, a nominal need exists for 15,090 AF of water for supplemental, late-season irrigation water."	Because of advances in modeling that have occurred since the Savory Reservoir EIS, the shortage estimates were determined using StateMod. The following text has been added to Section 1.2 (Background) of the final EIS for further clarification: For these shortages or need evaluations, a historic consumptive use analysis and a surface water allocation model representation of the Nowood River watershed were developed. Currently irrigated lands were determined from aerial photography, and currently idle but permitted lands were determined from Wyoming State Engineer's Office records and subsequent analysis with the hydrographer-commissioners involved in the day-to-day regulation of water in the watershed. In addition, data management tools StateDMI and TSTool were used to develop input files and analyze model results. An irrigation shortage is the difference between irrigation demand and irrigation supply. An irrigation demand is the required amount of water that a crop needs beyond what it receives from precipitation. This value is calculated and is a function of a variety of parameters including climate conditions, crop types and acreages, and soil parameters. The irrigation supply is the amount of water delivered to the crop and is simulated based on stream flow records, ditch capacities, system efficiencies, return flows, reservoir capacities and evaporation, and water rights.

Table F-5. NEPA Process Comments

Commenter	Comment ID	Comment	BLM Responses
WDA	006-1	WDA commented on the Preliminary DEIS and it appears many of our comments were not included before the DEIS was released. In addition to the comments below, we would ask the BLM re-review and include our Preliminary DEIS comments.	Comments received from all cooperating agencies on the internal preliminary draft EIS were reviewed for possible inclusion in the draft EIS. Not all comments were incorporated. BLM re-reviewed these comments as requested and has provided the following disposition of WDA comments on the preliminary draft document: • Some comments were too general in nature and did not provide sufficient detail needed to make revisions. • The CIAA for cultural resources was not modified because it is consistent with the Worland RMP. • The CIAA for land use was not modified because the 0.25-mile buffer is established in the Worland RMP for recreation sites. • Cumulative impacts section for noise was not modified because cumulative impacts do not just evaluate long-term effects, it also includes effects that would occur only during construction. • Cumulative actions for Public Health and Safety (or any resource) need to include any action that may have contributed to characterizing the past and current condition of the environment. NEPA requires the analysis of impacts to all potentially affected resources, independent of land ownership. • The CIAA for vegetation was not modified because it includes species most likely to present a potential noxious weed and invasive plant problem during and following construction. • The CIAA for water resources was not modified. • In characterizing cumulative actions (past and present), the EIS notes that existing wetlands may have been affected by agricultural practices. Any land-disturbing activities (including agriculture and ranching) have the potential to affect wetlands. A wetland delineation was conducted to identify wetlands to be included in the analysis.

Commenter	Comment ID	Comment	BLM Responses
WGFD	007-14	Page 133, Section 3.18.3.2 -These percent reductions are typically regarded as reconnaissance level assessments. Detailed site-specific studies are commonly needed to better quantify potential effects to habitat (and populations of these organisms). This detailed information and study is generally lacking for this project and we recommend such studies be conducted prior to permitting this project.	The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
WWP	009-1	This is an illegally limited range of alternatives, designed to limit the specific outcome of the alternative selected to the agency's preference to approve a dam in this location.	CEQ's *Forty Most Asked Questions Concerning CEQ's NEPA Regulations* guidance indicates that for a proposal with a large number of alternatives, only a reasonable number of examples covering the full spectrum of alternatives must be analyzed and compared. What constitutes a reasonable range of alternatives "depends on the nature of the proposal and the facts in each case." The range of alternatives considered for this project covers the full spectrum of alternatives and allows for a reasoned choice as required by NEPA. NEPA does not require the analysis of all potential alternatives. A total of 53 alternatives, including water storage and other alternatives, were considered.

Table F-6. Aquatic Species Comments

Commenter	Comment ID	Comment	BLM Responses
WGFD	007-1	Uncertainties associated with the range of flows that may be diverted and the speculative nature of water management, necessitate that the project operational criteria contained in the Final Environmental Impact Statement (FEIS) should be made a part of the U.S Corp of Engineers (USCOE) 404 permit. We recommend the BLM work with the Wyoming Water Development Commission to have this feature embraced by the 404 permit. In the absence of such regulatory guidance, there is little certainty about how the project will be operated once it is completed and thus what impacts may occur to fish, wildlife, and their habitats.	The BLM will work with the WWDO and the USACE through NEPA and the 404 permitting processes to provide guidance regarding reservoir operation. The project includes a conservation pool and bypass of base flow in Alkali Creek through the reservoir to maintain current downstream conditions. The bypass would not affect the conservation pool. These measures will be implemented through coordination with appropriate state agencies (e.g., WWDO, WDEQ, WGFD). Clarifying language has been added to Section 2.4.2.1.
WGFD	007-2	We do not see how this project will improve fisheries. The BLM should specifically identify where those fisheries are. The project may create a new fishery in the proposed reservoir but this is not an improvement.	Section 3.18.4.2.2 identifies both beneficial and adverse effects of the Proposed Action on aquatic species and their habitat. In terms of beneficial effects, there would be habitat improvements in Paint Rock and Alkali Creeks from construction that would improve stream stability. There would be beneficial and adverse effects in Medicine Lodge and Paint Rock Creeks as discussed in the Flow Conditions section. The locations of the stream segments with beneficial effects are identified in this section.
WGFD	007-3	Page vi, Table ES-2, Recreation - Determination of no effect of the proposed action on fishing is speculative given the lack of detailed analysis on how reduced flows would -influence sport fish. The decrease in flow in the lower Nowood River may negatively influence populations of popular sport fish and Species of Greatest Conservation Need (SGCN) such as Channel Catfish and Sauger. The proposed action may also positively affect fishing dependent on how water is managed in the reservoir.	Table ES-2 and Section 3.9.4.2 were revised to match statements regarding effects of flow changes on fish species in the Nowood River in Table ES-2 and Section 3.18.4.2.2.2. The impact discussion in Section 3.18.4.2.2, Flow Conditions and Habitat was revised to include new modeling results for the Proposed Action with and without irrigation of idle lands. Results for the Nowood River indicated that flow changes exceeding 10% are attributed mainly to the inclusion of idle land irrigation. No flow changes exceeding 10% would occur under the scenario with idle land not being irrigated. A mitigation measure consisting of an adaptive management plan would be developed through BLM coordination with appropriate state agencies (e.g., WWDO, WDEQ, WGFD) for the purpose of minimizing effects on fish species in the Nowood River. Language was also added to indicate that the Proposed Action also may positively affect fishing depending on how water is managed in the reservoir.
WGFD	007-4	Page vii, Water Resources - We previously commented that elimination of flow at any time of year in Alkali Creek would result in complete loss of the fishery in this stream. This condition is unacceptable and may create difficulties securing necessary federal permits. The significant flow decreases in the Nowood River (up to 71 %) is a significant concern. Quantitative data are needed to define the extent of this flow depletion on native and non-native fishes.	The impact discussion in Section 3.18.4.2.2, Flow Conditions and Habitat section was revised to reflect a year-round base flow bypass of 0.4 cfs. This bypass flow would maintain flow year-round in Alkali Creek, which reduces the effect on aquatic species. However, there still would be one to three months with flow reductions exceeding 10%. The adaptive management plan will include monitoring to determine if project-related impacts are affecting the desired condition and will include a suite of possible corrective actions that could be taken. The BLM will also work with the WWDO and the USACE through the 404 permitting process to provide guidance regarding reservoir operation as it affects flows. The project includes a conservation pool and bypass of base flow in Alkali Creek through the reservoir to maintain current downstream conditions. The bypass would not affect the conservation pool. These measures would be implemented for the purpose of minimizing effects on aquatic habitat and species in coordination with WGFD. The impact discussion in Section 3.18.4.2.2, Flow Conditions and Habitat also was revised to include new modeling results for the Proposed Action with and without irrigation of idle lands. Results for the Nowood River indicate that flow changes exceeding 10% are attributed mainly to the inclusion of idle land irrigation. No flow changes exceeding 10% would occur under the scenario with idle land not being irrigated. Clarifying language has been added to Section 2.4.2.1 and reflected throughout the document. Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD.
WGFD	007-5	Page ix, Terrestrial and Aquatic Wildlife -Replacement of existing stream habitat with reservoir habitat cannot be assumed to be a beneficial effect to the fish species now found in the stream. Some of them may exist in the reservoir but it is unlikely their abundance and species composition will be similar especially if and when predatory game fish become established in the reservoir.	The loss of stream habitat in Alkali Creek is considered an adverse effect, while the expansion of the reservoir and establishment of a conservation pool would be a beneficial effect on reservoir fisheries. The Proposed Action would include a year-round base flow bypass of 0.4 cfs, which would maintain flow year-round in Alkali Creek and reduce the effect on aquatic species. The existing fish species in Alkali Creek can adapt to reservoir conditions. However, their relative abundance and composition would likely change, as indicated in the comment.

Commenter	Comment ID	Comment	BLM Responses
WGFD	007-11	Page 113, first row -Temperature changes in summer and winter will be significantly different than stream temperatures at present and likely lead to change in the species composition and abundance. The analysis needs to consider the reservoir's effects on winter temperatures if a flow release is provided to maintain the downstream fishery. If water is released from near the top of the reservoir pool, negligible temperature changes should occur and would be beneficial. Summer releases will almost certainly be cooler than present stream temperatures and lead to a shift in fish and aquatic insect species composition.	A multilevel outlet, which would allow control of release temperatures, is part of the preliminary designs. Current inflows during winter months may be unnaturally warm considering a portion of the majority of winter flow comes from overflow of a stock tank that is supplied by an artesian well located upstream of the proposed reservoir. Clarifying language was added to Section 2.4.2.2.1 and 3.18.4.2.2 and Table 3.15-3. Water temperature will be addressed as part of the proposed adaptive management approach discussed in Section 3.15.6. The multilevel outlet would be one of the potential corrective actions to adaptively manage for unacceptable changes in water temperature.
WGFD	007-14	Page 133, Section 3.18.3.2 -These percent reductions are typically regarded as reconnaissance level assessments. Detailed site-specific studies are commonly needed to better quantify potential effects to habitat (and populations of these organisms). This detailed information and study is generally lacking for this project and we recommend such studies be conducted prior to permitting this project.	Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition and will include a suite of possible corrective actions that could be taken.
WGFD	007-15	Page 136, last paragraph - Not all of the fish species listed here are readily adaptable to lentic habitat. As a matter of principle, lentic habitat does not replace or mitigate lotic habitat because of the very significant characteristics of each. From a mitigation perspective, we recommend $at mitigation be habitat-based (type, quantity, and quality) vs. species-based (number of organisms). We concur the new reservoir will eliminate 2.1 miles of stream habitat. In combination with total dewatering of the stream below the proposed dam, the project will result in the total loss of considerable stream habitat. Release of continuous, adequate year-round flow below the reservoir may mitigate this impact.	The occurrence of these species includes stream and reservoir habitat, but their habitat preference is stream habitat. Text regarding their habitat preference was added to the paragraph. The Proposed Action would include a stream bypass flow of 0.4 cfs, which would maintain year-round flow in Alkali Creek. The bypass flow would reduce the effects of flow changes on aquatic habitat and species in Alkali Creek.
WGFD	007-16	Page 137, first partial paragraph -Reservoir fluctuation as reflected in end-of-month (E-O-M) storage for extended periods is helpful in determining the extent of reservoir fishery potential. A minimum fishery pool (conservation pool) is an effective tool for maintaining a persistent fishery but if that is the maximum end-of-year elevation on a regular basis, then that will be the limit of the potential fishery development. We recommend the Draft Environmental Impact Statement provide E-O-M storage projections by using at least the last I 0-years of data for flow availability.	Simulated end-of-month contents data were added to Appendix E and summarized in Section 3.15.4.2.1. The discussion of this information was also referenced in Section 3.18.4.2.2.
WGFD	007-17	Page 138, last paragraph and 139 -This discussion of benefits and impacts is subjective. In the absence of quantitative data the description is best described and conjecture. It is critical to bear in mind that impacts associated with flow depletions in some months are not mitigated by flow increases in other months. A quantitative time-series analysis is required to afford a credible evaluation of the flow levels or rates that may occur.	Data are not available to provide a quantitative time series analysis of the effects of flow change on fish species. Instream flow studies would be required to provide quantitative results as requested in this comment. Mitigation involving an adaptive management plan will be implemented to manage reservoir operation and releases for the purpose of minimizing effects on aquatic species.
WGFD	007-18	Pages 138, paragraph 2 under Flow Conditions and Aquatic Habitat -Puff should be changed to Poff	The revision was made as noted.
WGFD	007-19	Page 139, last paragraph in Flow Conditions and Aquatic Habitat -The effects of flow reductions on the fisheries, but especially on the SGCN species in the Nowood River cannot be accurately evaluated in the absence of more detailed analyses. Such analyses are typically made possible through a focused study with emphasis on instream flow and habitat suitability. These data and information are necessary to better understand the magnitude of the anticipated adverse effects which may influence the status, conservation, and management of the fishery in the lower Nowood River	Data are not available to provide a quantitative estimate of the effects of flow change on fish species. Instream flow studies and habitat suitability information would be required to provide quantitative results as requested in this comment. Mitigation involving an adaptive management plan will be implemented to manage reservoir operation and releases for the purpose of minimizing effects on aquatic species.
WGFD	007-20	Page 142, Mitigation -It is unclear if the conservation pool for the Nowood River is separate from the permanent conservation pool to support fish in the reservoir. Additional information is needed on details for both of these features. The document should specify if these pools are separate, how much water is to be held in them, and the conditions under which releases would be made to support adequate flow in the Nowood River	Mitigation involving an adaptive management plan will be implemented for stream flow, which will manage reservoir operation and releases for the purpose of minimizing effects on special status species in the Nowood River. Additional information is provided in the final EIS regarding the process used for this mitigation measure. The details of this measure will be established through BLM coordination with appropriate state agencies (e.g., WWDO, WDEQ, WGFD).
WWP	009-30	Flow changes exceeding 10% in a given month would have a significant effect on aquatic life. DEIS at 133. BLM summarizes that flow changes are important and can have positive or negative effects on various species, altering the composition of stream life assemblages. DEIS at 138. However, the BLM does not take a hard look at the potential consequences of flow changes on any one form of aquatic life. Each would be expected to have different thresholds of tolerance. For the agency to fail to investigate the impacts of flow changes on aquatic species, particularly state or BLM sensitive species and game species, is an oversight of important proportions. What are the most sensitive species to environmental perturbations, how have they been impacted by past human activities, and how will the present project impact them further, or alleviate past impacts?	Impacts of flow changes on fish and macroinvertebrates and special status aquatic species are discussed in Section 3.18.4.2.2, Flow Conditions and Habitat. The literature that was cited is applicable to a wide range of species. A literature review did not identify particular fish species that are sensitive to flow changes. It is assumed that all of the fish species in the analysis area would be sensitive to flow changes exceeding 20% in consecutive months.
WWP	009-31	BLM admits that aquatic invasive species like zebra or quagga mussels could be introduced during the project, but “[n]o best management practices or design features have been defined to require equipment or vehicle washings prior to working in multiple streams with the same equipment.” DEIS at 138. The EIS has failed to take a legally required ‘hard look’ at the potential impacts from these species, and also has failed to consider reasonable alternatives to prevent their spread. This is especially shocking given that local residents with a canoe or rowboat must pay for a tag and get their watercraft checked at checkpoints, yet this major project, which will involve heavy equipment digging directly in stream channels, will not be required to engage in mitigation measures to prevent the spread of aquatic invasives	The following mitigation measure is recommended in Section 3.18.6: If vehicles and equipment are moved across multiple streams, equipment would be cleaned with a spraying device that uses an uncontaminated water source (i.e., a water source with no aquatic invasive species being present).

