HYDROPOWER

This section addresses the potential impacts to hydropower that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect hydropower?

Overview

Scope

The hydropower resource in this analysis is the Navajo Dam Hydroelectric Plant owned by the City of Farmington (City) and operated by its nonprofit municipal electric utility to serve approximately 37,000 customers in northwest New Mexico.

Summary of Impacts

No Action Alternative: Would have no impact on the City hydropower generation.

250/5000 Alternative: Along with future development of NIIP, would have a projected 10-year financial impact to the City ranging from $5.3 million to $7 million annually (based on a 10-year average loss), with a possible accompanying rate increase to customers. Prior to full water development, these would be less than projected, due to increased irrigation season releases.

500/5000 Alternative: Along with future development of NIIP, would have a projected $3.2 million annual impact to the City (based on a 10-year average loss).

In addition, modification to existing equipment may be required, and/or purchasing additional replacement power from fossil fuel power plants could have negative environmental impacts under both action alternatives.

Impact Indicators

Any increases in power supply expenses, rates, equipment replacement/ modification costs, or replacement power needs as a result of changes in operation of Navajo Dam were considered adverse impacts.

Affected Environment

The Navajo Dam Hydroelectric Plant is owned and operated by the City and began full commercial operation in 1989. The City supplements its power supply with contract purchases from a mix of gas-fired, coal-fired, and hydroelectric generation to meet its energy demands that in 1999 reached 149 megawatts (MW).

The City nonprofit electric utility, a municipal entity, operates independently of the city's general fund, neither contributing to, nor relying on, the city budget for its existence.

From 1989 through 1999, the plant has averaged 135,226 megawatt hours (MWh) per year for an average output of 15.4 MW (see tables III-6 and III-7). Originally designed to take advantage of the post-dam operating criteria of constant release rates in the range of 1,000-1,200 cfs, the facility never experienced this flow regime due to dry years in the early 1990's and the commencement of the SJRBRIP endangered fish study in 1992. From 1992 until 1999, the normal release rate was constrained below 600 cfs except for the spring fish releases when the flows were increased to the 3,500-5,000 range for varying periods of time depending upon the study criteria and the runoff for that year. Normal operation for the facility during the 7-year study was, with slight variances, 600 cfs for 10 months and 3,500-5,000 cfs for 2 months. Mixed into this were various Reclamation inspections, low flow tests, and facility outages, which kept the average output in the 15-16 MW range.

Table III-6.—Navajo Power Plant annual production

Year	Annual production (MWh)	Average (MW)	FERC charges ($)
1989	131,182	15.0	184,381
1990	111,936	12.8	179,301
1991	150,336	17.2	252,536
1992[1]	166,312	19.0	252,536
1993	139,869	16.0	230,068
1994	127,938	14.6	240,974
1995	121,467	13.9	236,268
1996	140,377	16.0	220,950
1997	139,199	15.9	218,376
1998	119,539	13.6	193,738
1999	139,331	15.9	278,441
Average	135,226	15.4	226,143

[1] Abnormally wet summer; if normal, would have been 114,236 MWh, 13.06 MW (averaged).

Table III-7.—Flow versus output

Flow (cfs)	Output (MW)
200	4.0
250	5.6
300	7.5
350	8.5
400	9.5
450	12.0
500	13.5
550	15.0
600	16.0

Generally, the discharge through the plant's two turbine generating units is a function of reservoir releases determined necessary by Reclamation to satisfy downstream water rights, fish and wildlife habitat needs, flood control, and CRSP operation. However, NIIP water supply is taken directly out of the reservoir and does not pass through the power plant. Under normal conditions, all reservoir releases less than 1,320 cfs flow through the powerhouse and are used to generate power. During floods, periods of excess water, and recently, fish releases, when the reservoir release rate exceeds the discharge capacity of the generating units, the excess amount is released through the outlet works or the auxiliary outlet works.

Licenses and Other Agreements

Navajo Nation.—The City also entered into an agreement with the Navajo Nation to settle a dispute over benefits derived from the production of electric power. This agreement provided for the dismissal of any and all appeals regarding licensing, water rights, and equipment transfer by Reclamation to the City. As part of this agreement, the City agreed to and paid the Navajo Nation $2,143,998. The agreement also encompassed future rates and power delivery to the Navajo Nation.

Federal Energy Regulatory Commission (FERC).—In August, 1983, the City applied for a license under Part I of the Federal Power Act to construct, operate, and maintain Navajo Dam Hydroelectric Project No. 4720. The license was issued in October 1985 for a period of 50 years. A requirement of the permit process was an economic feasibility study based on the projected electric production versus the amount of fossil-fired generation which would have to be purchased in lieu of the project. The permit states that the project would save approximately 187,000 barrels of oil or 53,000 tons of coal per year.

The City is required to pay FERC an annual fee based on the capacity of the generating units and the amount of energy generated. The charges from 1989 to date have averaged $226,143 per year.

Reclamation.—The City entered into a license agreement[44] with Reclamation defining property(s), responsibilities, and fees associated with construction and operation of the hydroelectric facility. One provision of the agreement states, "The Facility shall be permitted to use all flows released by Reclamation through the main outlet works to the extent of the physical capacity of the City's penstock and turbines" (item 10(e)). The agreement also provides that "The City agrees that the time and quantity of water releases and release changes from the dam will be at the sole discretion of Reclamation" (item 10(a)).

Methodology

Current and projected data were obtained from plant operations and records maintained by the City and other material, including an economic study (R.W. Beck, 1985).

To assess potential facility damage from the Summer Low Flow Test, the unit was opened, inspected, and photographed in detail to note existing conditions. The unit was also inspected immediately after the Summer Low Flow Test to document any damage.

Impacts Analysis

The City currently purchases more than 43,600 MWh to meet its system energy requirements because the utility's internal resources cannot meet system demand. Because any reduction in the output of the hydroelectric units at Navajo Dam results in additional purchases to outside entities, it is possible to calculate the effect of any loss of generation from the units at Navajo Dam.

Hydropower data in volume II show the replacement power cost analysis and MWh that would be lost under the No Action and action alternatives. The calculations are based on a 10-year forecast of replacement power costs using modeling data for anticipated average flows for the flow regimes analyzed. Two flow regimes were considered in the analysis—250 and 500 cfs minimum release rates. These flow regimes were compared to the No Action Alternative, which was also derived from hydrologic modeling data compiled

[44] Memorandum of Understanding, March 25, 1986.

from 1929–93. Results show that, for the 10-year period from 2001 through 2010, the financial impact to the City would be about $53.1 million for the 250/5000 Alternative and about $31.5 million for the 500/5000 Alternative.[45] This results in an annual average range of losses from $3.2 to $5.3 million. This loss occurs primarily because of two factors: first, NIIP is assumed to be completed under the action alternatives and water diverted to NIIP does not go through the power plant; second, high spring releases require bypasses at the power plant. It should be noted that diversions of water to NIIP have been authorized for many years and effects on hydropower were to be expected.

Another potential major impact to the operation of the Navajo plant from the 250/5000 Alternative concerns the turbines, which may be unable to run for extended periods of time at flows lower than 350 cfs without sustaining major damage. During the 1996-1997 Winter Low Flow Test, the units experienced extreme vibration and noticeable cavitation damage. After the Summer Low Flow Test, damage noted was slight "frosting" on the leading edge of the turbine blades. No other damage was noted, but it is anticipated further damage would be associated with flows of less than 350 cfs. Because both the low-flow test periods were very short, it was not possible to determine the effect that sustained low-flow operation would have on the units. Subsequent investigation has revealed that a design modification could help to alleviate the problem. Cost for the modification to mitigate the damage is conservatively estimated at $75,000 to $100,000. If this modification were not possible or did not solve the problem, and the 250 cfs flow regime caused damage which jeopardized the integrity of the equipment, the facility might have to be taken out of service for the duration of any future low-flow period, in which case the financial impact of this alternative to the City would be about $70.4 million. This results in an annual average loss of $7 million.

During the Summer Low Flow Test, the generating unit averaged 6 MW per day, ranging from 5.7 to 6.4 MW per day. Calculations based on the unit performance curves indicated the loads should be 5.6 MW per day. The minimal variation in power production seemed to have an adverse effect on noise from the unit. The noise from the turbine runner sounded like gravel passing through the unit, and there appears to be a direct correlation with the wicket gate adjustment on the unit and the noted noise. As the wicket gates are closed to reduce the passing flows to the generating unit, the noise in the generating unit appears to increase.

---

[45] Power costs are based on actual proposals for replacement power received by the City in August of 2000 for the period of 2001 through 2005. The costs used in calculating the city's potential replacement cost are the least cost of all the proposals received by the City. Output corrections for flow variations are based on the manufacturers' data, using an average head of 360 feet.

Impacts Summary

No Action Alternative

The No Action Alternative, which moderates flows throughout the year, would generally benefit the City's hydropower generation. In addition, under this alternative, NIIP would not reach full development, allowing the potential release of additional water to pass through the power plant.

Action Alternatives

Changes in expenses as a result of the action alternative–such as replacement power costs to account for a shortfall in production at Navajo Dam–must be passed on to City customers. It is highly probable that the estimated replacement power costs are not representative of future power costs, if recent history is any indication.[46]

Even if replacement costs remain as projected, the City may have to increase rates to cover the loss in revenue caused by the decreased output of the Navajo units. As the electric industry transitions to a deregulated market, this could result in the loss of customers by the utility, which would cause further financial hardship.

In addition, the replacement power which the City might have to purchase would come from fossil fuel generation, most likely from coal-fired power plants. Decreasing the amount of hydroelectric power produced at the Navajo Plant could result in increased air pollution and could have a negative impact on the environment.

250/5000 Alternative(Preferred Alternative)

As discussed in chapter II, there is flexibility in summer releases under the 250/5000 Alternative. This could reduce impacts to hydropower during an interim period; for example, powerplant output would increase from 5.6 MW to 8.5 MW when irrigation season releases were maintained at 350 cfs versus 250 cfs. However, impacts discussed below are expected to occur in the long term. Additional long-term impacts would occur with full development of NIIP under this alternative.

This alternative operation, combined with upstream depletions by NIIP, would have a projected 10-year financial impact to the City ranging from $5.3 million to $7 million

---

[46] Replacement power costs during the summer of 2000 ranged from $65 per MWh to $750 per MWh, compared to the $60 per MWh used in the cost analysis contained in this report.

annually (based on a 10 year average loss), with a possible accompanying rate increase to customers. These impacts might be lessened if the City could feasibly replace equipment at the plant to enable it to more efficiently generate power at lower operating flows.

500/5000 Alternative

This alternative would have a projected 10-year financial impact to the City of $3.2 million annually (based on a 10-year average loss), with a possible accompanying rate increase to its customers. In addition, under this alternative, NIIP would not reach full development, allowing the potential release of additional water to pass through the power plant.

DIVERSION STRUCTURES

This section addresses the potential impacts to diversion structures that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect irrigation and M&I diversion structures?

Overview

Scope

The scope includes San Juan River water diversion structures downstream of Navajo Dam and other diversion structures drawing water from Navajo Reservoir.

Summary of Impacts

No Action Alternative: Would have no impact to water diversion structures downstream of Navajo Dam and other diversion structures drawing water from Navajo Reservoir.

250/5000 Alternative: Might result in potentially adverse impacts to a few water users' ability to physically take water at their diversion structures downstream from Navajo Dam. Impacts to diversion structures taking water from Navajo Reservoir are not anticipated.

500/5000 Alternative: Would have some impact to water diversion structures downstream of Navajo Dam and other diversion structures drawing water from Navajo Reservoir. During extended drought periods, shortages to NIIP would occur due to reservoir water levels dropping below the NIIP inlet works.

Impact Indicators

The primary indicators for evaluating impacts include the capability of the individual diversion and intake structures to achieve their full diversion capacity during high and low flows from the San Juan River without significant damage or impairment. Adverse impacts associated with high flow releases from Navajo Dam (up to 5,000 cfs) are those requiring diversion structure managers to undertake repairs to flow-damaged diversion structures. Adverse impacts occur when diversions of legal entitlements cannot be made due to physical constraints of the diversion mechanism at flows less than 500 cfs. Such impacts may result in the need to alter the river channel or the diversion structures in order to receive water from the San Juan River.

Affected Environment

The existing San Juan River water diversion structures downstream of Navajo Dam, and other diversion structures drawing water from Navajo Reservoir, include the following: (main diversions are shown on accompanying figure III-6).

Navajo Reservoir Water Diversions

(1) Navajo Indian Irrigation Project (NIIP) headgate
(2) Various New Mexico State Parks pump intakes

San Juan River Water Diversions (Downstream of Navajo Dam to Animas River Confluence)

(1) New Mexico State Parks Cottonwood Campground (Streambed Intake Gallery)
(2) Navajo Dam Water Users Association (Streambed Intake Gallery)
(3) Citizens Ditch– includes diversions for Bloomfield Irrigation District, Jaquez Ditch, La Acequia de la Pumpa, City of Bloomfield, Lee Acres, El Paso Natural Gas, Conoco, Morningstar, and Plateau (Note: City of Bloomfield currently diverts water from the Citizens Ditch but is designing a direct diversion from the San Juan River)

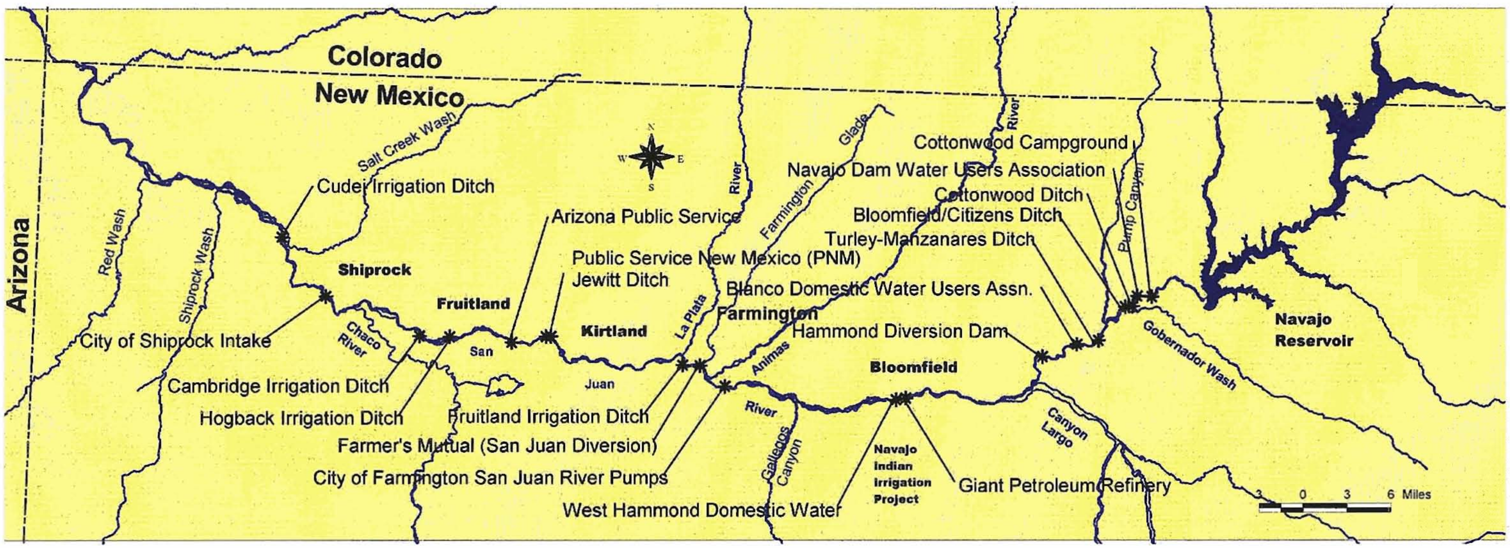


Figure III-6.—Primary water diversions downstream from Navajo Reservoir.

(4) Cottonwood Ditch (old Archuleta Ditch area)
(5) Turley-Manzanares Ditch
(6) Blanco Domestic Water Users Association (Streambed Intake Gallery)
(7) Hammond Conservancy District Canal
(8) Giant Refinery - (flow-through channel and pump diversion from the San Juan River)
(9) West Hammond Domestic Water Users Association
Lee Acres Water Users Association (receives water from the West Hammond Water Users Association)
(10) Williams Field Service (pump diversion from the San Juan River)
(11) City of Farmington - (usually diverts from the Animas River but has a pumping plant on the San Juan River for use during droughts)

San Juan River Water Diversions (Downstream of the San Juan-Animas Rivers Confluence)

(12) Lower Valley Water Users - (currently divert water from the Farmers Mutual Ditch but have the right to divert directly from the San Juan River)
(13) Farmers Mutual Ditch - (usually diverts from the Animas River but also has the right to divert from the San Juan River)
(14) Fruitland Irrigation Project Canal (Navajo Nation/BIA)
(15) Public Service Company of New Mexico - San Juan Generating Plant Intake
(16) Jewitt Valley Ditch
(17) Arizona Public Service Company - Four Corners Generating Plant Intake
(18) Hogback Irrigation Project Canal (Navajo Nation/BIA– now includes diversions for both the Hogback and Cudei Projects)
(19) Cambridge Ditch (Navajo Nation/BIA)
(20) Shiprock Municipal Water (diverts water via pumps)
(21) Numerous pump intakes in Utah

Methodology

Any short- or long-term, direct or indirect, or cumulative impacts were evaluated by:

- ❑ Interviewing the reservoir superintendent, Reclamation O&M staff, and water users.

- ❑ Examining the hydrologic release pattern for each alternative with special emphasis on the effect each has on reservoir levels and river flows, and comparing the proposed releases to historical reservoir and dam flow release records.

- Reclamation personnel visited and inspected each of the known river and reservoir diversion structures during periods of high flows (5,000 cfs) in June 2000 and during the Summer Low Flow Test conducted in July 2001. (Some of the major diversion structures are depicted in the following photographs.)

- Reclamation and Corps of Engineers (Corps) personnel visited selected river diversion structures and met with the representatives of entities operating the diversions in September 2000 to discuss the sections of the Clean Water Act (CWA) (Section 404) that affect diversion structures, the authority for enforcing the appropriate sections of the CWA, and the latest interpretations of those sections.

Impacts Analysis

No Action Alternative

Diversion structures would benefit from more moderate flows under the No Action Alternative; however, infrequent high releases could continue to damage diversion structures, although less than under the action alternatives.