Commenter	Comment ID	Comment	BLM Responses
WWP	009-32	There is a dearth of information on distribution of fishes, aquatic invertebrates, and other species of special concern. This is a baseline information failure. There also is no cumulative effects analysis that considers how past irrigation projects and their ongoing consequences will interact with the impacts of the proposed reservoir, making it impossible for the reader (or the agency) to determine whether this particular reservoir with be “the straw that breaks the camel’s back” for a particular species or group of species.	Available published information including unpublished file information provided by WGFD was used in describing aquatic biological resources within the project area. Past irrigation effects on aquatic biological resources are discussed in the No Action Alternative in Section 3.18.4.1.2.
EPA	011-10	Although Appendix C states that no impacts to fisheries in Alkali Creek would occur as a result of the Proposed Action, Appendix E of the Draft EIS shows that Alkali Creek below the proposed dam would experience a 100% decrease in flow for 6 to 8 months of the year, which would prevent attainment of designated uses. Due to operation of the ACRP and increased use of water for irrigation, Medicine Lodge Creek would experience decreases of up to 52% in September and 31 % in June. The Nowood River would experience decreases in flow up to 71 % in July of dry years. The Draft EIS acknowledges that flow reductions in Medicine Lodge Creek and the Nowood River would cause substantial loss of aquatic habitat and adverse effects to fish, macroinvertebrates and special status species (pages 135-136), but does not directly assess or specify the effects of these decreased flows on attainment of related designated uses. We recommend that the EIS evaluate how each alternative could affect attainment of the designated beneficial uses of affected waterbodies. We also recommend analyzing in detail other alternatives and/or committing to actions that would prevent contributing to violations of State WQS.	The Proposed Action would include a year-round base flow bypass of 0.4 cfs, which would maintain flow year-round in Alkali Creek and reduce the effect on aquatic species. Revised modeling that reflects the bypass and scenarios with and without irrigation of idle lands for the Proposed Action was conducted. Results indicated that flow changes exceeding 10% are attributed mainly to the inclusion of idle land irrigation. There would be just one or two months in Alkali and Paint Rock Creeks with flow changes exceeding 10% under the Proposed Action without idle lands being irrigated. There would be no flow changes exceeding 10% in Medicine Lodge Creek and the Nowood River under the Proposed Action without idle lands being irrigated. In addition, mitigation involving an adaptive management plan will be implemented to manage reservoir operation and releases for the purpose of minimizing effects on aquatic species. These measures would be implemented for the purpose of minimizing effects on aquatic habitat and species in coordination with WGFD, and water quality and use attainment in coordination with WDEQ. Clarifying language has been added to Sections 2.4.2.1 and 3.18.4.2.2 and reflected throughout the document.

Table F-7. Cultural Resources Comments

Commenter	Comment ID	Comment	BLM Responses
Northern Cheyenne Tribe	004-1	Cultural resources previously identified and yet to be identified have the potential to be fully inundated or destroyed by construction of the Alkali Creek Reservoir. The cumulative impacts, especially visual impacts, to identified cultural sites require tribal monitors at each phase of construction and that process should be in included in the final EA, with the MOA included in an appendix to best address how this process will be completed. Or, a work plan should be created to ensure that this is completed, and that the sites will be protected by fencing and/or protective barriers as it is anticipated that the number of visitors will increase	The BLM continues to work with the tribes to address these and other comments as part of their ongoing consultation process.
WWP	009-19	BLM states that it consulted with a number of tribes concerning this project. DEIS at 35, 38. What was the nature of this consultation, and was there actually information received from these tribes?	Tribes were invited to be cooperating agencies under NEPA via a letter on December 16, 2016. An invitation to consult under NHPA was sent on October 10, 2017, and results of Class III investigations and associated documents were sent on February 12, 2018. BLM cultural resource specialists subsequently followed up with tribes through telephone calls and emails to solicit input and provide updates to the tribes. Consultations with tribes that have an interest in the project continued throughout the EIS process, consistent with applicable regulations and guidance, including the NHPA. This information has been added to Section 3.3.3.
WWP	009-20	BLM references SWCA field investigations (DEIS at 36). Did these investigations involve a thorough and comprehensive field inventory of the area to be subjected to surface disturbance by a qualified archaeologist?	Yes. Class III investigations were conducted for the entire project direct area of potential effect, which covers all proposed project surface disturbance. Investigations were conducted under the supervision of field directors and principal investigators listed under current Wyoming BLM Cultural Resource Use permits. This has been clarified in Section 3.3.2.

Table F-8. Geology and Minerals Comments

Commenter	Comment ID	Comment	BLM Responses
WCCD	001-3	If the mining leases are not actively being pursued, we fail to see how they can be included in the reasonably foreseeable future actions. The entire CIAA for PH&S needs to be reviewed and reassessed for a sensible analysis.	The mineral lease parcels are awaiting the state’s leasing decision. It is a reasonably foreseeable future action that the state might approve one or more of the leases and that one or more lease parcels could then be mined. Therefore, the mineral lease parcels should be included in the cumulative effects analysis. No change has been made to the final EIS. The second part of the comment provides no direction for review or revisions to this section and therefore was not addressed.

Table F-9. Land Use Comments

Commenter	Comment ID	Comment	BLM Responses
WWP	009-21	The Cumulative Impacts Analysis Area (CIAA) for the project is absurdly restricted to "the project area with a 0.25-mile buffer." DEIS at 151. This is entirely inappropriate. The effects of irrigation on land use extend throughout the entire Paint Rock, Medicine Lodge, Alkali Creek, and Nowood watersheds. This is therefore the appropriate CIAA for the project on land use. Past conversion of native habitats to irrigated pasture or tilled croplands for hay, alfalfa, or human food crops has resulted in major impacts to native wildlife, in addition to the obvious impact that stream dewatering and changes in flow patterns stemming from irrigation have resulted in major losses of aquatic habitat and biodiversity over the century-plus history of irrigated agriculture in the Bighorn Basin. The instant project will result in additional irrigation of thousands of acres, and this conversion of habitats must be fully evaluated, both directly and cumulatively with all the other habitat losses within these watersheds that result from the conversion of native plant communities to irrigated pasture or cropland. What are the current land and habitat statuses of the thousands of acres into which irrigation will expand as a result of this project? What will the impacts of converting these habitats to irrigated croplands or pastures be on the native wildlife that may depend on them for habitat?	The CIAA for land use was not modified because the 0.25-mile buffer is established in the Worland RMP for recreation sites. In addition, the cumulative effects analysis looks at the incremental impact of the land use changes caused by the Proposed Action or Modified Proposed Action. These land use changes (conversion of a riparian area to a dam and a reservoir) occur within the project area; the 0.25-mile buffer incorporates peripheral land uses and any potential conflicts or edge effects where there may be an incremental impact. The cumulative effects of the project on surface water and wildlife habitat are discussed in Section 4.15 and 4.18, respectively. More detail on past human activities in the wildlife CIAA has been added to Section 4.18.1. Habitat loss is discussed as a direct impact of the Proposed Action and the Modified Proposed Action in Sections 3.18.4.2.1 and 3.18.4.3.1, respectively. BLM notes that currently idle but permitted irrigable acres may go back into production independent of the proposed reservoir. However, it is reasonable to assume that a reliable water supply may also encourage some of the idle but permitted irrigable lands to go into production. It is not known with any certainty how many acres may be put into production following completion of the proposed project; this acreage cannot be quantified and associated with habitat loss at this time.

Table F-10. Noise Comments

Commenter	Comment ID	Comment	BLM Responses
WWP	009-22	BLM states, "Based on the isolated setting and land use described for the analysis areas and the proximity of these areas to WY 31, the estimated ambient noise level in the analysis areas is approximately 48 dBA (ANSI 2013)." DEIS at 50. This is a startlingly, perhaps ridiculously, high estimate. How was it derived? Did BLM place noise meters anywhere in the Project Area to measure actual background noise? Compare to 54 dBA estimated ¾ mile away from a bulldozer and scraper, working together. DEIS at 51. Elsewhere in Wyoming, ambient noise ranges from 15 to 19 dBA.	While a dBA level below 25 for background noise does show up in literature, it is typically associated with lek noise ambient conditions derived from an L_{50} or lower measurement. These levels occur less than 50% of the time during periods with ideal weather conditions of no wind and no biologic interference from animals or insects in areas with no nearby roadways. This analysis used a conservatively representative value that accounts for noise from wind, environmental, and anthropogenic factors that influence the proposed project area. Due to the nature of noise attenuation, the bulldozer/scraper example would need to be almost 3 miles away to experience a noise equivalent to the background level given the exponential decrease in sound with distance. Based on this information, no revision to the final EIS is necessary.

Table F-11. Public Health and Safety Comments

Commenter	Comment ID	Comment	BLM Responses
WCCD	001-2	The list of activities in the PH&S analysis seems contrived. To include everyday activities associated with agriculture, road construction, and the presence of small towns in a risk assessment of Public Health and Safety is inappropriate. The assumption that (livestock) grazing is a risk to PH&S is completely unfounded.	These past and present activities potentially contribute to effects on soils, surface water, and groundwater because of spills or releases of chemicals or petroleum products that were identified as potential issues on Page iii. Their listing here is only recognition that these activities may involve the use of materials that, if released into the environment, could have negative impacts. Small quantity releases over time result in cumulative effects that may adversely affect these media in some areas. Overall, the risk of contamination from these sources to these media is generally considered to be low.
WCCD	001-3	If the mining leases are not actively being pursued, we fail to see how they can be included in the reasonably foreseeable future actions. The entire CIAA for PH&S needs to be reviewed and reassessed for a sensible analysis.	The mineral lease parcels are awaiting the state's leasing decision. It is a reasonably foreseeable future action that the state might approve one or more of the leases and that one or more lease parcels could then be mined. Therefore, the mineral lease parcels should be included in the cumulative effects analysis. No change has been made to the final EIS. The second part of the comment provides no direction for review or revisions to this section and therefore has not been addressed.
WDA	006-2	The BLM later discusses potential dam failure and potential adverse impacts of failure (Section 4.8.2; pg. 154), yet never makes a connection between statements in 4.8.1 (pg.153) and the project itself. If the intent of Section 4.8.1 is to illustrate the ongoing and potential future actions that could be impacted by a dam failure this is not being clearly conveyed. If this Is the intent, the BLM should qualify all statements with "In the event of dam failure ... " or .similar. We suggest the BLM review 40 CFR 1508.7 definitions and appropriately tailor the discussion within the analysis	The list of contributing cumulative actions provided in Section 4.8.1 is not a list of cumulative effects. It is a list of individual actions that when added together may contribute to cumulative public health and safety effects related to the public health and safety issues identified on Page iii. A contributing cumulative action is not the same as a cumulative effect. The cumulative effects analysis looks at whether the Proposed Action and Modified Proposed Action would add incrementally to other contributing actions to create cumulative effects on a particular resource. Therefore, the intent of Section 4.8.1 is not to illustrate ongoing and future actions that could be impacted by dam failure, but to provide a list of past, present, and reasonably foreseeable actions that when added together with any incremental effect from the Proposed Action or Modified Proposed Action would be considered a cumulative effect related to the issue identified. The first two paragraphs in Section 4.8.2 describe potential contributing cumulative actions from the Proposed Action and Modified Proposed Action (hazardous material releases and dam failure). The third paragraph evaluates whether potential hazardous material releases and dam failure would add incrementally to other contributing actions in the analysis area to create a cumulative impact.

Commenter	Comment ID	Comment	BLM Responses
WWP	009-29	We are also concerned that the resulting reservoir will provide Stillwater breeding habitat for the Culex tarsalis mosquitoes that carry West Nile virus. See DEIS at 135. We are not convinced that an undefined "mosquito abatement plan" (DEIS at 142) is adequate mitigation, and BLM is not in a position to take a hard look at the impacts of the project on West Nile virus and sage grouse without defining the mosquito abatement plan and its specific provisions in the EIS, and evaluating its effectiveness therein.	All BLM RMP objectives and guidelines will be applied during the implementation and operation of the proposed project, which includes the treatment of water storage impoundments to control mosquito breeding.

Table F-12. Recreation Comments

Commenter	Comment ID	Comment	BLM Responses
WCCD	001-1	As stated, WCCD feels a five mile buffer is too large. The reservoirs listed, are beyond a five mile radius and should not be included in the CIAA for the project area.	Reservoirs listed in Section 4.9.1 that are outside the CIAA have been removed and the analysis updated accordingly.
WGFD	007-3	Page vi, Table ES-2, Recreation - Determination of no effect of the proposed action on fishing is speculative given the lack of detailed analysis on how reduced flows would -influence sport fish. The decrease in flow in the lower Nowood River may negatively influence populations of popular sport fish and Species of Greatest Conservation Need (SGCN) such as Channel Catfish and Sauger. The proposed action may also positively affect fishing dependent on how water is managed in the reservoir.	Table ES-2 and Section 3.9.4.2 were revised to match statements regarding effects of flow changes on fish species in the Nowood River in Table ES-2 and Section 3.18.4.2.2.2. The impact discussion in Section 3.18.4.2.2, Flow Conditions and Habitat was revised to include new modeling results for the Proposed Action with and without irrigation of idle lands. Results for the Nowood River indicated that flow changes exceeding 10% are attributed mainly to the inclusion of idle land irrigation. No flow changes exceeding 10% would occur under the scenario with idle land not being irrigated. A mitigation measure consisting of an adaptive management plan would be developed through BLM coordination with appropriate state agencies (e.g., WWDO, WDEQ, WGFD) for the purpose of minimizing effects on fish species in the Nowood River. Language was also added to indicate that the Proposed Action also may positively affect fishing depending on how water is managed in the reservoir.
WWDO	008-1	The Wyoming Game and Fish Department has expressed interest in managing the recreational uses and associated facilities at the reservoir. Rather than limiting reservoir use to non-motorized boats and recreation, perhaps it would be more appropriate to require the ACR Proponent to consult with the WGFD Habitat and Access Branch for final recommendations.	Section 2.4.2.1 indicates that the WGFD and the BLM have expressed interest in managing the recreational uses and associated facilities at the reservoir. Because it is not known for certain that the WGFD will manage recreational uses and associated facilities at the reservoir, it does not make sense to have a mitigation measure requiring the proponent to consult with the WGFD Habitat and Access Branch to minimize noise. The mitigation measure as stated in Section 3.6.6 is a potential option to mitigate noise impacts; it may not necessarily be selected by the BLM in the Record of Decision.
WWP	009-2	A secondary aspect of the Purpose and Need to provide public recreation. DEIS at i. However, far superior public recreation opportunities in a reservoir setting are already available in close proximity to the Project Area at Bighorn Canyon National Recreation Area. The BLM has not made any finding that the recreation opportunities at Bighorn Canyon NRA are somehow limited or unavailable, nor that a new (much smaller and with less spectacular scenery) reservoir would provide a significant improvement in local recreational opportunities. BLM lists several other irrigation reservoirs in the local area. DEIS at 154. What is the level of recreation use on these reservoirs, if any, and how would the addition of Alkali Creek Reservoir provide a new and different need for recreational opportunities currently unmet by existing irrigation reservoirs?	Reservoirs in Section 4.9.1 that are located outside the CIAA (5-mile radius) were incorrectly included and have been removed. While recreation opportunities at other reservoirs in the region may provide greater benefits, that does not negate potential recreation benefits that would be available as a result of the proposed Alkali Creek Reservoir. The analysis in the EIS does not discuss or imply that the Alkali Creek Reservoir would provide new or unique recreational experiences that are either unavailable or underserved within the region. An analysis of recreational use on nearby reservoirs is not necessary for a reasoned choice between alternatives.