Impacts of various flow release levels are shown in table III-8.

250/5000 Alternative (Preferred Alternative)

As discussed in chapter II, flexibility is anticipated in irrigation season releases under the 250/5000 Alternative. This could reduce any impacts during an interim period; however, impacts discussed below are expected to occur in the long term.

Analysis shows that releases lower than 500 cfs, under this alternative, would be experienced for up to 3 months in the summer and most of the winter of any given year. A few river diversion structures below the dam would experience impacts from this alternative, most significantly in the reach of the San Juan River from Navajo Dam to the confluence of the Animas River in Farmington. The main impact to a few of the diversion structures is that low river flows might make it difficult to divert water to their systems without some modifications to the river channel or to the structures.

Impacts associated with springtime and possible fall peak releases of up to 5,000 cfs under this alternative include damage to diversion structures. Such damage usually requires the irrigators to rework the river channel near the head of the ditch in order to get water into the ditch after the peak releases are completed and base flow releases resume.


Cottonwood Diversion and intake gallery.


Bloomfield - Citizens Diversion and wasteway.


Navajo Dam Water Users Association intake gallery


Turley-Manzanares Diversion.

Table III-8.—Summary of annual impacts on the operation and performance of the San Juan River and Navajo Reservoir water diversion structures and water user entities between Navajo Dam and the Animas River confluence from high or low releases

Diversion name	Release level	Impacts and potential remedies (K = $1,000)
New Mexico State Parks Cottonwood Campground (water well)	High flow (5,000 cfs)	None – should not affect structure's ability to divert
	Low flow (500 cfs)	None - should not affect structure's ability to divert
	Low flow (250 cfs)	May affect structure's ability to divert Intake gallery and well may need to be modified -$2K
Cottonwood Ditch Streambed Intake Gallery	High flow (5,000 cfs)	None – should not affect structure's ability to divert
	Low flow (500 cfs)	None – should not affect structure's ability to divert
	Low flow (250 cfs)	None – should not affect structure's ability to divert
Citizens Ditch Rock Weir and Diversion Intake Channel[1]	High flow (5,000 cfs)	Diversion channel overflow cuts needed before and rock weir repairs necessary after flows at 5000 cfs or above Cost - $2K
	Low flow (500 cfs)	None - should not affect structure's ability to divert
	Low flow (250 cfs)	Rock weir embankment in river channel is needed – cost $1.5K.
Navajo Dam Water Users Association Intake Gallery[2]	High flow (5,000 cfs)	None – should not affect structure's ability to divert
	Low flow (500 cfs)	None - should not affect structure's ability to divert
	Low flow (250 cfs)	River channel modification is needed – cost $1K
Turley-Manzanares Rock Weir and Diversion Intake Channel[1]	High flow (5,000 cfs)	Diversion channel overflow cuts needed before and rock weir repairs necessary after flows at 5,000 cfs or above – cost $2K
	Low flow (500 cfs)	Rock weir embankment in river channel is needed – cost $1.5K
	Low flow (250 cfs)	Rock weir embankment in river channel is needed – cost $1.5K
Hammond Project Diversion Dam[1]	High flow (5,000 cfs)	None – should not affect structure's ability to divert
	Low flow (500 cfs)	None – should not affect structure's ability to divert
	Low flow (250 cfs)	None – should not affect structure's ability to divert

Table III-8.—Summary of annual impacts on the operation and performance of the San Juan River and Navajo Reservoir water diversion structures and water user entities from high or low releases (continued)

Diversion name	Release level	Impacts and potential remedies (K = $1,000)
Williams Field Service Pump Intake	High flow (5,000 cfs)	None – should not affect structure's ability to divert
	Low flow (500 cfs)	None – should not affect structure's ability to divert
	Low flow (250 cfs)	River channel modification needed – cost $1.5K
West Hammond Domestic Water Users Association Rock Weir and Diversion Intake[2]	High flow (5,000 cfs)	None – should not affect structure's ability to divert
	Low flow (500 cfs)	None – should not affect structure's ability to divert
	Low flow (250 cfs)	River channel modification and rock weir embankment is needed – cost $1.5K
Giant Refinery Flow-Through Channel and Pump[2]	High flow (5,000 cfs)	None – should not affect structure's ability to divert
	Low flow (500 cfs)	None – should not affect structure's ability to divert
	Low flow (250 cfs)	River channel modification and rock weir embankment is needed – cost $1.5K
City of Farmington Municipal San Juan River Pump Intake[2]	High flow (5,000 cfs)	None – should not affect structure's ability to divert
	Low flow (500 cfs)	None – should not affect structure's ability to divert
	Low flow (250 cfs)	River channel modification and rock weir embankment is needed – cost $1.5K
Summary of costs to all diversion entities	High flow (5,000 cfs)	Cost – $4K
	Low flow (500 cfs)	Cost – $3K
	Low flow (250 cfs)	Cost – $12K
Summary of total costs to all diversion entities for alternatives	500/5000 Alternative	Cost – $7K
	250/5000 Alternative	Cost – $16K

Note: Costs would apply for each instance when action is needed.
[1] Section 404 permit not required for construction work in river channel within immediate vicinity of diversion structure.
[2] Section 404 permit required for construction work in river channel within immediate vicinity of diversion structure. File with Albuquerque Corps of Engineers office.

Increased coordination among Reclamation, various water user entities, and local, State, and Federal agencies and emergency organizations would be required when periods of high downstream tributary flows were experienced simultaneously with high-flow dam releases under all hydrologic alternatives being considered. High flow releases from the dam might have to be curtailed at such times to safely allow passage of these high downstream inflows. Maximum safe channel capacity in the reach of the San Juan River from Navajo Dam to the confluence of the Animas River in Farmington is 5,000 cfs.

The irrigation diversion structures which sustain damage from high flows could be repaired without obtaining a CWA Section 404 permit. Owners of domestic or M&I river intake or diversion structures which sustain damage would be required to file for a Section 404 permit, as applicable, with the Corps.

The managers of irrigation diversion structures unable to receive water from the San Juan River during low flows would be allowed under terms of the CWA, Section 404, to alter the river channel in the immediate vicinity of the diversion structure in order to receive water to it. Managers of domestic or M&I river intake or diversion structures unable to receive water from the San Juan River during low flows would be required to file for a Section 404 permit with the Corps.

500/5000 Alternative

There would be some impacts to water diversion structures under the 500/5000 Alternative. During extended droughts, low reservoir water elevations would interfere with water supplies for NIIP. Based on hydrologic modeling, this occurred one year in 65. In relation to the 500 cfs minimum release rate, some impacts would be expected to a few diversion structures. Impacts may also occur to a few diversion structures under the 5,000 cfs release. As such, high-flow impacts under this alternative would be similar to those under the 250/5000 Alternative. Table III-8 lists diversion structures.

Technical Assistance

Reclamation has offered to look at the effects of high and low flows under its Technical Assistance to the States Program. To date, Reclamation has completed a preliminary design for an intake structure for the Turley-Manzanares Ditch Company to alleviate the problems associated with high flows. If requested by the State of New Mexico, Reclamation will further investigate the severity of impacts associated with high and low flows. Funding of the structural modifications will be the responsibility of the owners of the intake or diversion structures.

Monitoring

During low flows, increased monitoring by Reclamation of river gaging stations and at other critical points along the river downstream of the dam would have to be carried out. The State of New Mexico is responsible for administering water rights in New Mexico.

Reclamation will work with other responsible agencies to pursue installation of additional remote weather monitoring equipment at key sites within tributary drainages to support the gathering of critical downstream tributary flow data that assists operational decision making. Such decisions would need to be made when periods of high downstream tributary flows were experienced simultaneously with high dam releases.

WATER QUALITY

This section addresses the potential impacts to water quality that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect water quality and maintain water quality standards?

Overview

Scope

The scope includes Navajo Reservoir and the San Juan River to Lake Powell.

Summary of Impacts

No Action Alternative: Existing trends of water quality degradation would be expected to continue in the San Juan River below Navajo Dam.

Action alternatives: The increased spring releases would lower concentrations of contaminants in the San Juan River because of dilution; lower releases under the 250/5000 Alternative during the rest of the year would increase concentrations, and periods of exceedences of water quality standards could also potentially increase. Lower flows could affect discharge permits (i.e., for the Bloomfield wastewater treatment plant).

Impact Indicators

Exceedences of Federal, State, and Tribal water quality standards were considered an adverse impact.

Affected Environment

The San Juan River is characterized by good water quality when flows are released through Navajo Dam, but water quality progressively degrades downstream due to natural and induced bank erosion, diversions, agricultural and municipal use, and tributary contributions. The State of New Mexico has listed reaches of the San Juan River where water quality does not fully support intended uses. Turbidity, fecal coliform, and bottom sediments impact the designated uses of the river most often. Several trace elements (selenium, aluminum, arsenic, mercury, copper, and zinc) have occasionally exceeded State standards from Navajo Dam to Farmington, New Mexico (Reclamation, 2000a).

San Juan River water quality generally declines to Shiprock, New Mexico, with the stretch of the river between Farmington and Shiprock having the highest number of water quality standard exceedences. At the Four Corners gage/sampling site, water quality improves and the number of exceedences decreases, but water quality declines again from Four Corners to Mexican Hat, Utah (Reclamation, 2000a).