Table F-13. Socioeconomics Comments

Commenter	Comment ID	Comment	BLM Responses
WGFD	007-7	Page 68 Socioeconomics - This document lacks a quantitative benefit/cost analysis. The project description would be strengthened by enlisting an objective third party specialist such as staff at the University of Wyoming Department of Agricultural Economics to provide this information.	The 2016 CEQ guidance states that "NEPA does not require monetizing costs and benefits" (CEQ 2016). BLM does not customarily conduct a cost-benefit analysis in the context of a NEPA evaluation. The following text has been added to Section 3.10.3: "The model does not monetize the costs and benefits of the Proposed Action and action alternatives because the 2016 CEQ guidance states that this is not required under NEPA (CEQ 2016)." Council on Environmental Quality (CEQ). 2016. Regulations for implementing the procedural provisions of the National Environmental Policy Act. Available at: https://ceq.doe.gov/ceq_regulations/regulations.html.
WWP	009-5	The cost of an alternative is an explicit criterion for alternative evaluation. DEIS at 12. The BLM has not produced cost estimates for the proposed Action as well as the various alternatives dismissed from detailed consideration. This is an important oversight. BLM also should state costs for all alternatives, both those considered in detail and those dismissed from consideration, so the public can see the differences.	In Appendix C of the final EIS, cost is considered in the fourth tier of alternatives screening. No dismissed alternatives made it to Screen 4.

Table F-14. Special Status Species Comments

Commenter	Comment ID	Comment	BLM Responses
WWP	009-25	BLM must consider all of the impacts of past human activities in the CIAA on big game and raptor populations, and on the populations of all Sensitive Species (state or BLM), in order to credibly conduct a cumulative effects analysis that places the impacts of the Alkali Cree Reservoir impacts in meaningful context. BLM must also provide distribution and population trends for BLM and state-listed Sensitive Species, which is important baseline information. Instead of undertaking a cumulative effects analysis, BLM merely lists the additive effects of the project, without considering the degree to which these add to pre-existing effects from foregoing projects and pre-existing human structures, land uses, and activities. DEIS at 161. This is flatly inadequate.	Under NEPA, the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the proposed action and alternatives, when combined with past and present actions, on a particular resource. The CEQ's 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that "CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions." In addition, CEQ regulations "do not require agencies to catalogue or exhaustively list and analyze all individual past actions." Provision of distribution and populations trends is therefore outside the scope of this analysis. In addition, distribution and population trend data for special status species are not available for the CIAA. Section 4.18.2 has been modified to better incorporate contributing cumulative actions.
WWP	009-26	There are five sage grouse leks within 4 miles of the project area, the closest of which is 2.9 miles from the proposed reservoir. DEIS at 129. But important baseline information, like lek counts and lek count trends over the past several decades, is omitted. The project would eliminate about 105 acres of Priority Habitat Management Area for sage grouse. DEIS at 135. Direct surface disturbance is listed at 10.33 acres; the EIS needs to explain this discrepancy. Using the 10.33 acre figure, BLM has conducted a DDCT analysis for the project, which results in a 3.31% surface disturbance within the project area. What exactly is BLM counting as "surface disturbance" in this DDCT analysis? Are irrigated cropfields included? While flood-irrigated pasturage does not necessarily entail surface disturbance, any crop fields that are plowed or disked should be counted as "surface disturbance" for the purposes of calculating the DDCT surface disturbance cap, and we are concerned that BLM has neglected to do this.	Baseline lek count data was omitted as part of the streamlining process. The wildlife impact analysis is qualitative in nature, and lek count data doesn't change the results. Of the 105 acres of project area that lies within the core area, the majority of those acres have already been identified in the DDCT as existing disturbance (agricultural land is counted as existing disturbance). Only 10.33 acres of the project have not been counted in the DDCT as existing disturbance. Text was added to Section 3.18.4.2.1 to clarify why 10.33 acres of project disturbance was used in the DDCT.
WWP	009-27	In addition, additional irrigation fields of significant acreage (see above) will result from this impoundment project; to what extent will these be disked or plowed, entailing surface disturbance? These additional acres of plowed or disked irrigated land that fall within the PHMA DDCT area must be added to the surface disturbance for the project.	BLM notes that currently idle but permitted irrigable acres may go back into production independent of the proposed reservoir. However, it is reasonable to assume that a reliable water supply may also encourage some of the idle but permitted irrigable lands to go into production. It is not known with any certainty how many acres may be put into production following completion of the proposed project. With that said, most of the 3,150 acres of idle lands are outside of the Sage Grouse Core Area. Those idle lands that do fall within the core area largely fall within acres already counted under existing disturbances. There are approximately 550 acres within the core area (v. 4) and 534 acres within the Project DDCT boundary. Of the 534 acres, 523 acres fall within the Statewide Disturbance file. This means project-related disturbance within the DDCT boundary would be approximately 11 acres. This information was added to Section 3.18.4.2.1.
WWP	009-28	Fencing should not be constructed in sage grouse habitats, either in PHMA or GHMA. BLM's proposal to construct new fences as part of the project, but mitigating this by adding fence markers (DEIS at 142) would only prevent approximately 60% of the collision mortality experienced at an unmarked fence (see, e.g., Christiansen 2009). Additional mortality for low-flying sage grouse should be prevented, not added, as a result of this project. In addition, existing fences within sage grouse habitats of the Hyattville Core Area, particularly within 5.3 miles of leks, should be removed as mitigation should the Alkali Creek Reservoir be approved.	Fencing is necessary for this project for multiple reasons. It decreases risk to human health by preventing people from entering at unsafe locations. Fencing is necessary to exclude livestock from entering and contaminating the reservoir area (e.g., *E. coli*). This would help protect reservoir and downstream water quality.

Table F-15. Stream Morphology and Sedimentation Comments

Commenter	Comment ID	Comment	BLM Responses
WCCD	001-6	Please review for accuracy. "Wet Year" changes list July in both the Increase and Decrease columns.	The 'July' increase was corrected to 'August' increase.
WDEQ	002-1	WDEQ requests clarification on how accumulated sediment will be managed in the reservoir. If the intention is to release sediment, WDEQ requests that the EIS analyze the potential impacts to downstream water quality.	There are no plans to flush sediment from the reservoir to minimize sediment accumulation. Sediment that enters the reservoir is intended to be stored. The outlet works will have the ability to sluice an insignificant amount of sediment that may deposit directly adjacent to the outlet works gates to prevent blockage of the gates. This has been clarified in Section 3.15.4.2.2.
WGFD	007-9	Page 105 -The apparent complete elimination of flow in Alkali Creek downstream from the proposed reservoir (for storage) will eliminate all fishery values in that stream segment. We recommend no storage of water in Alkali Reservoir from October through March. Outflow of the reservoir during this period should approximate inflow.	The project includes a bypass of base flow of 0.4 cfs in Alkali Creek to maintain year-round flow in this stream. The bypass flow would not affect the conservation pool. In addition, mitigation involving an adaptive management plan will be implemented to manage reservoir operation and releases for the purpose of minimizing effects on aquatic species. This plan will be implemented through coordination with WWDO, EPA, and WGFD. Clarifying language has been added to Section 2.4.2.1.

Commenter	Comment ID	Comment	BLM Responses
WGFD	007-12	Page 113, row eight -If winter releases are made from the bottom of the reservoir, considerable bank erosion could occur from repeated ice formation and break-up process each winter. Releasing cooler water in the winter from near the surface would minimize the potential for this negative effect.	A multilevel outlet, which would allow control of release temperatures to address ice formation concerns, is part of the preliminary designs. Current inflows during winter months may be unnaturally warm considering the majority of winter flow comes from the artesian well located upstream of the proposed reservoir. In addition, structures are proposed to stabilize Alkali Creek to mitigate potential erosion or stability issues that may occur as a result to flow regime changes. Clarifying language was added to Section 2.4.2.2.1.
WWDO	008-2	Would a more defined time period for assessments and surveys be appropriate, rather than "for the life of the project"? It is likely that the need for additional stream stabilization measures and their implementation would occur within the first 10 years following ACR completion.	The BLM agrees, and the text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.

Table F-16. Surface Water Comments

<table>
<tr><th>Commenter</th><th>Comment ID</th><th>Comment</th><th>BLM Responses</th></tr>
<tr><td>WCCD</td><td>001-4</td><td>Please review the data for this section for accuracy in comparison to Appendix E, Table 2 1B, Dry Year.</td><td>Table 3.15-1 was corrected as follows: Medicine Lodge Creek downstream of Anita Ditch – Dry Year:
<table>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>13</td><td>12</td><td>11</td><td>11</td><td>54</td><td>28</td><td>3</td><td>2</td><td>9</td><td>15</td><td>18</td><td>16</td></tr>
</table></td></tr>
<tr><td>WGFD</td><td>007-4</td><td>Page vii, Water Resources - We previously commented that elimination of flow at any time of year in Alkali Creek would result in complete loss of the fishery in this stream. This condition is unacceptable and may create difficulties securing necessary federal permits. The significant flow decreases in the Nowood River (up to 71 %) is a significant concern. Quantitative data are needed to define the extent of this flow depletion on native and non-native fishes.</td><td>The BLM will work with the WWDO and the USACE through NEPA and the 404 permitting processes to provide guidance regarding reservoir operation as it affects flows. The project includes a conservation pool and bypass of base flow in Alkali Creek through the reservoir to maintain current downstream conditions. The bypass would not affect the conservation pool. These measures would be implemented for the purpose of minimizing effects on aquatic habitat and species in coordination with WGFD.

Clarifying language has been added to Section 2.4.2.1 and reflected throughout the document.</td></tr>
<tr><td>WGFD</td><td>007-8</td><td>Page 105 -The information in this table would be easier to understand and provide more clarity of the flow changes at each location were presented in graphic format as well as tabular.</td><td>The information in Table 3.15-2 is presented graphically in Appendix E.</td></tr>
<tr><td>WGFD</td><td>007-10</td><td>Page 105 -To ensure channel stability and avoid impacts associated with ice formation and break-up, we recommend that non-irrigation season reservoir releases be made from near the reservoir surface where the colder water approximates natural temperatures. This release will encourage formation of a stable ice cap that will minimize stream bank erosion and protect existing stream fisheries.</td><td>A multilevel outlet, which would allow control of release temperatures to address ice formation concerns, is part of the preliminary designs. Current inflows during winter months may be unnaturally warm considering the majority of winter flow comes from the artesian well located upstream of the proposed reservoir.

In addition, structures are proposed to stabilize Alkali Creek to mitigate potential erosion or stability issues that may occur as a result to flow regime changes.

Clarifying language was added to Section 2.4.2.2.1.</td></tr>
<tr><td>WGFD</td><td>007-17</td><td>Page 138, last paragraph and 139 -This discussion of benefits and impacts is subjective. In the absence of quantitative data the description is best described and conjecture. It is critical to bear in mind that impacts associated with flow depletions in some months are not mitigated by flow increases in other months. A quantitative time-series analysis is required to afford a credible evaluation of the flow levels or rates that may occur.</td><td>Data are not available to provide a quantitative time series analysis of the effects of flow change on fish species. Instream flow studies would be required to provide quantitative results as requested in this comment. Mitigation involving an adaptive management plan will manage reservoir operation and releases for the purpose of minimizing effects on aquatic species.</td></tr>
<tr><td>WWDO</td><td>008-3</td><td>It is important to note the trend in the ACR service area is that currently idle, but permitted irrigable acres (3,150 acres) are going back into production. This is due in part to change in ownership and improvements in technology. Permitted acres that have a valid water right for irrigation have the current ability to divert water from the stream for beneficial use. Therefore, the changing conditions (stream flow) associated with these lands going into production are independent of the Proposed Action and its associated environmental effects.</td><td>BLM agrees that currently idle but permitted irrigable acres may go back into production independent of the proposed reservoir. However, it is reasonable to assume that a reliable water supply may also encourage some of the idle but permitted irrigable lands to go into production. Because there is no way to demonstrate a causal link between the reservoir and idle lands, the analysis includes both possibilities. This was done in an attempt to better determine the actual contribution of the Proposed Action on modeled stream flows.

Clarifying language was added to Sections 2.4.1, 3.15.4.1, 3.15.4.2.1, 3.16.4.1, 3.16.4.2, 3.18.4.1.2, and 3.18.4.2.2.</td></tr>
<tr><td>WWP</td><td>009-10</td><td>The proposed reservoir would reduce spring flows in Paint Rock Creek by up to 33%, in Medicine Lodge Creek by up to 16%, and in Alkali Creek by up to 100%. DEIS at 104. However, it does not appear that the BLM has considered the range or pre-project streamflows, from drought years to high-water years. BLM should be modeling water flows before and after the project not just for average flows, but also for floods of various magnitudes resulting from rainstorms or snowmelt events. The releases from the reservoir in late summer would increase flows in Alkali Creek below the reservoir by more than 500%. Id. However, in Paint Rock and Medicine Lodge Creek, “irrigation diversions by exchange” would reduce streamflow in Medicine Lodge Creek by up to 52% in September and in Paint Rock Creek by 20% in August, in order to irrigate currently-unirrigated acres. This is a net loss for aquatic ecosystems and the wetlands they support.</td><td>Average and median monthly stream flow data for wet, normal, and dry water years are presented in Section 3.15 and Appendix E. This data presents both pre- and post-project stream flows and provides a range of hydrologic conditions (dry, normal and wet years, i.e., from drought years to high-water years). Longer duration snowmelt events are reflected in the monthly stream flow data; short-duration rainstorm events are beyond the capability of the monthly analysis. These items were clarified in Section 3.15.3.1.</td></tr>
</table>

Commenter	Comment ID	Comment	BLM Responses
SEO	010-1	Please be aware that per Wyoming Statute §41-3-603, the water commissioner has the authority to require the filling of any reservoir whenever practical and whenever water is available for storage from the stream from which the appropriation is established. This means that under the “one fill rule,” when in regulation and in order of priority, the reservoir is entitled to fill only once using carryover from the previous year (from October 1st through September 30th). We would like clarification as to whether this regulatory limitation has been incorporated into the StateMod model and the related analysis reflected in the DEIS.	The StateMod model was set to operate in accordance with the “one fill rule,” and the analysis in the draft EIS is reflective of this. This clarification of model operation was added to Section 3.16.4.2 of the final EIS.
SEO	010-2	It is unclear if the StateMod model incorporates both the surplus diversion regulatory requirement into its analysis as well. Clarification is requested as to whether or not this consideration was included in the StateMod results analyzed by the DEIS.	The StateMod model incorporates both surplus and excess water rights, which permit an additional 1 cfs per 70 acres irrigated to be diverted. This clarification of model operation was added to Section 3.16.4.2 of the final EIS.

Table F-17. Vegetation Comments

Commenter	Comment ID	Comment	BLM Responses
WCCD	001-8	Given the adjoining of private and federal lands for this project, WCCD has some concerns with the DEIS where the distinction between private property rights and federal oversite are not clearly delineated. Although WCCD is satisfied with the reclamation plan, the long term monitoring and weed control on private vs federal lands is not clearly defined. Private land owners have no need to report to federal agencies regarding the presence or absence of plant species on private lands. WCCD recognizes the DEIS was intended to analyze the project as a whole, and is in full support of invasive species control, but would like to clarify areas where the need for federal oversite ends.	A clarification has been added to Section 3.13.6. The BLM has no jurisdiction over private property. The analysis in the EIS addresses both public and private property because under NEPA, the BLM has a responsibility to analyze impacts from directly connected actions and to propose actions to avoid, minimize, and mitigate adverse effects. On private lands, weed management will need to comply with landowner and Wyoming Weed and Pest Control Act requirements. The WWDO weed management plan does not provide for different management on private and public lands and it is likely that the same weed control measures can be implemented on both, except where an individual landowner may require different management.
WCCD	001-9	WCCD would suggest language clarifying adherence to Trespassing to Unlawfully Collect Resource Data in any monitoring, mitigation planning, etc.	A clarification has been added to Section 3.13.6. BLM has no authority to require trespass on private land. Access to private lands will be based on agreements between WWDO and individual landowners.

Table F-18. Water Rights and Irrigation Comments

Commenter	Comment ID	Comment	BLM Responses
WDEQ	002-1	WDEQ requests clarification on how accumulated sediment will be managed in the reservoir. If the intention is to release sediment, WDEQ requests that the EIS analyze the potential impacts to downstream water quality.	There are no plans to flush sediment from the reservoir to minimize sediment accumulation. Sediment that enters the reservoir is intended to be stored. The outlet works will have the ability to sluice an insignificant amount of sediment that may deposit directly adjacent to the outlet works gates to prevent blockage of the gates. This has been clarified in Section 3.15.4.2.2.
SEO	010-1	Please be aware that per Wyoming Statute §41-3-603, the water commissioner has the authority to require the filling of any reservoir whenever practical and whenever water is available for storage from the stream from which the appropriation is established. This means that under the “one fill rule,” when in regulation and in order of priority, the reservoir is entitled to fill only once using carryover from the previous year (from October 1st through September 30th). We would like clarification as to whether this regulatory limitation has been incorporated into the StateMod model and the related analysis reflected in the DEIS.	The StateMod model was set to operate in accordance with the “one fill rule,” and the analysis in the draft EIS is reflective of this. This clarification of model operation was added to Section 3.16.4.2 of the final EIS.
SEO	010-2	It is unclear if the StateMod model incorporates both the surplus diversion regulatory requirement into its analysis as well. Clarification is requested as to whether or not this consideration was included in the StateMod results analyzed by the DEIS.	The StateMod model incorporates both surplus and excess water rights, which permit an additional 1 cfs per 70 acres irrigated to be diverted. This clarification of model operation was added to Section 3.16.4.2 of the final EIS.
SEO	010-3	During dry years, Medicine Lodge and Paint Rock Creeks typically go into priority regulation by late June. Under Alternative C, this means that an unmet 50-day fill period due to earlier-than-normal priority regulation could render the reservoir to be less effective at reducing shortages as compared to the Alternative B 30-day fill period. Additional analysis that discusses this scenario and its possible effects on the ability for the reservoir to fill under Alternative C should be incorporated into this section.	Sections 3.15.4.3.1 and 3.16.4.3 describe the simulated reservoir supply sources, volumes, and rates. These sections were revised with the change in proposed reservoir operation to provide a year-round Alkali Creek bypass of 0.4 cfs to minimize adverse effects on fish species. Clarification was added to these sections about potential conditions that could cause the reservoir to not fill under the Modified Proposed Action (Alternative C).

Table F-19. Water Quality Comments

Commenter	Comment ID	Comment	BLM Responses
WCCD	001-5	Drinking water standards should not be discussed for Alkali Creek since it is not used as a drinking water source. The water quality due to contact with sedimentary rock is a natural condition out of our control. To use the term "elevated" implies it is not meeting some requirement which is within our control or in need of being met for its use.	Alkali Creek is classified as a 2AB water, therefore drinking water standards apply even though it may not be currently used as a drinking water source. Surface water classification and designated uses were added to Section 3.15.2.3. The draft EIS Section 3.15.2.3 was modified to state that WDEQ does not have surface water quality standards for TDS and sulfate. These constituents do not have water quality standards per WDEQ Chapter 1 Surface Water Quality Standards.

Commenter	Comment ID	Comment	BLM Responses
WCCD	001-7	It is unclear if this is a DEIS assumption or taken from the TMDL, but to assume the presence of E.coli is due to anthropogenic activities is inaccurate. Virtually all mammals are colonized with E.coli, including big game, birds, rodents, etc. See https://www.ncbi.nlm.nih.gov/ pmc/articles/PMC4510460/	Section 3.15.4.2.3 paragraph 5 of the draft EIS was clarified as to the potential source(s) of *E. coli* in the reservoir water supply.
WDEQ	002-2	The WDEQ appreciates the additional selenium sampling conducted by the WWDO. The sampling should allow WWDO to better understand the potential for selenium leaching and the ability of the reservoir to attain surface water quality criteria for selenium protective of aquatic life and human health. The WDEQ requests clarification on whether the results of the additional selenium sampling will be incorporated into the Final EIS.	Results of the additional selenium soil sampling within the footprint of the proposed reservoir indicated that selenium was present above method detection limits at only one of the 13 tested locations. Using these results, Trihydro conservatively estimated that the equilibrium selenium concentration in the reservoir would be at or below 0.0026 mg/L, which is well below the numeric criteria for selenium protective of aquatic life and human health. The Trihydro memo will be referenced in the final EIS, and as a result, selenium has not been carried forward as an issue for detailed analysis in the final EIS as noted in Section 1.6.1.4.
WDEQ	002-3	The WDEQ recommends including a description of anticipated impacts from selenium leaching in the reservoir on downstream waterbodies and designated uses in Alkali and Paint Rock Creeks due to water released from the reservoir.	Trihydro's recent memo regarding the selenium soil sampling results indicates that selenium concentration in the proposed reservoir is not expected to exceed Wyoming surface water quality standards. Because selenium concentration in the reservoir water is expected to be below water quality standards, this level of assessment downstream does not appear to be warranted. As a result, selenium has not been carried forward as an issue for detailed analysis in the final EIS as noted in Section 1.6.1.4.
WDEQ	002-4	The second paragraph on this page mentions that "an adaptive management approach is warranted" and the DEIS also recommends E.coli sampling in Medicine Lodge Creek, Paint Rock Creek, and the reservoir itself. The WDEQ requests clarification on whether there are plans to develop and implement a monitoring and adaptive management strategy to address *E. coli* and whether this plan will be included as part of the FEIS. If so, the WDEQ recommends that the plan also include *E. coli* monitoring for Alkali Creek downstream of the dam.	The BLM agrees, and the text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
WDEQ	002-5	The DEIS states: "The increase in recreation and wildlife in the area has the potential to affect *E. coli* levels; however, given the large reservoir volume and water residence time, this effect would be minor and should not lead to a change in suitability in accordance with the Chapter 1 (Wyoming Surface Water Quality Standards) of the Wyoming Water Quality Rules and Regulations." It is not clear if this sentence is specifically referring to *E. coli* levels in the reservoir itself, or the larger hydrologic system that it is connected to. Also, it is not clear what the term "suitability" is intended to mean in this sentence as well. Typically, surface water quality criteria are thought of in terms of being met or being exceeded and surface water designated uses being supported or not supported. WDEQ requests clarification on these statements, including how the large reservoir volume and residence time would impact *E. coli* concentrations, if at all.	Section 3.15.4.2.3 paragraph 10 of the draft EIS was revised as follows: "The increase in recreation and wildlife in the area could affect *E. coli* concentrations/loading in the water within the analysis area. This further supports the need for an AMP."
WGFD	007-11	Page 113, first row -Temperature changes in summer and winter will be significantly different than stream temperatures at present and likely lead to change in the species composition and abundance. The analysis needs to consider the reservoir's effects on winter temperatures if a flow release is provided to maintain the downstream fishery. If water is released from near the top of the reservoir pool, negligible temperature changes should occur and would be beneficial. Summer releases will almost certainly be cooler than present stream temperatures and lead to a shift in fish and aquatic insect species composition.	A multilevel outlet, which would allow control of release temperatures, is part of the preliminary designs. Current inflows during winter months may be unnaturally warm considering a portion of the majority of winter flow comes from overflow of a stock tank that is supplied by an artesian well located upstream of the proposed reservoir. Clarifying language was added to Section 2.4.2.2.1. Water temperature will be addressed as part of the proposed adaptive management approach discussed in Section 3.15.6. The multilevel outlet would be one of the potential corrective actions to adaptively manage for unacceptable changes in water temperature.
WGFD	007-12	Page 113, row eight -If winter releases are made from the bottom of the reservoir, considerable bank erosion could occur from repeated ice formation and break-up process each winter. Releasing cooler water in the winter from near the surface would minimize the potential for this negative effect.	A multilevel outlet, which would allow control of release temperatures to address ice formation concerns, is part of the preliminary designs. Current inflows during winter months may be unnaturally warm considering the majority of winter flow comes from the artesian well located upstream of the proposed reservoir. In addition, structures are proposed to stabilize Alkali Creek to mitigate potential erosion or stability issues that may occur as a result of flow regime changes. Clarifying language was added to Section 2.4.2.2.1. Water temperature will be addressed as part of the proposed adaptive management approach discussed in Section 3.15.6. The multilevel outlet would be one of the potential corrective actions to adaptively manage for unacceptable changes in water temperature.
WWP	009-6	How will the reductions in streamflows further concentrate pollutants and contaminants downstream, during periods of water diversion and storage? What are the current *E. coli* loads for all streams downstream from the proposed project and its diversions? What will be the loads throughout the year, below the facilities?	Data from the 2013 TMDL report on *E. coli* loading for the TMDL reaches were added to Section 3.15.2.3 of the final EIS. The change in *E. coli* loading in the TMDL reaches was quantified using a simple mass balance analysis with no decay using an assumption about *E. coli* concentration at the reservoir diversions. This analysis was added to Sections 3.15.3.3 and 3.15.4.2.3. Insufficient data exist to quantify other constituent changes. For this reason, the text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
WWP	009-7	there is no analysis of how stored water might or might not enable the growth and increase of *E. coli* loads while water is stored throughout the hot months of summer, as a result of nutrient or suspended solids in reservoir waters.	The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will address *E. coli* and will incorporate monitoring to determine if project-related impacts are affecting the desired condition.

Commenter	Comment ID	Comment	BLM Responses
WWP	009-8	there does not appear to be an adequate analysis of the potential of thermoclines to form, which could potentially result in anaerobic environments and reduced decomposition which ultimately leads to algae blooms and lowered dissolved oxygen levels, either in the reservoir itself or downstream, when reservoir waters are released. A comprehensive analysis of projected dissolved oxygen, pH, bacterial levels, algae densities, and total dissolved solids is needed for the reservoir and downstream stream reaches to satisfy NEPA's baseline information	The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
WWP	009-9	changes in water quality for 303(d) impaired waters and Total Maximum Daily Loads (TMDLs) under the Clean Water Act need to be carefully evaluated.	The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will address *E. coli* and will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
WWP	009-11	The EIS does provide some descriptive listing of types of impacts of sedimentation as a result of the project, but fails to quantify and describe the consequences of the reservoir, irrigation diversions, and changes in flow regime on flow conditions, streamcourse substrate, and resulting changes to aquatic communities that would be expected to result from these changes. The DEIS states that erosion control measures would be emplaced during construction operations, but does not explain the nature or effect of these mitigation measures, or the extent to which they might (or might not) mitigate sediment loading during construction. The reservoir and associated diversions would reduce downstream flows of water, increasing stream width-to-depth ratios, and preventing overbanks (flood) flows. DEIS at 108. This would result in warmer water temperatures downstream, harmful to trout, and would prevent flooding that is important to bottomland nutrient deposition and cottonwood seedling recruitment, which depends on scouring flows. In addition, downstream erosion would increase during the delivery period with unnatural increases in water flow. DEIS at 113.	Impacts to stream morphology are quantified by the percent reduction to bankfull flows that may occur from the maximum amount of diverted water during the dominant discharge period. Impacts to channel form are generally described by a potential change in channel form (Channel Evolution Model [Rosgen 2006][1]), and qualified by channel contraction, decreased entrenchment ratios, increase width to depth, and a reduction to sediment transport capacity. The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition. Corrective actions may include direct modifications to stabilize the channel and restore physical processes to support biological attributes. Potential impacts during construction would be mitigated per SWPPP BMPs and any special provisions outlined in the 404/401 permit requirements.
WWP	009-13	See DEIS at 158. Similarly, surface water quality fails to take into account past impacts on water quality from pre-existing irrigation, roads, agricultural land uses, and other human impacts. DEIS at 158. The BLM should also quantify the relative contributions of livestock grazing versus septic systems, which would seem to be a relatively minor contributor to *E. coli* contamination given the sparse residential development in the area.	Surface water quality does take into account past impacts on water quality as described in Section 4.15.3.1 ("farming and ranching activities"). Quantification of the relative *E. coli* contributions of livestock grazing versus septic systems is outside the scope of this analysis because the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the Proposed Action and alternatives, when combined with past, present, and reasonably foreseeable actions, on a particular resource. The CEQ's 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that "CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions." In addition, CEQ regulations "do not require agencies to catalogue or exhaustively list and analyze all individual past actions." Sections 4.15.1.2 and 4.15.3.2 have been edited to better incorporate contributing cumulative actions for surface water and water quality.
EPA	011-01	The Draft EIS and supporting documents do not include an analysis of the project's potential to impact water quality in the streams downstream of the proposed reservoir. The EPA is concerned that the ACRP appears likely to contribute to violations of WQS in these streams with existing water quality impairments.	Data from the 2013 TMDL report on *E. coli* loading for the TMDL reaches were added to Section 3.15.2.3 of the final EIS. The change in *E. coli* loading in the TMDL reaches was quantified using a simple mass balance analysis with no decay using an assumption about *E. coli* concentration at the reservoir diversions. This analysis was added to Sections 3.15.3.3 and 3.15.4.2.3. Insufficient data exist to quantify other constituent changes. As such, an adaptive management plan to address water quality standards exceedance and use nonattainment in accordance with Chapter 1 (Wyoming Surface Water Quality Standards) of the Wyoming water quality rules and regulations was added to the final EIS.
EPA	011-02	…the ACRP would divert and capture water from unimpaired stream reaches in Medicine Lodge Creek, Paint Rock Creek and Alkali Creek during spring runoff. Both Paint Rock Creek and the Nowood River downstream of the proposed project are impaired by *E. coli* bacteria from rangeland operations; therefore, they currently do not meet Wyoming's WQS for *E. coli*. The Wyoming Department of Environmental Quality's (WDEQ) total maximum daily load (TMDL) report for *E. coli* in the Big Horn River Watershed and related documentation indicate that spring runoff is a time of relatively high bacterial load and concentration in the downstream impaired reaches. Therefore, diversion and capture of unimpaired water during the spring has the potential to increase downstream concentrations of *E. coli* and other pollutants during the times when the water quality in those streams is exceeding WQS.	Data from the 2013 TMDL report on *E. coli* loading for the TMDL reaches were added to Section 3.15.2.3 of the final EIS. The change in *E. coli* loading in the TMDL reaches was quantified using a simple mass balance analysis with no decay using an assumption about *E. coli* concentration at the reservoir diversions. This analysis was added to Sections 3.15.3.3 and 3.15.4.2.3. Insufficient data exist to quantify other constituent changes. For this reason, the text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
EPA	011-03	Appendix E of the Draft EIS shows that the impaired reach of Paint Rock Creek is predicted to experience a 13% and 15% decrease in flow in April and May, respectively, of wet years and a 33% decrease in flow in April of dry years during diversion. We recommend that the EIS incorporate any available monitoring data and specific analysis and quantification of expected changes to concentrations of *E. coli* and other existing pollutants. Those predicted pollutant concentrations should then be compared to WQS for waters downstream of the proposed reservoir and diversions.	Data from the 2013 TMDL report on *E. coli* loading for the TMDL reaches were added to Section 3.15.2.3 of the final EIS. The change in *E. coli* loading in the TMDL reaches was quantified using a simple mass balance analysis with no decay using an assumption about *E. coli* concentration at the reservoir diversions. This analysis was added to Sections 3.15.3.3 and 3.15.4.2.3. Insufficient data exist to quantify other constituent changes. For this reason, the text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.