The State of New Mexico has issued fish consumption advisories because of elevated mercury concentrations in fish within Navajo Reservoir and the San Juan River from Hammond Diversion to the mouth of the Mancos River.

A number of facilities (city wastewater treatment plants and power plants) have National Pollution Discharge Elimination System (NPDES) discharge permits along the San Juan River. These permits are based on critical low-flow values determined from flow in the river where they discharge.

The San Juan River is a drinking water source for communities between Navajo Dam and Farmington. The construction and operation of Navajo Dam have improved the quality of raw water for domestic use between the dam and Farmington. However, treatment problems still occur, particularly in connection with storm runoff events.

Previous Water Quality Studies[47]

Studies used in analyzing water quality impacts included extensive water quality studies that have been conducted on the San Juan River and its tributaries within the last 10 years.

[47] The discussion is a brief summary of the detailed results produced by the studies in question. The summaries are general in nature, and the reports should be read for detailed analysis of the findings.

The U.S. Geological Survey (GS) has conducted studies under the Department of the Interior's National Irrigation Water Quality Project (Blanchard et al., 1993; Thomas et al., 1998). The SJRBRIP was initiated in October 1991 and has been collecting data on water quality on the San Juan River ever since. In addition, water quality data were collected and analyzed as part of the NIIP environmental studies on the San Juan River mainstem as well as on tributaries, seeps, springs, ponds, and wells on the project lands. Table III-9 is a summary of historical water quality data collected on the San Juan River at the GS gaging stations. Figure III-1 (at the beginning of chapter III) shows the location of GS gages and water sampling sites on the San Juan River.

The early GS investigations (Blanchard et al., 1993) were reconnaissance-level studies to identify whether irrigation drainage: (1) has caused or had the potential to cause adverse harmful effects to human health, fish, and wildlife; or (2) may adversely affect the suitability of water for other beneficial uses in the Basin. It concluded that selenium was the major trace element of concern in all sampled media (water, bottom sediments, and biota). The GS performed a detailed study of selenium and selected constituents in water, bottom sediments, soil, and biota associated with irrigation drainage in the San Juan River area (Thomas et al., 1998). Selenium was much less concentrated in water samples than in bottom sediment, soil, or biota samples. Mean selenium concentrations in water samples were greatest from seeps and tributaries draining irrigated lands; less concentrated at irrigation-drainage sites and ponds on irrigated land; and least concentrated at irrigation-supply sites, in backwater, and at San Juan River sites. Other elevated trace elements in water, bottom sediments, soils, or biota included lead, molybdenum, strontium, zinc, vanadium, barium, cadmium, chromium, iron, mercury, and aluminum.

The NIIP biological assessment (Bureau of Indian Affairs, 1999) assessed the impacts from full development of NIIP. The "Water Quality Analysis" section concluded that the project will increase arsenic, copper, selenium, and zinc levels in the San Juan River. It was concluded that levels of arsenic and zinc concentrations would be below levels of concern for the two endangered fish species. Conclusions on copper were less certain, but levels are not expected to impact the two endangered fish species. Selenium received a low hazard potential, but uncertainty about actual levels in biota downstream from the project and chronic toxicity to razorback sucker leaves the possibility of some impact to the recovery of the species. The Navajo Nation developed water quality regulations in 1999.[48] The predicted arsenic, copper, selenium, and zinc levels in the biological assessment are below the Navajo Nation water quality standards. The predicted dissolved selenium level is 1.9 µg/L, while the Navajo Nation standard for total selenium is 2.0 µg/L in the San Juan River. The NIIP biological assessment assumed that the minimum release rate from Navajo Reservoir would be 250 cfs in the future.

[48] The Navajo Nation Water Quality Standards are awaiting Environmental Protection Agency approval.

Table III-9.—Historical (1950–98) water quality measurements on the San Juan River

Parameter	Farmington		Shiprock		Four Corners		Bluff	
	n	Mean	n	Mean	n	Mean	n	Mean
Alkalinity total (mg/L as $CaCO_3$)	607	114	646	119	59	121	2,333	147
Aluminum dissolved (µg/L as Al)	34	34.4	138	58.5	40	63.9	174	64.1
Aluminum total (µg/l as Al)	30	5,283	83	15,636	30	11,373	134	20,500
Arsenic dissolved (µg/L as As)	76	1.9	267	2.3	78	1.8	345	1.9
Arsenic total (µg/L as As)	78	2.8	224	4.4	72	3.8	309	4.3
Boron dissolved (µg/L as B)	315	49.5	678	103.9	45	126.0	1,720	68.7
Cadmium dissolved (µg/L as Cd)	11	0.8	71	0.9	15	1.2	56	1.0
Cadmium total (µg/L as Cd)	12	5.7	29	3.6	7	3.7	15	3.7
Calcium dissolved (mg/L as Ca)	859	61.6	1,178	72.4	135	65.6	2,627	93.8
Calcium total (mg/L as Ca)	5	71.5	12	70.8	6	78.8	23	88.8
Chloride total in water (mg/L)	830	9.8	1,084	16.9	104	13.5	2,568	20.6
Chromium dissolved (µg/L as Cr)	4	11.3	53	3.2	4	2.9	48	2.5
Chromium total (µg/L as Cr)	9	51.8	25	22.5	5	17.0	17	52.1
Cobalt dissolved (µg/L as Co)	9	1.5	67	1.4	10	1.6	53	1.5
Cobalt total (µg/L as Co)	13	44.4	29	22.9	7	10.6	21	41.7
Copper dissolved (µg/L as Cu)	45	3.8	165	4.2	48	5.0	203	4.9
Copper total (µg/L as Cu)	45	29.5	121	35.5	42	20.8	163	35.8
Fecal coliform (counts/100 mL)	93	10,588	162	1,040	23	256	72	185
Hardness calc. (mg/L as $CaCO_3$)	859	189	1,154	237	123	222	2589	326
Hardness total (mg/L as $CaCO_3$)	824	189	969	245	45	224	2423	336
Iron dissolved (µg/L as Fe)	164	47.2	251	31.2	42	22.0	69	30.5
Iron total (µg/L as Fe)	15	25,691	39	30,449	13	13,405	201	4,809
Lead dissolved (µg/L as Pb)	67	0.7	256	1.5	70	0.8	343	1.0
Lead total (µg/L as Pb)	79	30.3	222	27.6	71	23.6	305	26.1
Magnesium dissolved (mg/L as Mg)	859	8.4	1,176	13.4	135	14.4	2,628	25.0
Magnesium total (mg/L as Mg)	5	11.9	12	14.0	6	17.4	23	27.1
Manganese dissolved (µg/L as Mn)	26	22.3	110	45.0	30	6.3	86	6.1
Manganese total (µg/L as Mn)	20	852	56	978	27	449	39	1,109
Mercury dissolved (µg/L as Hg)	70	0.12	254	0.13	75	0.10	338	0.11
Mercury total (µg/L as Hg)	78	0.14	225	0.15	71	0.13	309	0.14

Table III-9.—Historical (1950–98) water quality measurements on the San Juan River (continued)

Parameter	Farmington n	Farmington Mean	Shiprock n	Shiprock Mean	Four Corners n	Four Corners Mean	Bluff n	Bluff Mean
Nickel dissolved (µg/L as Ni)	28	6.1	146	4.6	36	5.2	184	4.6
Nickel total (µg/L as Ni)	28	6.8	105	12.1	39	9.7	144	15.5
Nitrite + nitrate total (mg/L as N)	47	0.27	98	0.39	27	0.74	55	0.78
Oxygen dissolved (mg/L)	251	9.5	455	9.8	159	9.5	478	9.2
pH lab (standard units)	879	7.81	1,097	7.89	107	8.25	1,357	7.78
pH field (standard units)	60	8.13	190	8.26	60	8.25	285	8.20
Phosphorus total (mg/L as P)	59	0.27	164	0.32	31	0.37	95	0.58
Residue total filtrable (dried at 180° C) (mg/L)	374	382	667	498	102	422	1,313	656
Selenium dissolved (µg/L as Se)	81	0.6	277	1.0	78	1.3	349	1.1
Selenium total (µg/L as Se)	76	0.7	227	0.9	71	1.6	309	1.4
Selenium total recoverable (µg/L as Se)	10	0.5	29	1.0	10	0.9	47	0.8
Silver dissolved (µg/L as Ag)	2	0.75	51	0.56	n/a	n/a	45	0.56
Silver total (µg/L as Ag)	2	0.75	10	1.10	n/a	n/a	9	2.06
Sodium dissolved (mg/L as Na)	836	44.7	951	64.6	112	49.3	2,047	79.2
Sodium total (mg/L as Na)	5	37.7	12	38.5	6	43.8	23	58.2
Solids susp.-residue on evap. at 180 °C (mg/L)	59	242	191	956	60	663	283	934
Specific conductance (µmhos/cm @ 25 ° C)	905	550	1136	716	112	644	2,020	931
Sulfate total (mg/L as SO_4)	827	154	1,083	225	104	193	2,568	329
Turbidity (NTU, FTU, JTU)	117	158	142	527	104	406	92	503
Water temperature (°C)	60	10.6	227	12.2	79	12.4	343	12.6
Zinc dissolved (µg/L as Zn)	80	9.2	268	9.2	77	7.8	346	15.7
Zinc total (µg/L as Zn)	75	92.9	224	114.1	71	204.0	306	109.6

Source: Final Supplemental Environmental Impact Statement, Animas-La Plata Project, Technical Appendices, Water Quality Analysis (Reclamation, 2000a).