[1] Rosgen. 2006. A Stream Channel Stability Assessment Methodology. In *Proceedings of the Seventh Federal Interagency Sedimentation Conference*, Vol. 1. (pp. II-18–II-26). Reno, Nevada: Subcommittee on Sedimentation.

Commenter	Comment ID	Comment	BLM Responses
EPA	011-04	Potential changes to stream temperatures should also be analyzed against applicable WQS. Per the Clean Water Act (CWA) Section 404(b)(1) Guidelines (Guidelines), a CWA Section 404 permit for the discharge of dredged or fill material may not be issued if doing so would cause or contribute to violations of any applicable State WQS.4	The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
EPA	011-05	The EPA recommends that the EIS evaluate whether the ACRP and alternatives to the ACRP would cause or contribute to WQS violations so that the Corps can make a permitting decision in compliance with the regulatory requirements at 40 CFR § 230.l0(b) and (c). The EPA recognizes that the WDEQ has an important role under the CW A Section 401 (a)(1) to certify that the selected project will comply with applicable WQS. We note that WDEQ's comments on the ACRP included questions and recommendations on the effects of the proposed project on *E. coli* concentrations. We are encouraged that WDEQ will be involved as a Cooperating Agency in the discussions leading to a Final EIS. WDEQ might be in the best position to identify potential opportunities to avoid these impacts given their familiarity with the causes and timing of impairment.	Data from the 2013 TMDL report on *E. coli* loading for the TMDL reaches were added to Section 3.15.2.3 of the final EIS. The change in *E. coli* loading in the TMDL reaches was quantified using a simple mass balance analysis with no decay using an assumption about *E. coli* concentration at the reservoir diversions. This analysis was added to Sections 3.15.3.3 and 3.15.4.2.3. Insufficient data exist to quantify other constituent changes. For this reason, the text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
EPA	011-06	We also note that in identifying "limited risk to human health from bacteria in or downstream from the reservoir," the Draft EIS (page 105) relies on the source of the bacteria being livestock rather than humans, and the outlet of the reservoir being near the bottom of a potentially stratified reservoir. However, livestock are known to harbor many human pathogens and the Draft EIS provides no evidence that the reservoir would stratify to allow for the release of cold water beneath a thermocline, beyond stating that the morphometry of the basin lends itself to stratification. The EPA recommends clarifying these points in the EIS.	The statements on reservoir stratification were clarified, and the statements on limited risk to human health were removed from the final EIS.
EPA	011-07	The Draft EIS does not evaluate potential water quality changes in the proposed reservoir. The Draft EIS (pages 104-105) anticipates that changes to the source water in the proposed reservoir would not occur. However, storing large volumes of water in reservoirs affects the quality of water. For example, temperature of the water can increase due to increased surface area and potential stratification of the stored water can lead to formation of anoxic zones, which can increase sediment release of nutrients and subsequent growth of algae and bacteria. Relevant WQS in reservoirs include dissolved oxygen, temperature, pH, metals, algal growth, bacterial concentrations, total suspended solids, turbidity and total/dissolved organic carbon. A change in any of these parameters caused by reservoir operations, inputs, and fluctuating water levels may influence water quality, fisheries, or recreational use within or downstream of the proposed reservoir. Importantly, reservoir water from the ACRP would be released during times of lower bacterial load and concentration in the downstream impaired reaches (late summer and fall, see TMDL report and related documentation.) Therefore, depending on how water quality changes in the proposed reservoir, these releases could potentially cause or contribute to impairment during these times of year.	The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
EPA	011-08	Because available data are insufficient to model water quality in the proposed reservoir or other potential reservoir sites considered in the EIS, the EPA recommends the BLM develop and include in the EIS an adaptive management plan for the resource affected by the selected project. WDEQ has also recommended adaptive management for reservoir water quality. In order for adaptive management to be successful, we recommend that the plan include: A monitoring plan with committed resources to monitor trends in water quality and determine if the reservoir will meet WQS; Defined thresholds for determining when additional management action is needed to ensure attainment of WQS and support recreational uses of the reservoir; Identification of the management actions that will be implemented if a threshold is triggered to bring water quality below the threshold.	The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
EPA	011-09	The Draft EIS does not evaluate the potential impacts to attainment of beneficial uses designated in Wyoming's WQS. The WQS applicable to Alkali Creek, Paint Rock Creek and the Nowood River include designated uses of game and non-game fisheries, fish consumption, aquatic life other than fish, drinking water, recreation, wildlife, industry, agriculture, and scenic values. Potential effects of the alternatives on attainment of these uses are not directly assessed in the Draft EIS.	Data from the 2016/2018 Integrated 305(b) and 303(d) report on use nonattainment were added to Section 3.15.2.3 of the final EIS. Insufficient data exist to model potential impacts to attainment of beneficial uses. For this reason, the text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
EPA	011-10	Although Appendix C states that no impacts to fisheries in Alkali Creek would occur as a result of the Proposed Action, Appendix E of the Draft EIS shows that Alkali Creek below the proposed dam would experience a 100% decrease in flow for 6 to 8 months of the year, which would prevent attainment of designated uses. Due to operation of the ACRP and increased use of water for irrigation, Medicine Lodge Creek would experience decreases of up to 52% in September and 31 % in June. The Nowood River would experience decreases in flow up to 71 % in July of dry years. The Draft EIS acknowledges that flow reductions in Medicine Lodge Creek and the Nowood River would cause substantial loss of aquatic habitat and adverse effects to fish, macroinvertebrates and special status species (pages 135-136), but does not directly assess or specify the effects of these decreased flows on attainment of related designated uses. We recommend that the EIS evaluate how each alternative could affect attainment of the designated beneficial uses of affected waterbodies. We also recommend analyzing in detail other alternatives and/or committing to actions that would prevent contributing to violations of State WQS.	The Proposed Action would include a year-round base flow bypass of 0.4 cfs, which would maintain flow year-round in Alkali Creek and reduce the effects on aquatic species. Revised modeling that reflects the bypass and scenarios with and without irrigation of idle lands for the Proposed Action was conducted. Results indicated that flow changes exceeding 10% are attributed mainly to the inclusion of idle land irrigation. There would be just one or two months in Alkali and Paint Rock Creeks with flow changes exceeding 10% under the Proposed Action without idle lands being irrigated. There would be no flow changes exceeding 10% in Medicine Lodge Creek and the Nowood River under the Proposed Action without idle lands being irrigated. In addition, mitigation involving an adaptive management plan will be implemented to manage reservoir operation and releases for the purpose of minimizing effects on aquatic species.

Commenter	Comment ID	Comment	BLM Responses
			These measures would be implemented for the purpose of minimizing effects on aquatic habitat and species in coordination with WGFD and water quality and use attainment in coordination with WDEQ. Clarifying language has been added to Sections 2.4.2.1 and 3.18.4.2.2 and reflected throughout the document.
USACE	012-02	USACE supports the idea of adaptive management to monitor water quality related concerns. We request to be involved in the development of specific adaptive management and monitoring plans as some details of the plans will likely be incorporated as special conditions of the 404 permit.	The text in Section 3.15.6 has been revised to include the development of an adaptive management plan to be completed before the publication of the ROD. The plan will incorporate monitoring to determine if project-related impacts are affecting the desired condition.
USACE	012-03	There are numerous water quality concerns tied to the reduction of flows in the lower watershed caused by the operation of filling the reservoir. A continuous release of a base flow (i.e. matching outflow of the reservoir to inflow of Alkali Creek or other potential optimal flow rates) has been discussed, but does not show up in this section of the EIS as a mitigation measure. More analysis is needed to evaluate effects of a continuous flow out of the reservoir on the same 6 locations within the analysis area (table 3.15-1). A good starting point could be to determine how much water is needed to eliminate the instances where reduction of stream flow is greater than 10% at those 6 locations? If said mitigation measure is implemented, would that water come from the conservation pool or additional diverted water from Paint Rock and/or Medicine Lodge Creek during spring runoff and could the base flow fluctuate throughout the year to minimize downstream affects? With so many variables tied to a continuous flow release from the proposed reservoir, it might be worth exploring the idea of evaluating this potential operational component as its own modified proposed action alternative.	The BLM will work with the WWDO and the USACE through NEPA and the 404 permitting processes to provide guidance regarding reservoir operation as it affects flows. The project includes a conservation pool and bypass of base flow in Alkali Creek through the reservoir to maintain current downstream conditions. The bypass would not affect the conservation pool. These measures would be implemented for the purpose of minimizing effects on aquatic habitat and species in coordination with WGFD and water quality and use attainment in coordination with WDEQ. Clarifying language has been added to Section 2.4.2.1 and reflected throughout the document.

Table F-20. Wetlands Comments

Commenter	Comment ID	Comment	BLM Responses
WWP	009-15	A number of identified wetlands would either be directly eliminated by the reservoir, of affected by changing hydrology downstream. DEIS at 123, 125. However, there is no clear delineation of where these wetlands are located with respect to the project footprint. See Figure 3.17-1.	Wetlands are depicted on Figures 3.17-1 and 3.17-2 but are difficult to see because the wetlands are narrow. These figures have been updated to clearly identify the locations of wetlands in the direct effects analysis area, including Alkali Creek, Anita Ditch, Anita Supplemental Ditch, and the portions of Medicine Lodge Creek and Paint Rock Creek within the direct effects analysis area. Wetlands in the direct effects analysis area (i.e., project footprint) are summarized by location in Table 3.17-1, and impacts to wetlands in the project footprint are described by project element in Section 3.17.4-2. Wetlands in the downstream are described by stream reach in Section 3.17.2, generalized maps depicting stream reaches are provided in Figures 1.2-1 and 1.2-2, and impacts are described by stream reach in Section 3.17.4.2.
WWP	009-17	BLM also does not appear to have conducted an impact analysis on wetlands downstream from the project area, which also would be expected to be impacted based on the projected changes to water flow regimes	This analysis was conducted and is documented in the final EIS. The analysis of downstream and indirect impacts is provided in Section 3.17.4.2.
WWP	009-18	BLM states that the project will entail a USACE Section 404 permit under the Clean Water Act, which requires offsetting mitigation. DEIS at 160. However, the agency fails in its obligation to disclose and evaluate the environmental impacts (positive and negative) of this offsetting mitigation, which is clearly a connected action to the project.	Under NEPA, connected actions are included in the description of alternatives, which forms the basis for the impact analysis. Mitigations are a result of the impact analysis and are not addressed as connected actions or as part of the action alternative. USACE requirements for development and implementation of a compensatory mitigation plan for wetlands losses includes requirements for multiple years of monitoring to document success or failure, with remedial measures developed if the mitigation is not meeting defined performance criteria. USACE-required mitigation is therefore expected to be effective at mitigating for wetland losses.
USACE	012-04	"Wetland affected": Is it possible to use terminology consistent with Section 404 of the Clean Water Act is this table? For instance, the Proposed Action would result in a loss of 2.4 acres of wetland, the 4.8 acres of wetland downstream of the reservoir on Alkali Creek and the 5 acres of wetland within the ditches could be categorized as relocated wetlands and temporary impacts to wetland, respectively. Defining the affects to wetlands as such would help the USACE make a LEDPA determination, per the 404(b)(1) Guidelines. This is important because we cannot consider compensatory mitigation when making the LEDPA determination. Only wetland losses require compensatory mitigation so that value is primarily what we would use to compare alternatives based on their affect to wetlands. As wetland affects are currently described within table C-1, it appears there are alternatives that could meet the purpose & need of the project, yet result in less affects to wetlands than the Proposed Action.	The table in Appendix C has been modified per the suggestion of the USACE and reflected throughout the final EIS.

Table F-21. Wildlife Comments

Commenter	Comment ID	Comment	BLM Responses
WWP	009-23	Domestic livestock have been introduced throughout the watersheds of the CIAA, and each cow-calf pair is equivalent in its forage use to 10 pronghorn, a little more than two elk, or 5.88 mule deer (Ogle and Brazee 2009). This means that a substantial population of native ungulates has already been displaced from the CIAA due to competitive exclusion by livestock. In addition, roads have been built through the CIAA. Each major road displaces elk for an 0.5-mile distance on either side of the road, and causes stress and elevated energy use for those that remain. Similar, but smaller effects for mule deer and pronghorn would be expected, particularly since both are also hunted species. The conversion of native habitats to irrigated pasture, alfalfa fields, hayfields, or food crop fields within the watersheds of the CIAA will have had impacts on these species of big game.	Under NEPA, the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the proposed action and alternatives, when combined with past and present actions, on a particular resource. The CEQ's 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that "CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions." In addition, CEQ regulations "do not require agencies to catalogue or exhaustively list and analyze all individual past actions." Provision of distribution and populations trends is therefore outside the scope of this analysis. In addition, distribution and population trend data for special status species are not available for the CIAA. Section 4.18.2 has been modified to better incorporate contributing cumulative actions.
WWP	009-24	for raptors, roads in particular but also overhead powerlines would have impacted local populations, potentially displacing them from preferred nesting habitats, reducing nest success for those that remained, and/or causing direct mortality through electrocutions and vehicle collisions that result from roadkill along roadways. These latter unnatural mortality factors make roadways and powerlines "ecological trap" habitats, attracting raptors to areas where their odds of survival are significantly impaired.	Under NEPA, the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the proposed action and alternatives, when combined with past and present actions, on a particular resource. The CEQ's 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that "CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions." In addition, CEQ regulations "do not require agencies to catalogue or exhaustively list and analyze all individual past actions." Provision of distribution and populations trends is therefore outside the scope of this analysis. In addition, distribution and population trend data for special status species are not available for the CIAA. Section 4.18.2 has been modified to better incorporate contributing cumulative actions.
WWP	009-25	BLM must consider all of the impacts of past human activities in the CIAA on big game and raptor populations, and on the populations of all Sensitive Species (state or BLM), in order to credibly conduct a cumulative effects analysis that places the impacts of the Alkali Cree Reservoir impacts in meaningful context. BLM must also provide distribution and population trends for BLM and state-listed Sensitive Species, which is important baseline information. Instead of undertaking a cumulative effects analysis, BLM merely lists the additive effects of the project, without considering the degree to which these add to pre-existing effects from foregoing projects and pre-existing human structures, land uses, and activities. DEIS at 161. This is flatly inadequate.	Under NEPA, the cumulative effects analysis is not an analysis of past and present actions on resources in the CIAA. It is an analysis of the incremental impacts of the proposed action and alternatives, when combined with past and present actions, on a particular resource. The CEQ's 2005 Guidance on the Consideration of Past Actions in Cumulative Effects Analysis states that "CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions." In addition, CEQ regulations "do not require agencies to catalogue or exhaustively list and analyze all individual past actions." Provision of distribution and populations trends is therefore outside the scope of this analysis. In addition, distribution and population trend data for special status species are not available for the CIAA. Section 4.18.2 has been modified to better incorporate contributing cumulative actions.
WWP	009-29	We are also concerned that the resulting reservoir will provide Stillwater breeding habitat for the Culex tarsalis mosquitoes that carry West Nile virus. See DEIS at 135. We are not convinced that an undefined "mosquito abatement plan" (DEIS at 142) is adequate mitigation, and BLM is not in a position to take a hard look at the impacts of the project on West Nile virus and sage grouse without defining the mosquito abatement plan and its specific provisions in the EIS, and evaluating its effectiveness therein.	All BLM RMP objectives and guidelines will be applied during the implementation and operation of the proposed project, which includes the treatment of water storage impoundments to control mosquito breeding.

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APPENDIX G

Additional Wetland Figures

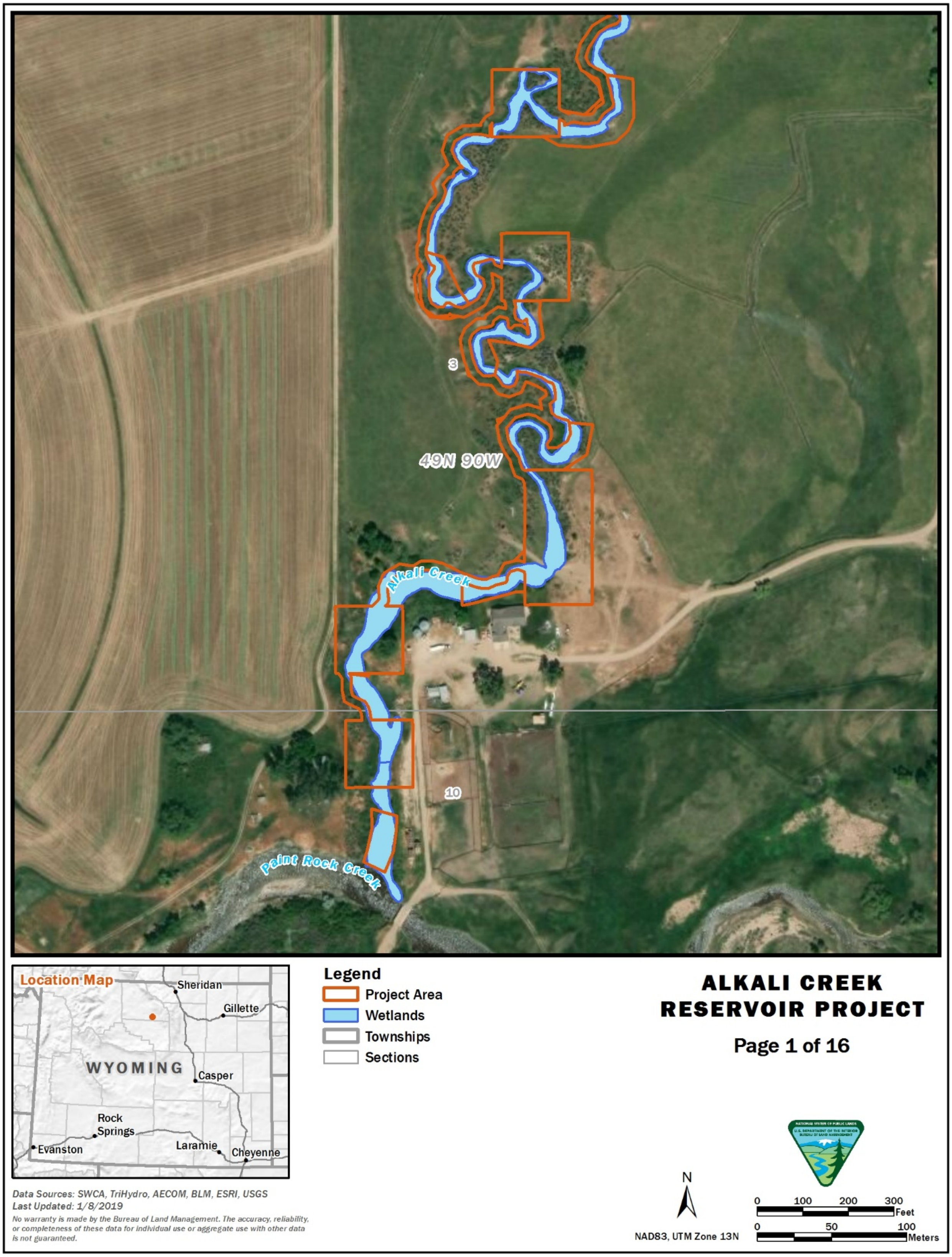

Figure G-1. Wetlands in the project area (direct effects analysis area) (page 1 of 16).

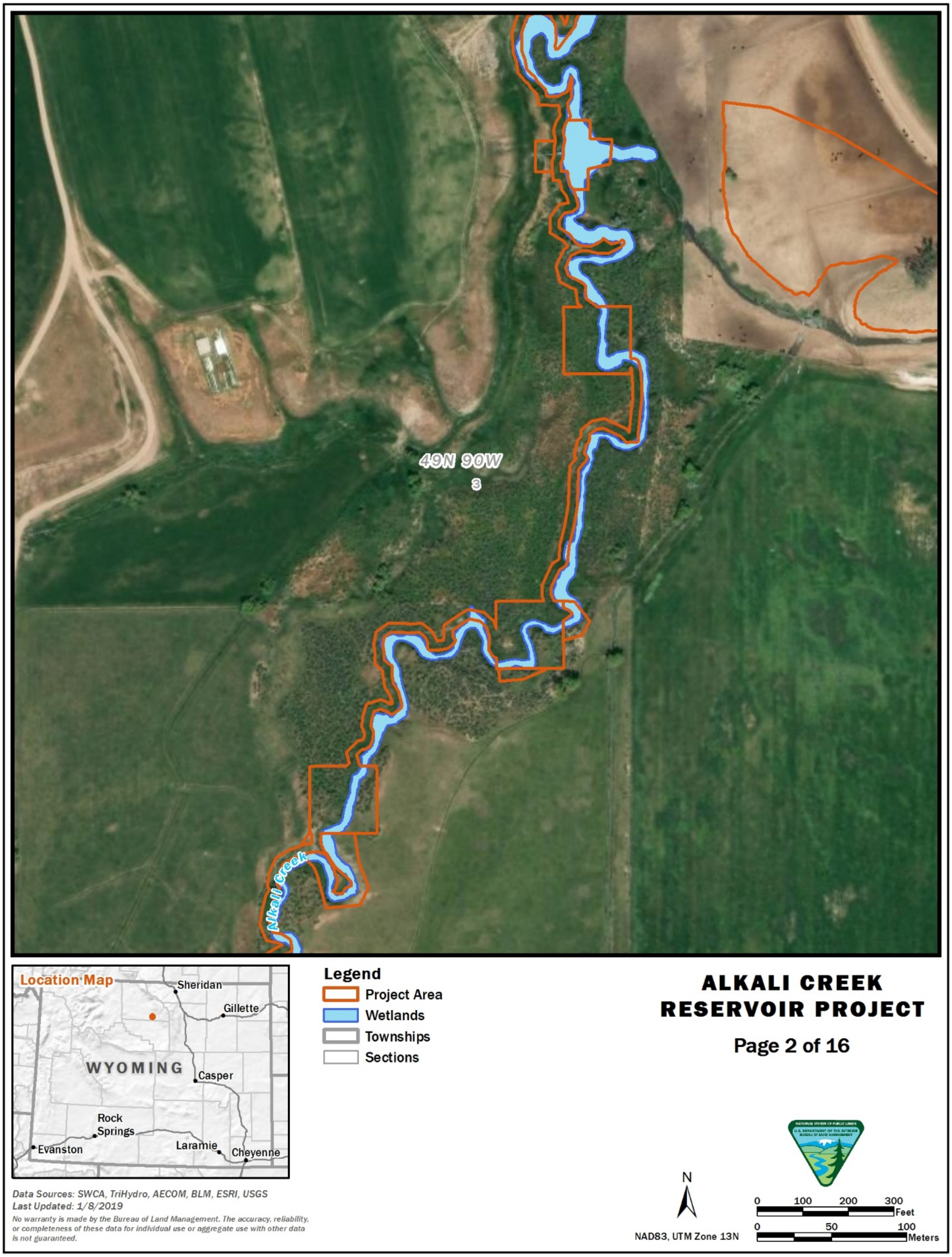

Figure G-2. Wetlands in the project area (direct effects analysis area) (page 2 of 16).

Figure G-3. Wetlands in the project area (direct effects analysis area) (page 3 of 16).

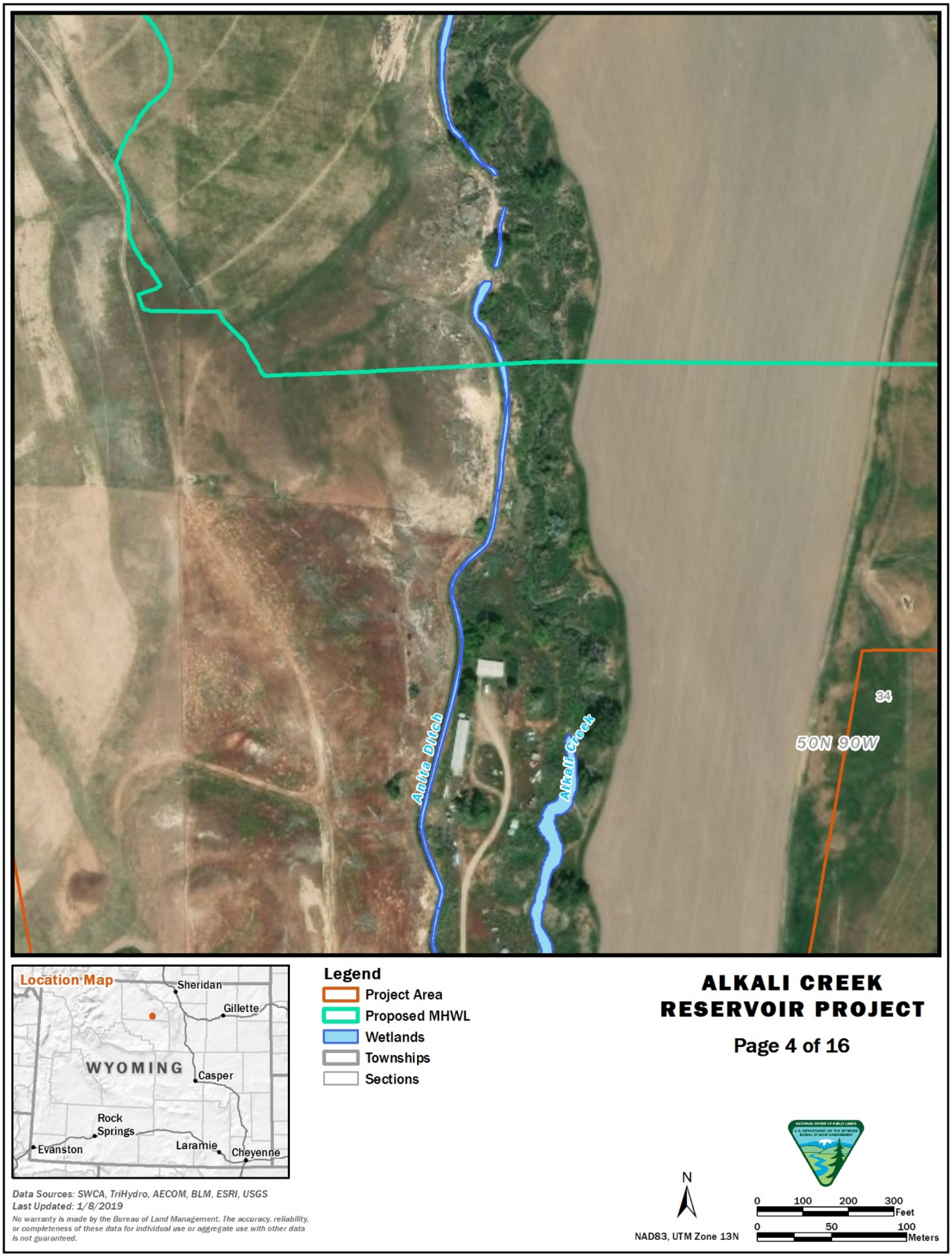

Figure G-4. Wetlands in the project area (direct effects analysis area) (page 4 of 16).

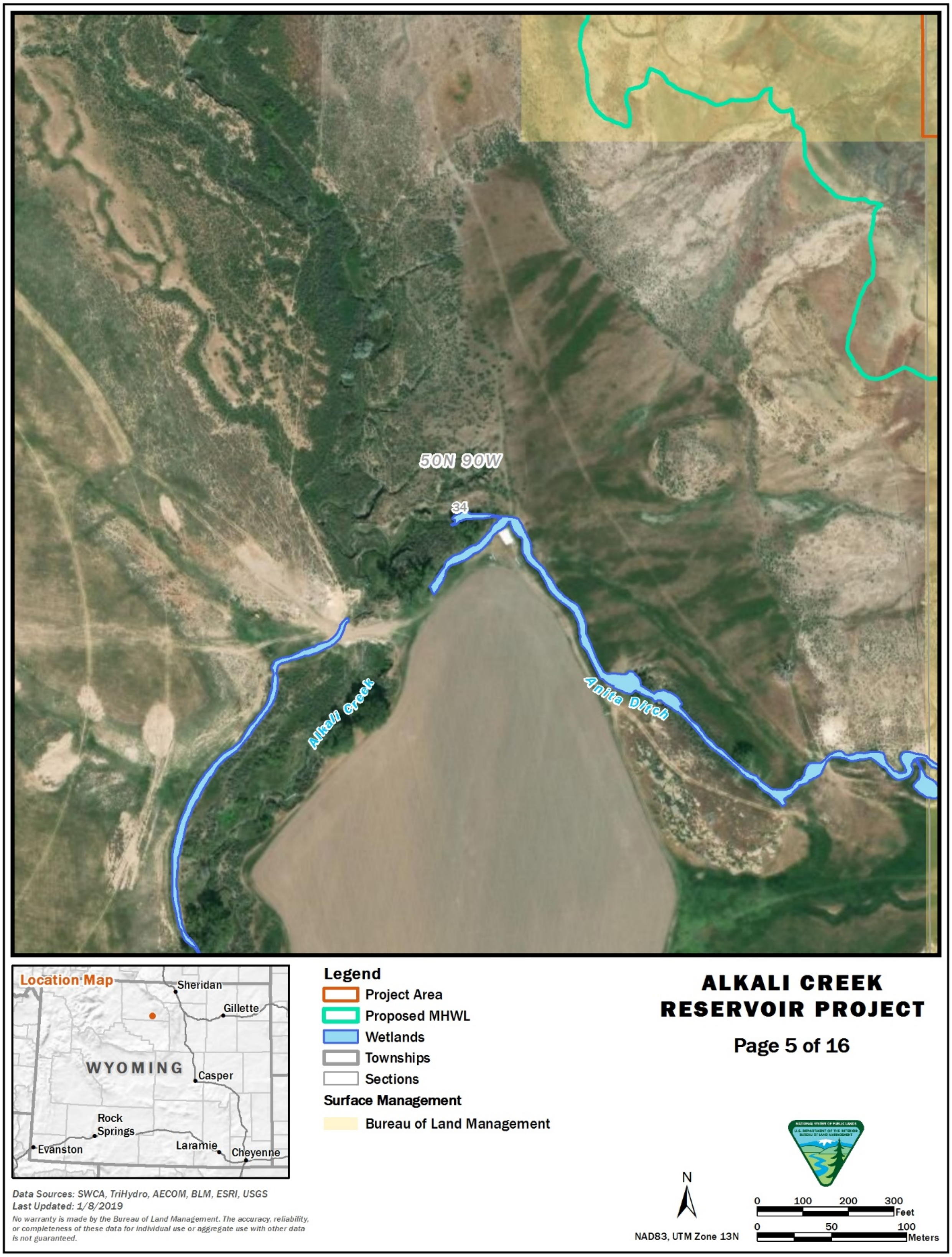

Figure G-5. Wetlands in the project area (direct effects analysis area) (page 5 of 16).