The SJRBRIP study on environmental contaminants in aquatic plants, invertebrates, and fishes of the San Juan River mainstem was completed in 1999. The trace elements evaluated included aluminum, arsenic, copper, selenium, and zinc. Aluminum appeared to be related to sediment geochemistry, and most life forms associated with sediment had elevated levels. Arsenic levels showed no consistent pattern for any river reach or site. Elevated arsenic levels were found in most plants and some invertebrates and fish. Elevated copper levels were found in the trout from upstream coldwater river reaches. Generally, copper concentrations in plants, invertebrates, and fish increased downstream below Farmington. Selenium concentrations were clearly elevated in all biota above ambient background concentrations. Zinc concentrations in plants, invertebrates, and fish below Farmington to the "Mixer area" (RM 135)[49] were generally higher than the rest of the river, and it appears the source may be the Animas River. The study found no consistent correlation between contaminant concentrations and river discharges.

As identified in the ALP Project FSEIS, a number of water quality standards are periodically exceeded in the San Juan River in New Mexico and Utah (Reclamation, 2000a). Above Farmington, there are a few historical exceedences in the San Juan River for aluminum, mercury, selenium, cadmium, and lead. Exceedences increased between Farmington and Shiprock, New Mexico, including several for copper and zinc. At Four Corners, New Mexico, exceedences decrease and then increase again at Mexican Hat, Utah. According to Utah regulations, there are exceedences in nutrients and TDS.

The FSEIS also reports: "These historic values could be slightly affected by the operation of Navajo Dam for endangered fish." The increase in spring runoff flows will result in improvement of water quality during the runoff period, but the lower flows during the rest of the year will provide less dilution and may impact the water quality of the San Juan River. Monitoring over the last 7 years of modified flows (reflects 500/5000 Alternative due to releases above 500 cfs) has not detected a measurable change in water quality.

Methodology

Impacts were evaluated by the following measures:

- Researching the existing water quality standards from the three States (Colorado, New Mexico, and Utah) and three Indian reservations (Southern Ute Indian, Navajo Nation, and Ute Mountain Ute) and identifying differences between them for reservoir and river segments of the San Juan River.

[49] The "Mixer area" is a suspected Colorado pikeminnow spawning site.

- Researching available water quality reports and assessments to determine possible impacts to the San Juan River from changes in the operation of Navajo Reservoir.
- Examining and comparing the hydrologic model output for each alternative against historical flows to determine possible variations in flow from the future operation of Navajo Reservoir.
- Evaluating the expected impacts on water quality against the water quality standards.
- Conducting discussions with water treatment plant operators concerning drinking water.

Water Quality Standards

State and Tribal water quality standards have been developed and applied on the San Juan River from the three States (Colorado, New Mexico, and Utah) and three Indian reservations (Southern Ute Indian and Ute Mountain Ute Tribes, and the Navajo Nation) through which it flows. The States and Tribes have developed numeric and narrative standards for streams, rivers, and lakes within their boundaries. The Ute Mountain Ute Tribe is in the process of developing draft water quality standards to be approved by the Environmental Protection Agency (EPA). The Southern Ute Indian Tribe adopted standards in 1997 for their reservation. The Southern Ute Reservation has private inholdings throughout, and the Tribal water quality standards presently apply only to reservation land owned by the Tribe within the reservation boundary.[50] The Navajo Nation adopted water quality standards for their reservation in 1999.

Regulators usually assess impacts to the surface water quality by looking at the exceedences of numeric standards. For the most part fishery aquatic standards are divided into chronic and acute standards based on exposure time that the fish species experience. There are also narrative standards which have no numeric values which regulate some physical attributes (i.e. color, odor, taste of fish, etc.). The chronic standard is often expressed as a 4-day average and the acute standard as a 1-hour average or single sample. Few water quality measurements are done this way. Most data are collected as a single sample and entered into a database as such. Exceedences for this EIS are based on comparing the single sample result to the chronic and acute standards as was done in the ALP Project FSEIS

[50] The State of Colorado has water quality jurisdiction on non-Indian land, but the Environmental Protection Agency and Southern Ute Indian Tribe do not agree with this arrangement. A recent agreement between the State of Colorado and the Tribe forms an Environment Commission which may resolve environmental conflicts between the two.

(Reclamation, 2000a). Violations of the water quality chronic standards are based on exceedences over a period of time (most standards state once in 3 years). Acute standards should never be exceeded.

State and Tribal.—The States are required under the CWA to report to the EPA on the condition of the streams, rivers, and lakes within their boundaries. One of these reports is a list of impaired (does not meet its intended use) stream or river segments (referred to as a Section 303(d) list). This list generally indicates the waterbody segment, a probable source of pollutant(s), uses not supported, and specific pollutant(s). The agency must develop a plan to improve the condition of the waterbody and meet its intended use. The present status of listing is:

- The State of Colorado draft Section 2000 303(d) list does not have any San Juan River segments listed.
- The Tribes are encouraged but not required to report impaired waterbodies to the EPA.
- Based on the latest State of New Mexico Section 303(d) listing, the San Juan River designated uses are not supported on the following segments: (1) San Juan River from Canyon Largo to Navajo Dam (turbidity and stream bottom deposits), (2) from Animas River confluence to Canyon Largo (stream bottom sediments and fecal coliform), and (3) from the Navajo Nation boundary at the Hogback to Animas River confluence (stream bottom deposits).
- In the State of Utah draft 2000 Section 303(d) listing, the San Juan River was removed from the year 2000 list because new waterbodies were delineated for the southeast Colorado watershed after an assessment was completed in 1998.

Impacts Analysis

No Action Alternative

No significant changes in Navajo Reservoir water quality are expected. Releases from Navajo Reservoir would be similar to those under historical 1973 - 91 period operations. Water quality parameters in the reservoir and in the San Juan River downstream to Lake Powell would probably be similar to existing conditions. Under the No Action Alternative, flow releases from Navajo Dam would not fall below 500 cfs under normal operations. Sources of pollutants along the river include municipal, industrial, and irrigation returns, and bank destabilization could occur mostly from Navajo Dam to Shiprock, New Mexico.

Water quality in the San Juan River can also change rapidly from thunderstorm runoff in streams and washes entering the river. Since the No Action Alternative flows would not be below NPDES permit critical low flows, NPDES permit facilities would not exceed permit limitations along the San Juan River.

Water treatment problems would still occur in connection with storm runoff events.

250/5000 Alternative (Preferred Alternative)

As discussed in chapter II, flexibility is anticipated in irrigation season releases under the 250/5000 Alternative. This would reduce impacts during the interim period; however, impacts discussed below are expected to occur over the long term. During the interim period, irrigation season minimum releases would be increased above 250 cfs most of the time, and this would provide more high-quality water to dilute pollutants.

No significant impacts to Navajo Reservoir water quality are anticipated under the 250/5000 Alternative. The spring releases from Navajo Reservoir would be maintained at 5,000 cfs, but releases the rest of the year could be lowered to 250 cfs. A 250-cfs release from Navajo Reservoir during the irrigation season would probably result in low flows (in the range of approximately 60-150 cfs) from Citizens Ditch (RM 217) diversion to Farmington (RM 181) due to irrigation demands. During the Summer Low Flow Test (Reclamation, 2002), several water quality parameters (temperature, aluminum, fecal coliform, total organic carbon, and conductivity) exceeded the State standards for this reach. Exceedences of water quality standards would probably increase at these lower flows over the long term.

Water quality parameter exceedences in the San Juan River from Farmington to Lake Powell would probably increase slightly, but significant increases in exceedences would probably not occur due to maintenance of the 500 cfs minimum flows in the critical habitat sections. Tables in volume II show the number of exceedences occurring along the San Juan River at the major GS gaging stations when compared to representative State and Tribal standards.[51]

A few exceedences occur under the 250/5000 Alternative at Archuleta, Farmington, Four Corners, and Bluff GS gages. The increase in exceedences at Shiprock occurs in fecal coliform, temperature, turbidity, and mercury.

Facilities with NPDES permits could be affected by reduced low flows in the river. The facility most affected by the change in flows would be the Bloomfield wastewater treatment

[51] Data for these tables were taken from a STORET retrieval and consist mostly of GS and BIA data collected within the last few decades. The small number of sample results likely skews the exceedences, but gives an indication of what could possibly happen under the flow regime of this alternative.

plant where the critical low flow of approximately 373 cfs is much higher than would occur under the 250/5000 Alternative. During the Summer Low Flow Test, flows in the vicinity of the Bloomfield wastewater treatment plant were 130 cfs, significantly lower than the critical low flow loading requirements for the permit. Some improvements to the plant have been made in anticipation of stricter New Mexico water quality standards. These stricter standards, in concert with the Preferred Alternative, could result in a loss of approximately $60,000 annually from the inability to continue treating El Paso Natural Gas waste water.[52]

Other facilities along the river (Farmington and Shiprock wastewater treatment plants, and power plants) would not be impacted because they are in the area downstream of the confluence of the Animas River where flows are scheduled to be above 500 cfs. The critical low flows for most of these facilities range between 250 and 415 cfs.

The Preferred Alternative may have an impact on the cost of treating water for human consumption. Communities that derive their drinking water from the San Juan River above Farmington include Navajo Dam, Blanco, Turley, Lee Acres, and West Hammond. Reclamation representatives contacted managers of the Blanco Water Users Association (BWUA), Navajo Dam Water Users Association (NDWUA), and West Hammond Domestic Water Association (WHDWA) to determine the potential for and magnitude of this impact. During these discussions, it became apparent that there could be an increased cost to treat water because of a reduction in the dilution rate when releases from Navajo Dam are lowered to 250 cfs.

Water treatment issues of greatest concern are E.coli and turbidity. The increased rate of their occurrence is directly related to run-off from storm events, especially during spring and summer months, when storm events flush contaminants into the river. These contaminants come from domesticated animals' waste, sewer lagoon/ponds, and other sources of E.coli contamination (i.e., improper disposing of waste from recreational vehicles/campgrounds). Increased turbidity results from soil erosion.

NDWUA and BWUA water supplies realize the greatest impacts from storm events due to their limited amount of storage—110,000 gallons and 80,000 to 90,000 gallons, respectively. Each of these facilities has approximately 1 to 1-1/2 days of user demand storage. The WHDWA has greater flexibility with a storage facility (pond) which impounds 75 acre-feet of water (approximately 24,500,000 gallons). This storage allows WHDWA to meet daily user demand for approximately 15 days. It also has the ability to use the larger storage facility to dilute contaminants, reduce associated treatment costs, and shorten the "recovery rate" (to the point at which water treatment returns to normal).

[52] Personal communication, Bob Campbell, City Manager, City of Bloomfield, New Mexico, September 17, 2003.

When managers of these treatment plants were asked what cost increases would be realized when releases were reduced to 250 cfs under the Preferred Alternative, they stated that it would be difficult to determine. Increased treatment costs are a function of storm events (severity and duration), dilution factors, and recovery time of treatment plants to provide treated water to their user areas. Therefore, without an extensive study over an extended period, increased treatment costs are indeterminate.

500/5000 Alternative

No significant impacts to Navajo Reservoir water quality are anticipated under this alternative. Under the 500/5000 Alternative, releases from Navajo Reservoir would be maintained at present levels (500/5,000 cfs), with most of the flow at 500 cfs (76 percent of the time). Since releases from Navajo Reservoir would be around 500 cfs most of the year, water quality exceedences in the San Juan River mainstem would probably increase slightly or remain as is (Reclamation, 2000a). Facilities with NPDES permits would not be affected due to flows being above the critical low flow values in their permits most of the time. Raw water treatment problems would still occur in connection with storm runoff events.

Impacts Summary

The low releases after the spring runoff under the 250/5000 Alternative would probably result in concentration increases and possible exceedences of water quality standards. If the exceedences occurred more than once in 3 years, a violation of the State or Tribal standards would occur. Short-duration low flow tests indicated some parameters exceeded the State's standards from Navajo Dam to the Animas River confluence. Long-term summer low flows may cause exceedences of the water quality standards or an increase in bioaccumulation of some trace elements.

The New Mexico State Department of Environment is scheduled to complete Total Maximum Daily Load (TMDL) studies on several segments of the San Juan River within the next several years. The TMDLs will identify best management practices that might be implemented to reduce non-point source pollutant loads into the San Juan River.

Best management practices taken to prevent violations of the State water quality standards would improve water quality in the river.

Facilities with NPDES permits would not be affected on the San Juan River except for the Bloomfield wastewater treatment plant, where the critical low flow (373 cfs) would be significantly higher than the flows in the San Juan River during 250 cfs releases from Navajo

Reservoir. Revision of the Bloomfield wastewater treatment plant NPDES permit and associated load reductions from the plant, and implementation of best management practices to reduce loadings from non-point sources, could mitigate impacts on water quality of base flow releases of less than 500 cfs that would occur under the 250/5000 Alternative.

Under the action alternatives, regular springtime snowmelt-runoff period peak releases of up to 5,000 cfs would result in cleaning the San Juan River channel bottom of substantial amounts of suffocating sediment contributed by erosion of tributary drainages. Scouring of such sediment is periodically necessary to restore and maintain spawning gravel bars for endangered fish species and productive backwaters and side channels used by endangered fish for rearing habitats. Restoring such scouring is to restore natural, pre-dam function to the river.

LIMNOLOGY

This section addresses the potential impacts to limnology that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect limnological conditions in Navajo Reservoir?

Overview

Scope

The resources considered in the limnology analysis encompass Navajo Reservoir and its inflow areas—the Pine, Piedra, and San Juan Rivers arms.

Summary of Impacts

No Action, 250/5000, and 500/5000 Alternatives: The water quality of Navajo Reservoir is expected to remain within historical limits, and no adverse impacts are identified.

Impact Indicators

Various biological, chemical, and physical variables were used in this evaluation; however the criteria used to determine any adverse limnological impacts from the alternative dam releases are as follows:

- Minor nutrient concentration changes in the reservoir with potentially reduced outflows
- Noticeable changes in biological productivity
- Changes to trophic state indices
- Substantial fluctuations in reservoir temperature profiles and stratification
- Changes in dissolved oxygen concentrations
- Noticeable changes in sediment deposition rates within the inflow areas

Affected Environment

Navajo Reservoir

Navajo Reservoir extends about 35 miles up the San Juan River, 13 miles up the Pine River, and 4 miles up the Piedra River into Colorado and has a storage capacity of 1,701,300 acre-feet at maximum water surface elevation 6085.0 feet (at the spillway crest). The dam has two outlet works (the main outlet work at elevation 5882.5 feet, and the auxiliary outlet works at elevation 5775.0 feet) as well as the auxiliary spillway (elevation 6085.0 feet). At its maximum elevation, the reservoir covers about 15,610 acres. The tributaries provide the majority of the water stored in the reservoir; however, several intermittent tributaries (arroyos) also contribute flows into the reservoir during storms. Variations in precipitation, dam operations, and contract water supply needs affect the seasonal fluctuations of the reservoir (Reclamation, 2001a).

Existing Reservoir Characteristics

Water quality parameters were measured within Navajo Reservoir on four dates during 2000, each date corresponding with a different season. Navajo Reservoir water surface elevations and storage quantities on those dates are shown in table III-10.

Nutrients.—Nutrients are important parameters within a lake or reservoir because phosphorous and nitrogen are the major nutrients required for the growth of algae and rooted vegetation in lakes (the primary producers within aquatic systems). Nutrient data for Navajo Reservoir are shown in table III-11.

Table III-10.—Navajo Reservoir water elevations and storage capacities

Date	Elevation (feet)	Live storage (acre-feet)	Releases (cfs)
January 19, 2000	6070.53	1,487,900	504.2
April 25, 2000	6072.20	1,511,300	504.2
August 29, 2000	6063.74	1,396,100	756.2
November 11, 2000	6057.63	1,318,000	504.2

Table III-11. — Nutrient summary data for 2000

	Location (mg/L)			
Variable	NAV 1[1]	NAV 2[1]	NAV 3[1]	NAV 4[1]
Ortho-P	0.010	0.009	0.012	0.011
Total P	0.017	0.019	0.031	0.021
NO3+NO2-N	0.087	0.075	0.041	0.031
Ammonia-N	0.015	0.023	0.022	0.028
Total Kjeldahl N	0.206	0.223	0.259	0.252
Total organic carbon	1.90	1.81	2.51	2.59
Diss. silica	5.12	5.05	6.34	5.48

[1] Shown in figure III-7.

Total phosphorous and nitrogen concentrations for each sampling location (see table III-11 and figure III-7) fall under the EPA's reference conditions for this ecoregion (see volume II for definitions of EPA's reference conditions and ecoregions). Total organic carbon values observed at Navajo Reservoir range from 2.68 to 4.38 mg/L. Dissolved silica concentration values ranging from 5.90 to 11.25 mg/L in Navajo Reservoir suggest that observed silica concentrations fall below average.[53]

[53] North American values derived Wetzel (2001).