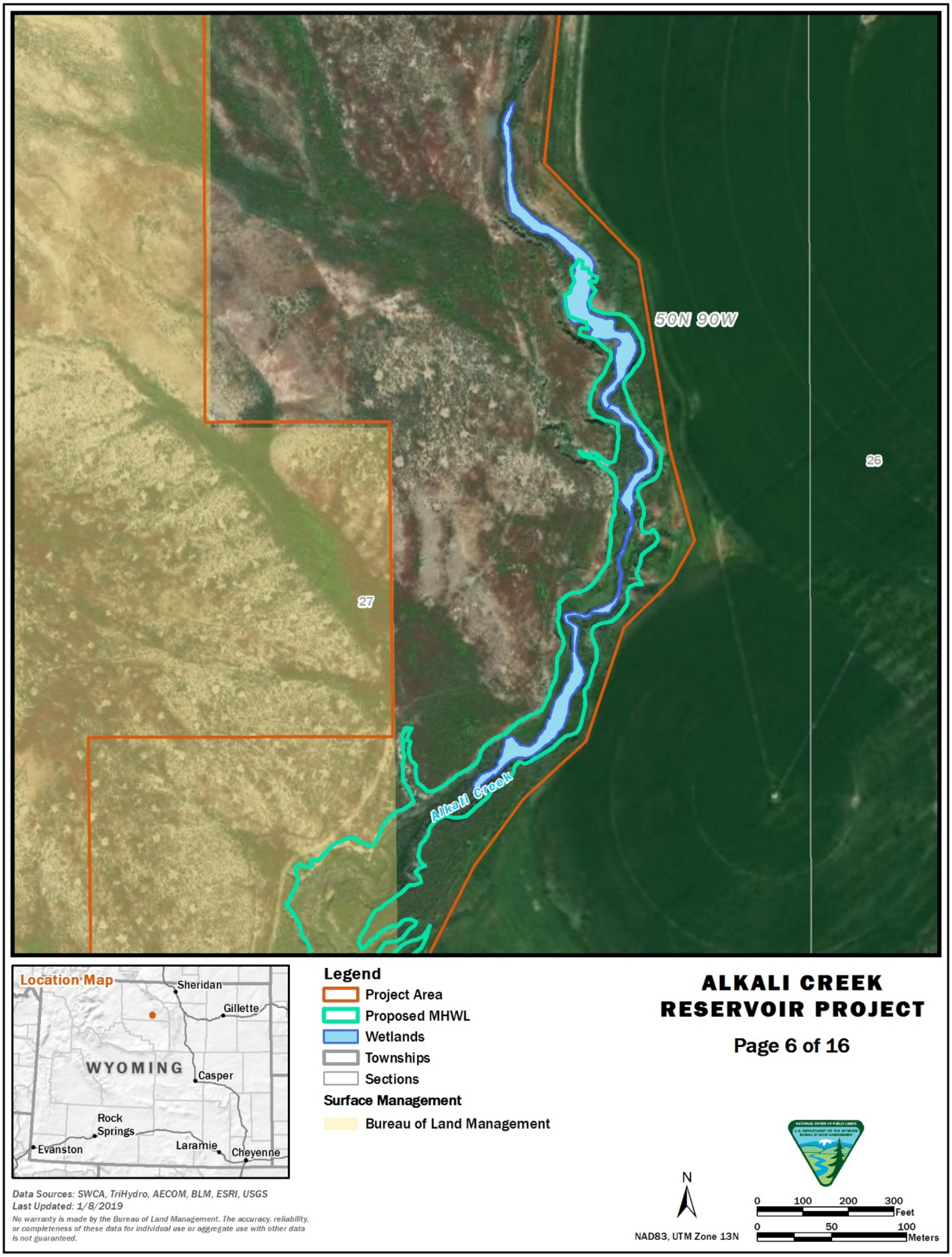

Figure G-6. Wetlands in the project area (direct effects analysis area) (page 6 of 16).

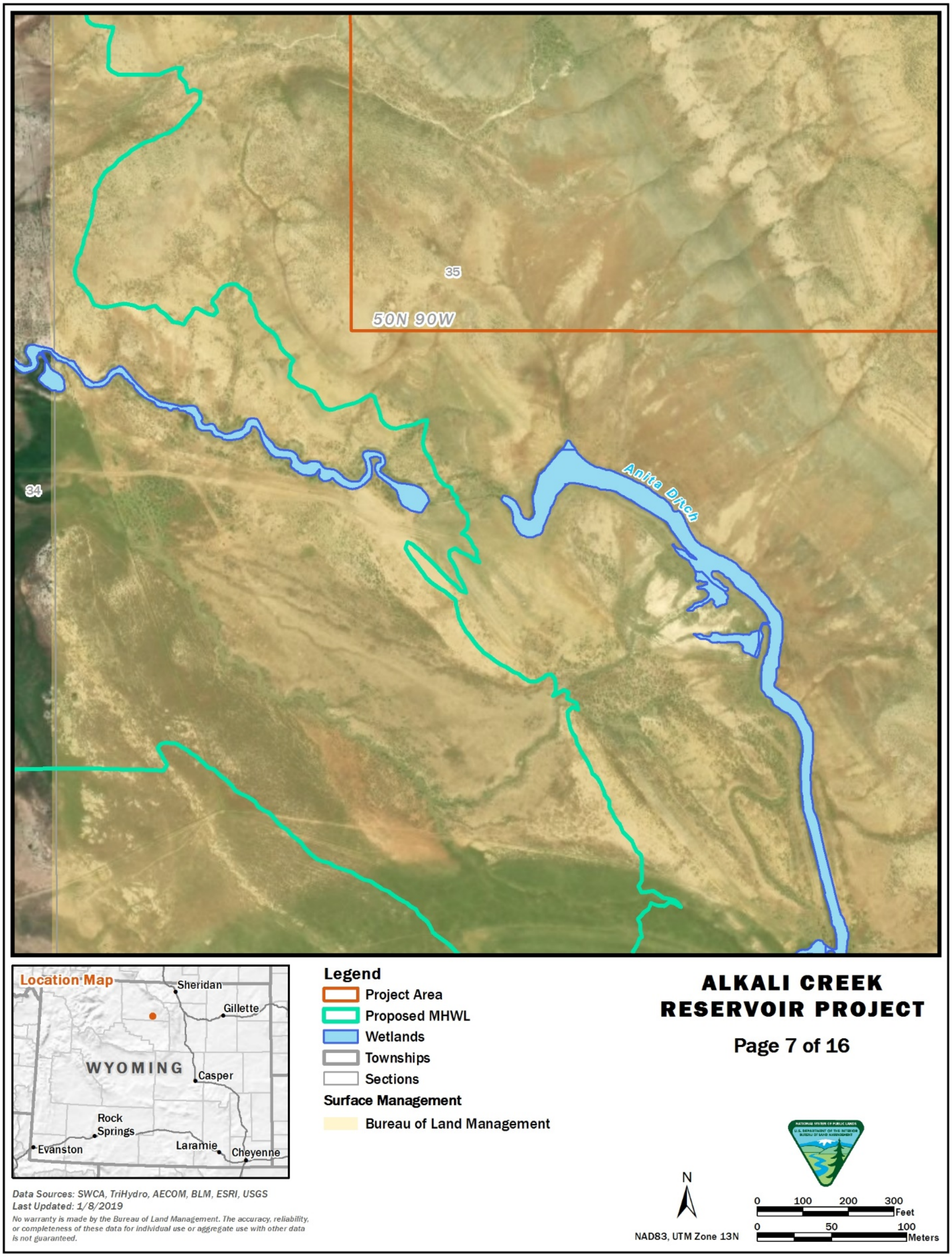

Figure G-7. Wetlands in the project area (direct effects analysis area) (page 7of 16).

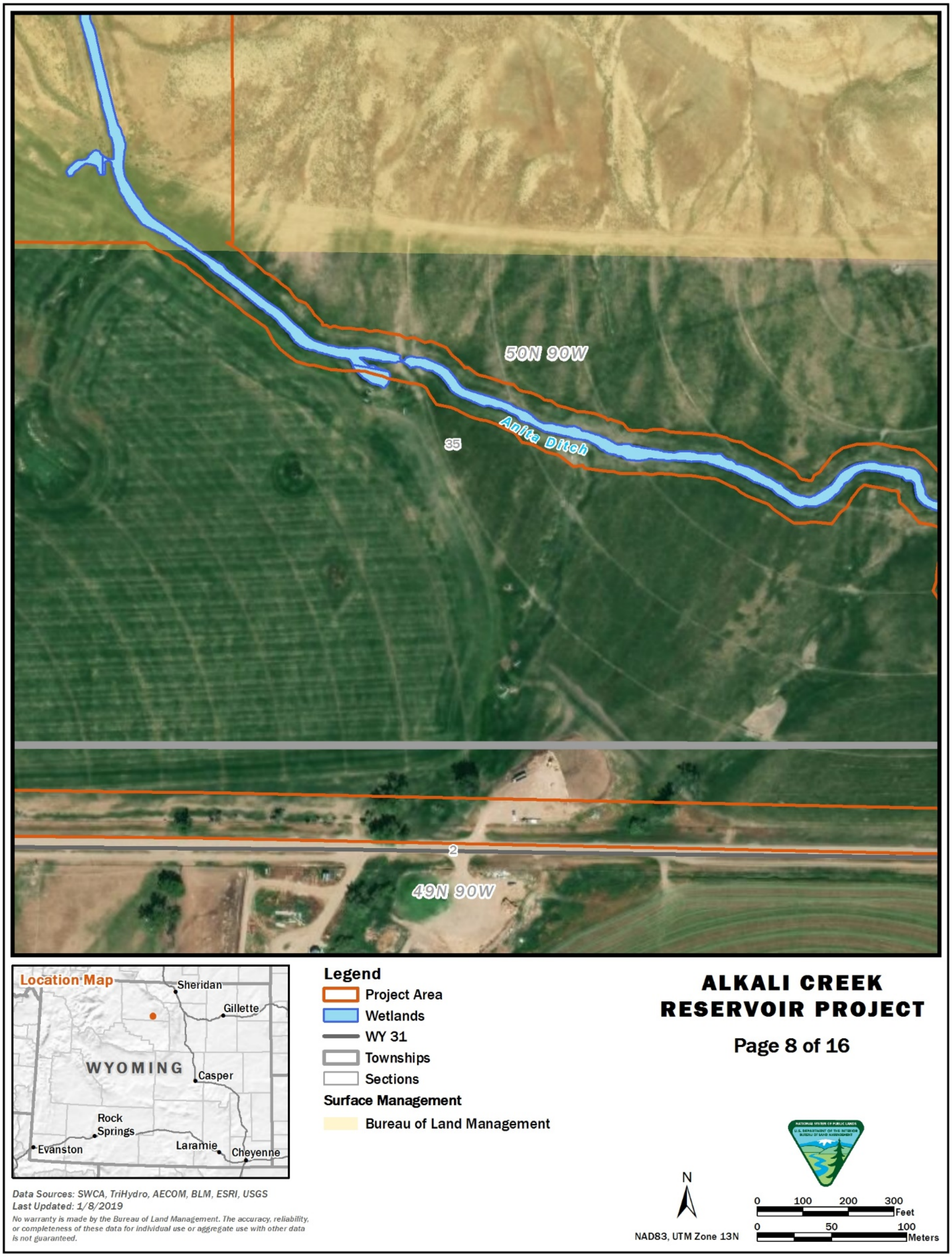

Figure G-8. Wetlands in the project area (direct effects analysis area) (page 8 of 16).

Figure G-9. Wetlands in the project area (direct effects analysis area) (page 9 of 16).

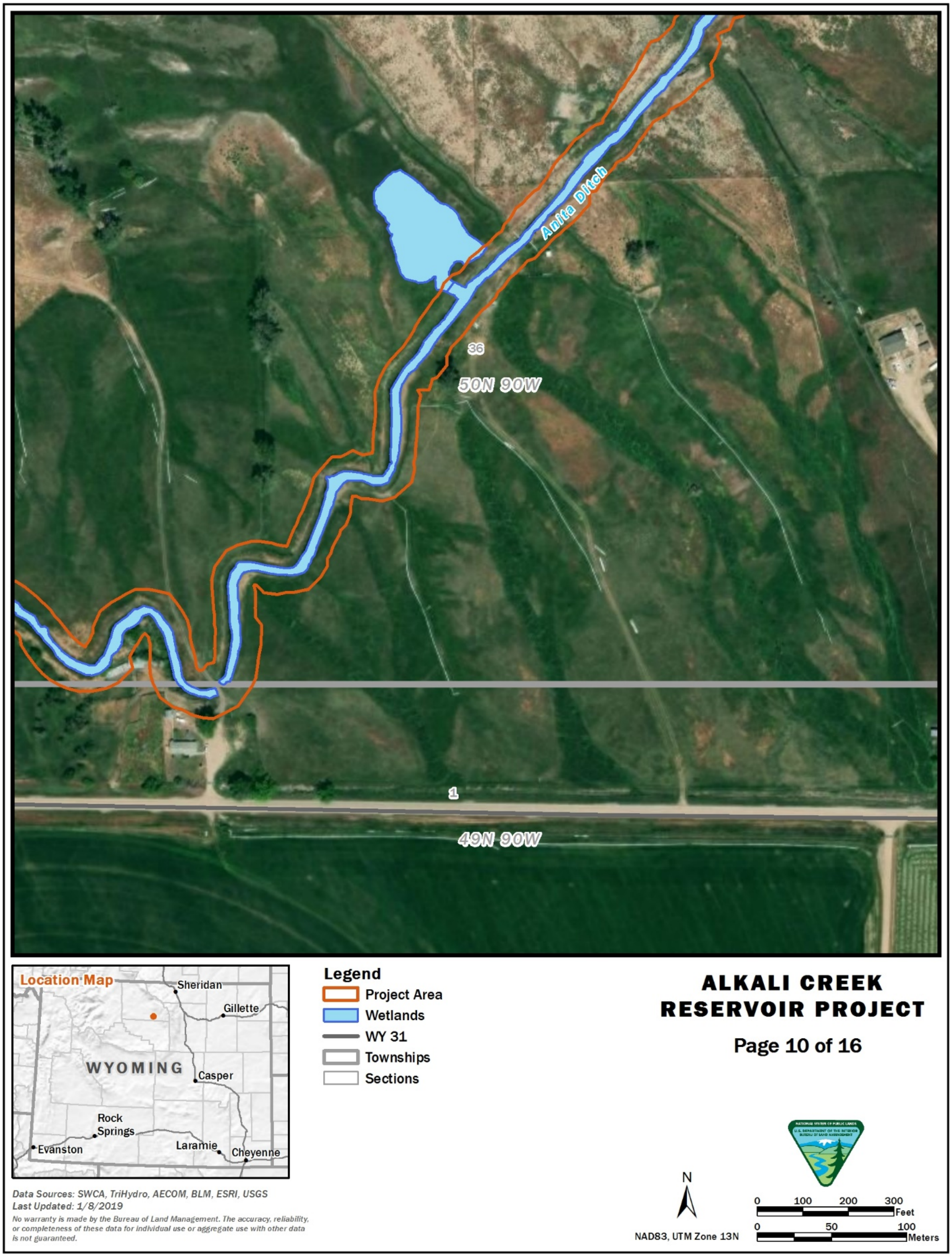

Figure G-10. Wetlands in the project area (direct effects analysis area) (page 10 of 16).