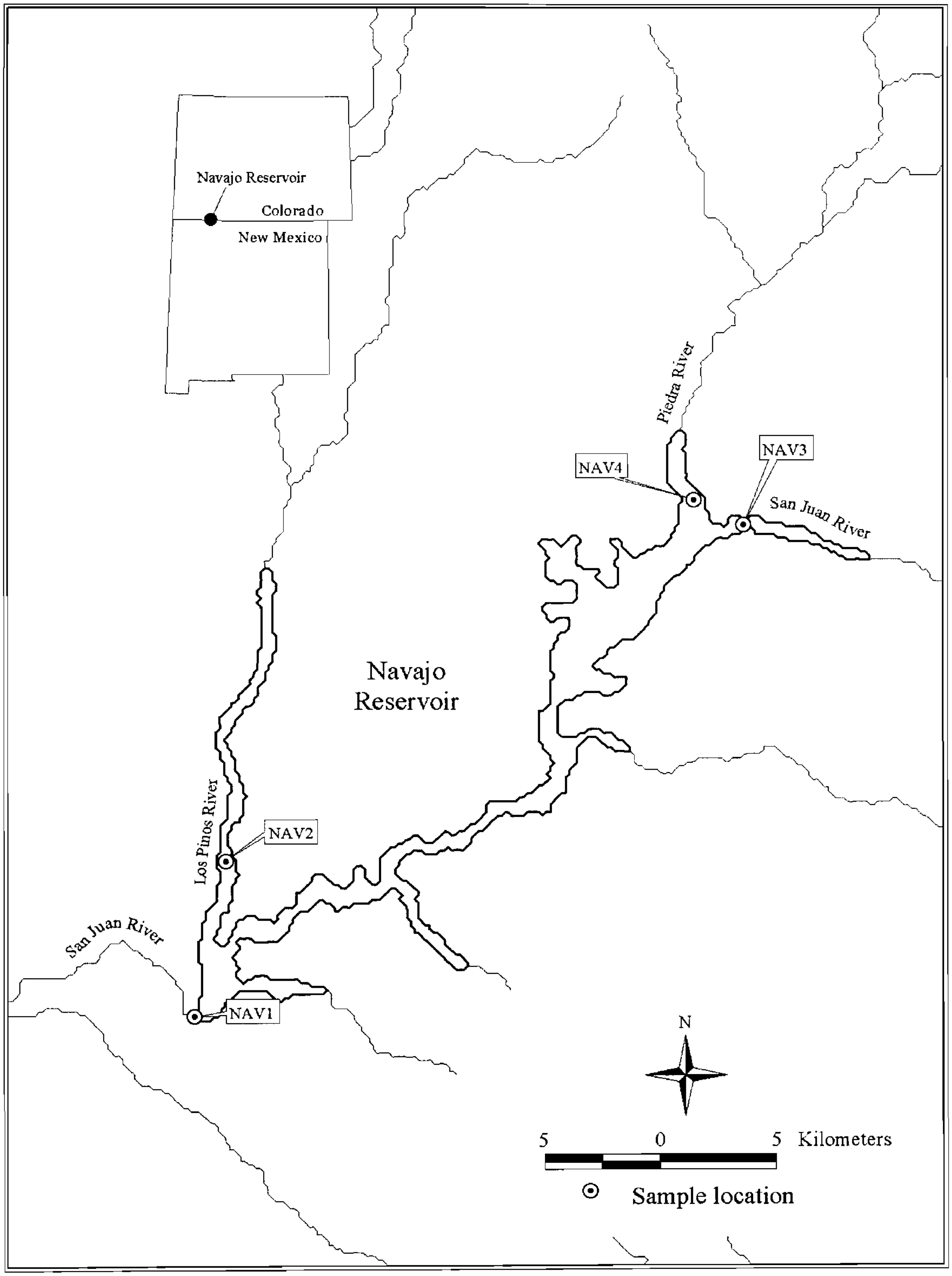


Figure III-7.—Map of Navajo Reservoir, including the limnological sampling locations.

Biological Productivity.—Aquatic environments are made up of various biological communities that consist of groups of interacting populations of species. These communities are separated out into levels of functionality, or trophic levels, in which the various populations compete with each other for available resources.

Photosynthetic organisms, such as algae and aquatic plants, represent the first level of the trophic structure and are known as the primary producers. Measurement of chlorophyll *a* content is representative of the primary productivity of the upper portions of the water column in lakes and reservoirs. Table III-12 depicts the overall chlorophyll *a* content for all sampling locations during each sampling event.

Table III-12.—Chlorophyll *a* summary for Navajo Reservoir (µg/L)

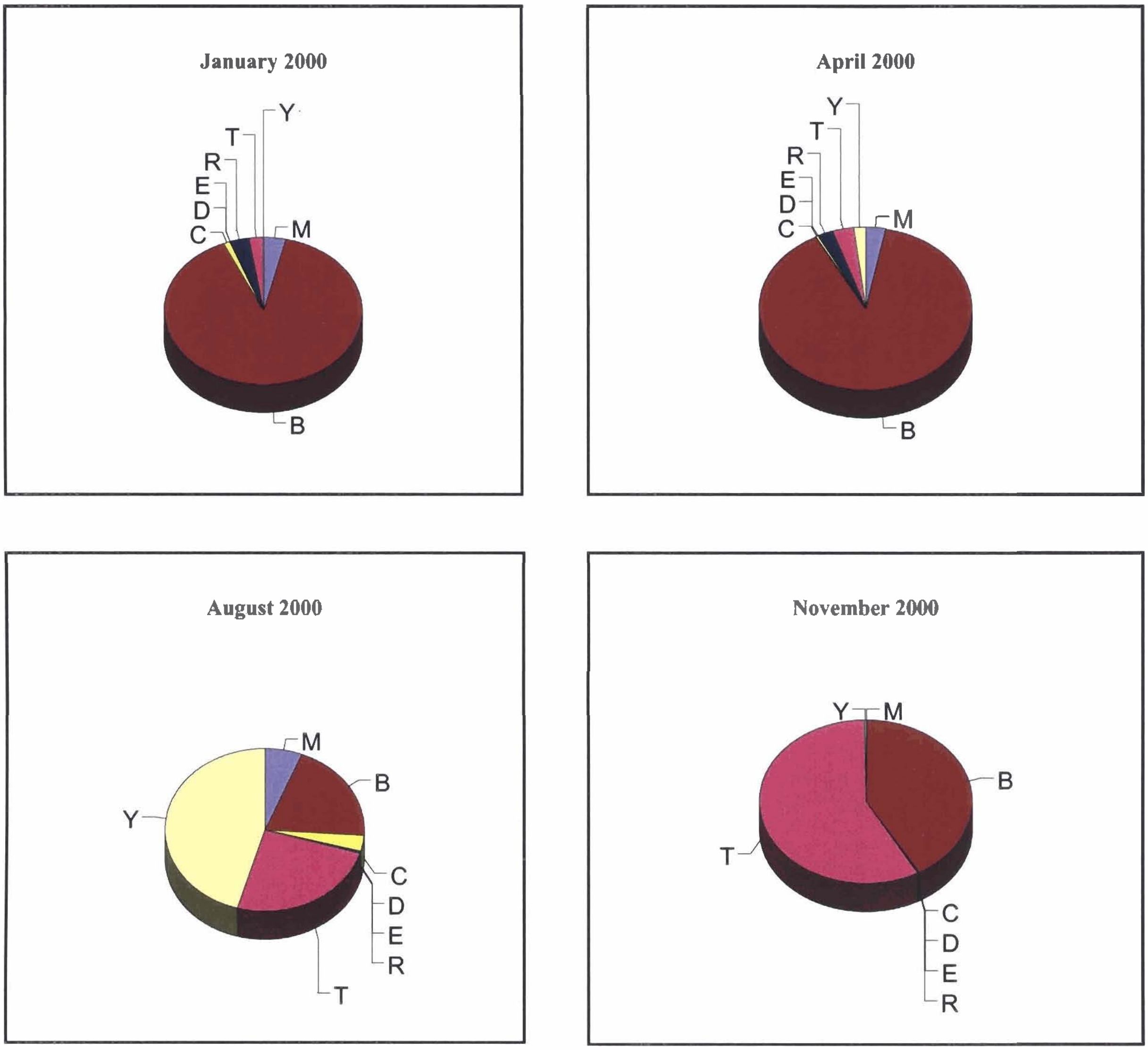
Sampling site	January 19, 2000	April 25, 2000	August 29, 2000	Average
NAV 1	0.79	3.03	1.32	1.71
NAV 2	0.69	1.08	1.97	1.24
NAV 3	2.24	2.27	5.30	3.27
NAV 4	7.17	3.88	2.74	4.59

The various types of populations that dominate aquatic environments can further be classified on the basis of their most common habitat. This study focused on the planktonic community. Plankton are the organisms that reside within the water column, and that are subject to water movement as a primary means of locomotion. Phytoplankton represent the various small plants (algae) or photosynthetic bacteria found within the water column. Figure III-8 depicts the various portions of phytoplankton observed during this study.

Zooplankton are macroscopic animals with very limited powers of locomotion that also exist within the water column. The three different classes of zooplankton found during this study can be seen in figure III-9.

Trophic State Indices.—The Trophic State Index (TSI) of a lake or reservoir is a relative expression of the water body's biological productivity. This index is derived from observations in three different water quality variables: total phosphorous concentrations, chlorophyll *a* concentrations, and Secchi depths[54] (Carlson, 1977). These three values range from 1 to 100. A TSI value of less than 35 indicates oligotrophic conditions. Mesotrophic conditions are noted at TSI values between 35 and 50. Eutrophic conditions are seen at TSI

[54] Secchi depth is a measure of the absorption characteristics of water and its dissolved and particulate matter.



Chlorophyta (**C**), Pyrrhophyta (**D**), Cryptophyta (**R**), Cyanophyta (**B**), Bacillariophyceae (**T**), Chrysophyta (**Y**), Euglenophyta (**E**), and a miscellaneous category (**M**) which consisted of various other algal types.

Figure III-8.—Average phytoplankton structure for Navajo Reservoir (cells/mL).