Figure G-11. Wetlands in the project area (direct effects analysis area) (page 11 of 16).

Figure G-12. Wetlands in the project area (direct effects analysis area) (page 12 of 16).

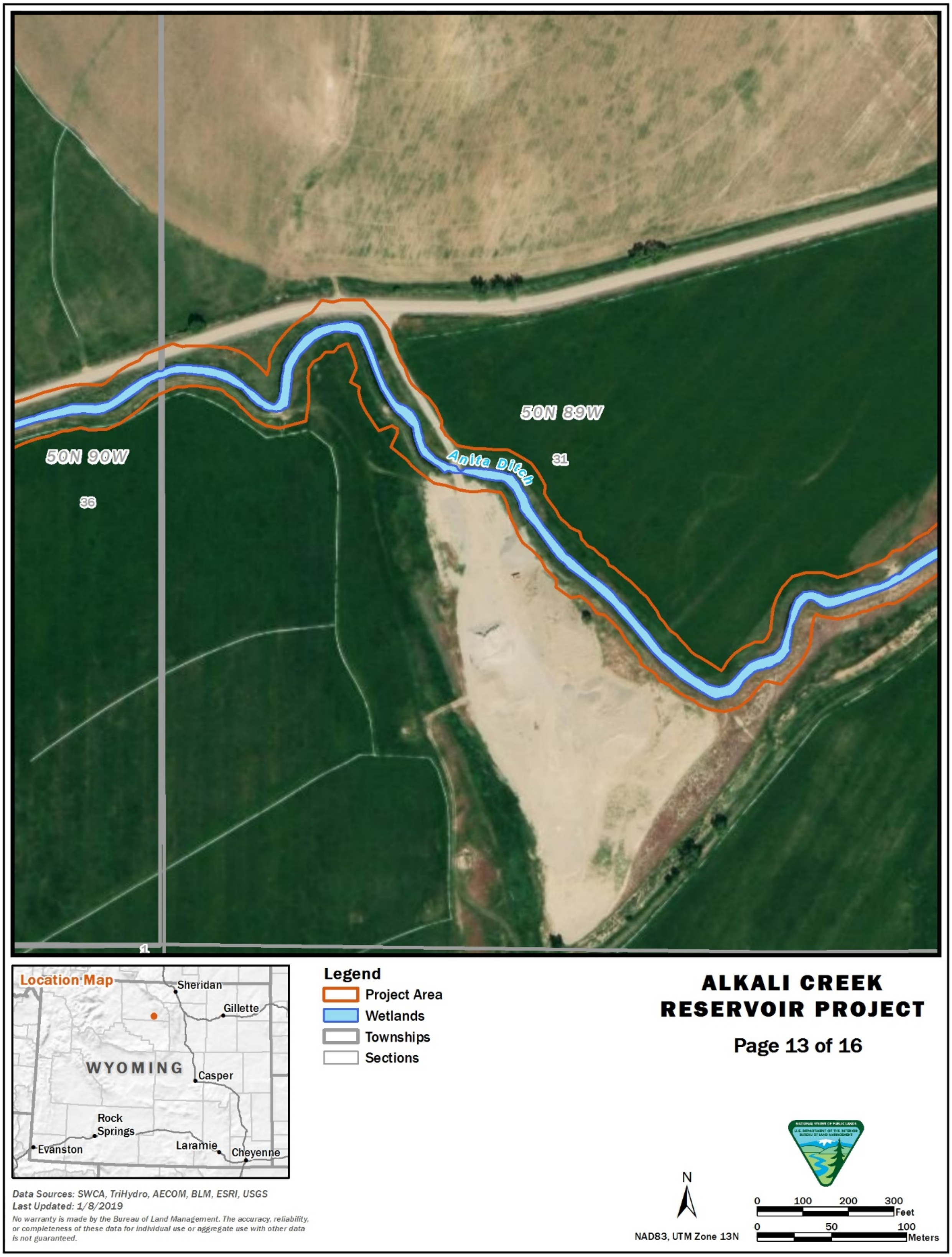

Figure G-13. Wetlands in the project area (direct effects analysis area) (page 13 of 16).

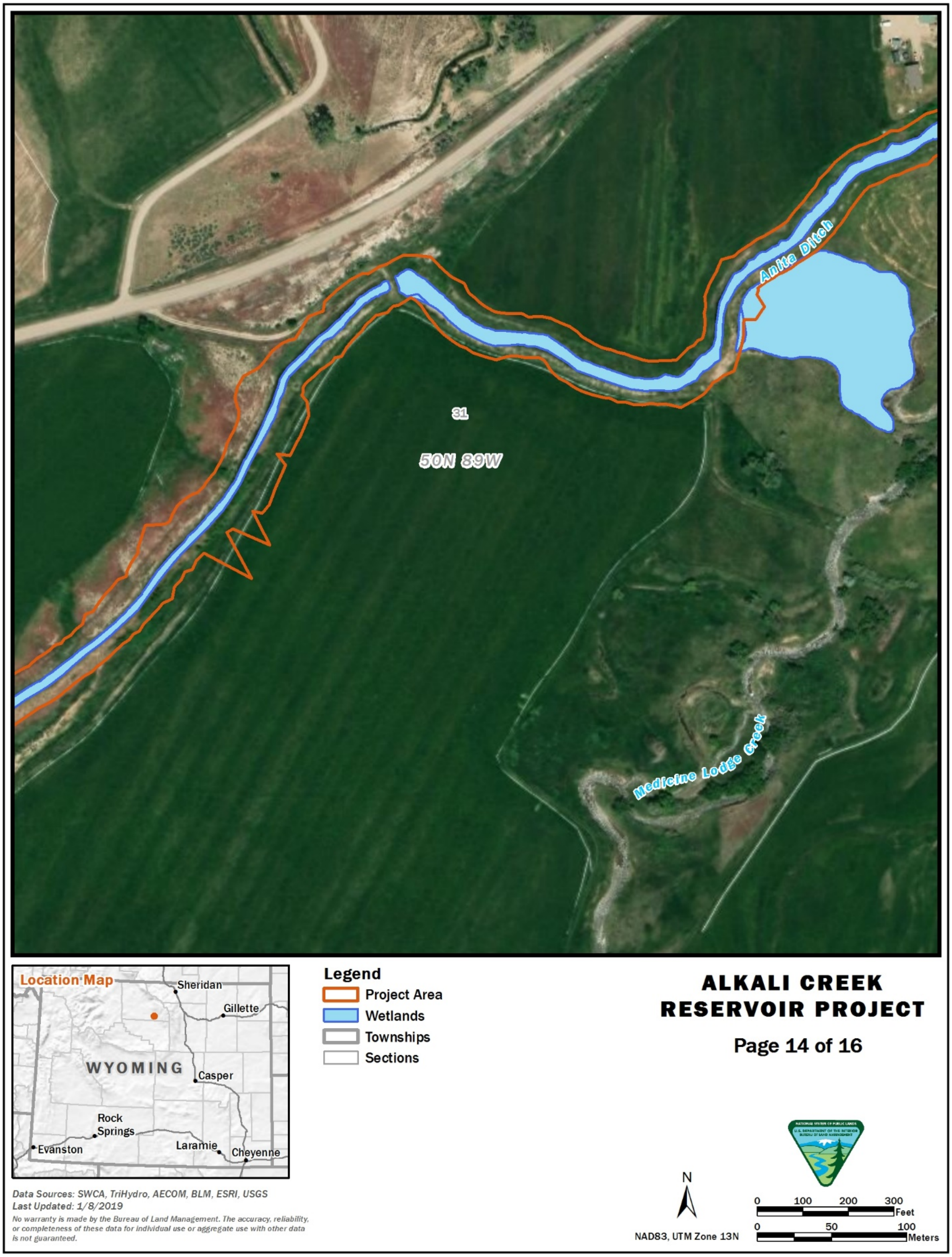

Figure G-14. Wetlands in the project area (direct effects analysis area) (page 14 of 16).

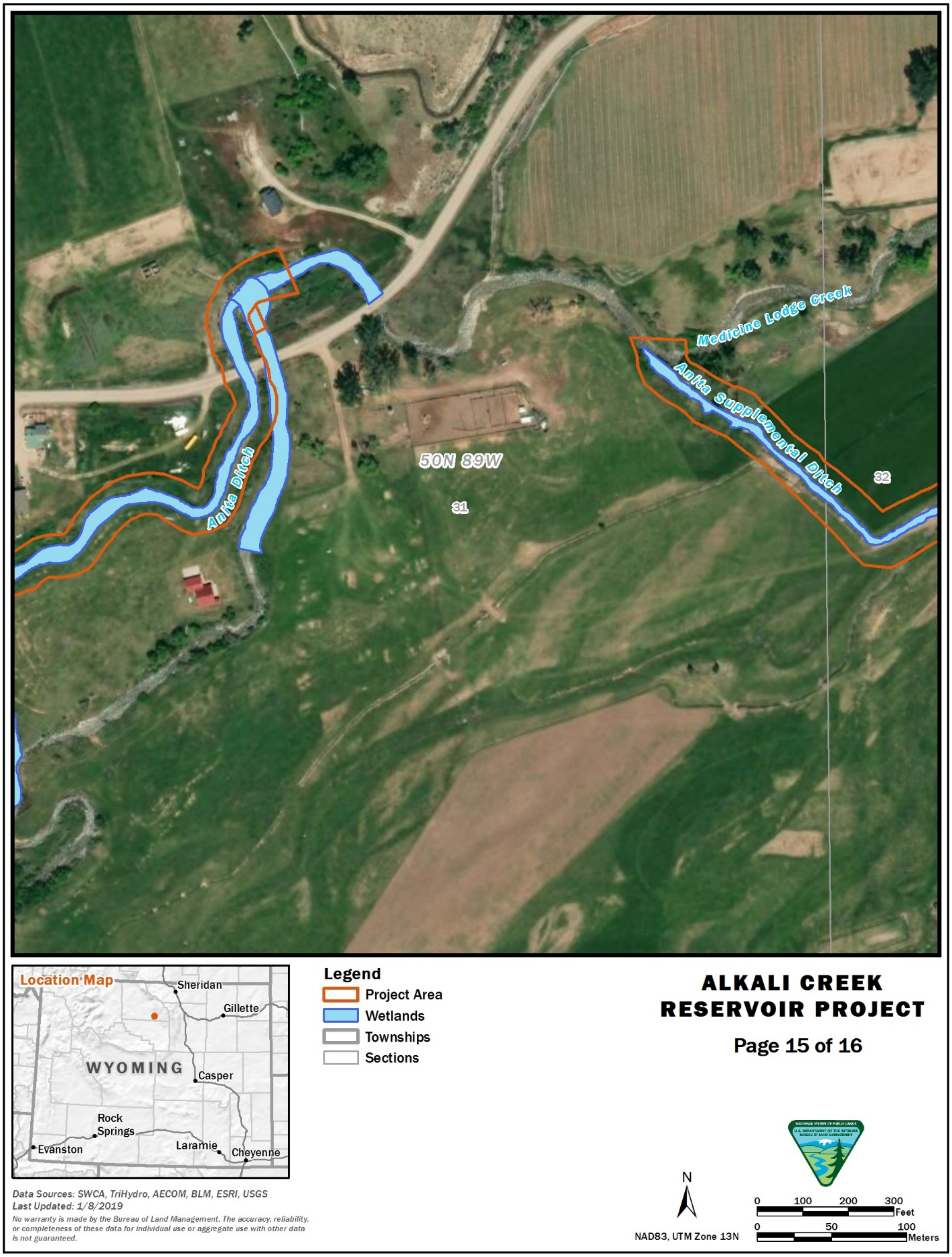

Figure G-15. Wetlands in the project area (direct effects analysis area) (page 15 of 16).

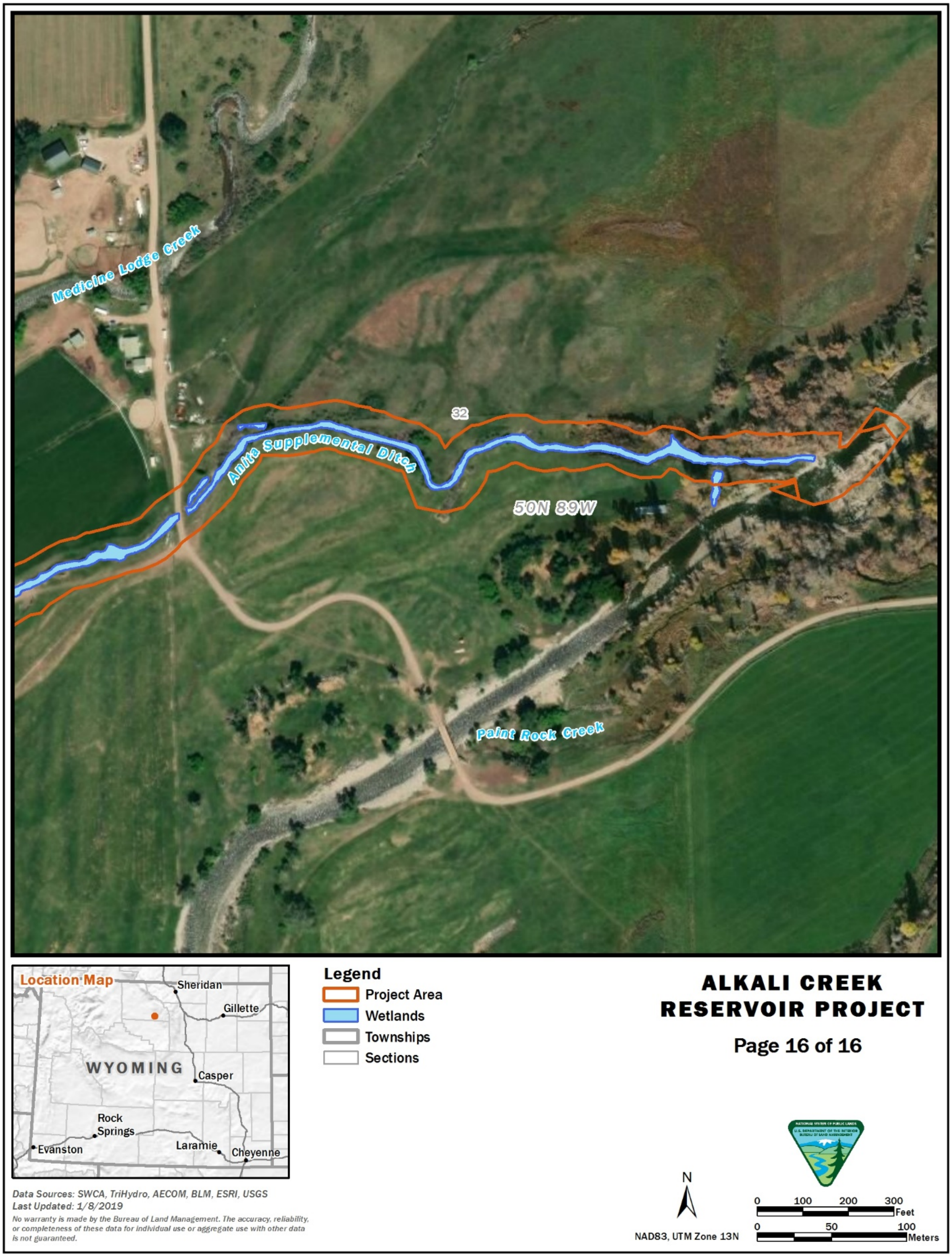

Figure G-16. Wetlands in the project area (direct effects analysis area) (page 16 of 16).