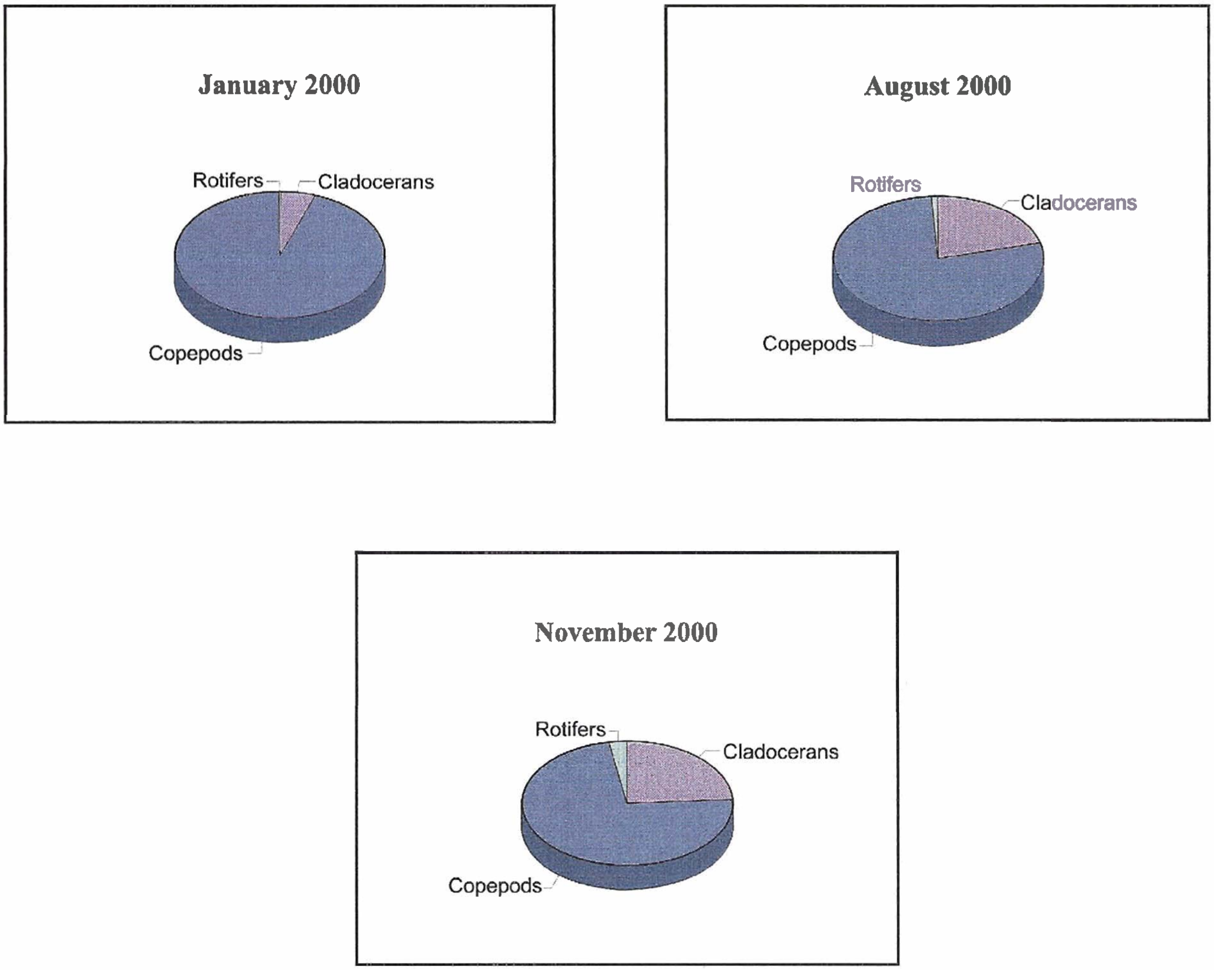


Figure III-9.—Average zooplankton structure for Navajo Reservoir.

values greater than 50, whereas hypereutrophic conditions are seen at values greater than 70. Higher numbers are usually associated with nuisance conditions such as undesirable algal blooms.

Navajo Reservoir TSI values were calculated and reported in table III-13. These values were also compared to similar reservoirs to gain some understanding as to the present conditions of Navajo Reservoir. The values reported were for the month of August, which is usually the period of maximum biological productivity.

Table III-13.—Comparison of Navajo Reservoir's trophic state indices to similar reservoirs

Reservoir	Total P	Chlorophyll *a*	Secchi depth
NAV 1	36.6	33.3	36.2
NAV 2	43.4	37.2	38.0
NAV 3	57.7	46.9	73.2
NAV 4	40.0	40.5	60.0
EB I[1]†	73.2	41.4	44.7
BMR-S[2]‡	-	39.6	43.7
BMR-C[3]‡	-	38.5	39.3
BMR-I[4]‡	-	40.5	45.9

- No data were available.
[1] Elephant Butte Reservoir collection site located at the buoy line at the dam.
[2] Blue Mesa Reservoir, Colorado - Sapinero Basin.
[3] Blue Mesa Reservoir, Colorado - Cebolla Basin.
[4] Blue Mesa Reservoir, Colorado - Iola Basin
† From Canavan, 2001. Data used were from August 1999.
‡ From Johnson et. al, 1996. Data used were from August 1995.

Temperature and Dissolved Oxygen (DO).—Navajo Reservoir's temperatures exhibit normal seasonal patterns, ranging from a maximum surface temperature of 23.4° C at NAV 2 on August 29, 2000 and a minimum surface temperature of 3.7° C at NAV 4 on January 19, 2000.

Oxygen levels were relatively uniform during January and April with slightly lower oxygen levels near the bottom of the water column. Slight increases in DO concentrations at two sampling sites (NAV1 and NAV2) in April 2000 could possibly signal the beginning of spring turnover. The DO levels observed at NAV2 resemble the beginning of spring turnover since the concentrations are varied with respect to increasing depth.

Temperature and DO concentrations for August 2000 at the same sites exhibit a strong thermocline beginning around 15 meters in depth and extending to about 40 meters in depth. DO concentrations at both sites exhibit a decrease in concentration right at the top of the thermocline, which is common, since this area tends to be quite productive with respect to biological activity. Otherwise, concentrations increase with respect to depth as a result of decreasing temperatures.

Other Parameters.—Major ions and solids for Navajo Reservoir are summarized in table III-14. These data are presented as averages calculated from concentrations of samples collected at all depths and stations.

Table III-14. —Major ions and solids summary data for 2000

	Location (mg/L)				
Variable	NAV 1	NAV 2	NAV 3	NAV 4	N. America[1]
Ca^{++}	23.8	23.9	22.9	26.0	21.0
Mg^{++}	4.39	4.38	4.84	5.03	5.00
Na^{+}	10.19	9.86	10.55	8.84	9.00
K^{+}	1.78	1.47	1.43	1.64	1.40
HCO_3^-	89.5	89.5	83.5	88.5	68.0
$SO_4^=$	29.5	28.8	34.2	35.1	20.0
Cl^-	1.92	1.85	1.96	1.90	8.00
Sr	0.225	0.225	0.214	0.240	-
B	0.014	0.012	0.018	0.014	-
TDS	143.5	159.4	161.7	169.1	-
TSS	3.4	8.4	11.4	10.0	-

[1] North American values derived from Wetzel (2001).

Most of the variables seen in table III-14 are relatively close to the values noted for North America (Wetzel, 2001) with higher concentrations in $HCO3^-$ and $SO4^=$ and lower Cl^- concentrations noted for Navajo Reservoir. Most of the variables exhibited little change between sampling locations. Near the dam (NAV 1), there is a considerable drop in the concentrations of dissolved and suspended solids. This natural occurrence is due to the settling process as rivers drain into reservoirs and as the water flow changes.

To assess sedimentation, Secchi depth measurements were performed, as shown in table III-15, as a way of visually gauging the clarity of the upper water column. This measurement, as well as total dissolved solids (TDS) and total suspended solids (TSS), can give an indication of the amounts of suspended matter within the water column.

Table III-15.—Navajo Reservoir Secchi depth measurements (meters) and the solids fractions (mg/L)

Date	NAV 1	NAV 2	NAV 3	NAV 4
January 19, 2000	1.07	0.86	1.02	0.95
April 25, 2000	3.20	2.20	0.30	0.50
August 29, 2000	5.20	4.60	0.40	1.00
November 11, 2000	5.60	1.80	0.70	0.70
TDS	143.5	159.4	161.7	169.1
TSS	3.4	8.4	11.4	10.0

Lastly, total trace metal concentrations were quantified during April 2000. Total trace metals consist of readily available (dissolved) and particulate metals that are bound to suspended materials within the water column. All dissolved trace metal fractions observed were within the EPA drinking water standards (EPA, 1976)[55] except for aluminum, which was found at 245 µg/L at NAV 3. EPA's Secondary Drinking Water Regulation Standards for aluminum range from 50 µg/L to 200 µg/L.

San Juan River Arm of the Reservoir

Streamflow in the San Juan River is mostly attributed to melting snowpack. The river peaks in the springtime and tapers off in the summer and fall, with periodic increases in flow

[55] While drinking water standards are not applied at a reservoir management level, they were used in this section because reservoir water may be used in the future for drinking purposes.

caused by storms. The San Juan River provides the majority of inflow into Navajo Reservoir. The river, regulated by Navajo Reservoir, and its tributaries sustain substantial irrigation use (Reclamation, 2000a).

Pine River Arm of the Reservoir

Streamflow in the Pine River is mostly attributed to melting snowpack. Streamflow is highly variable throughout the year with higher flows (up to 2,700 cfs) during the springtime melt of the snowpack. A reduction in flow occurs from midsummer through fall (down to 100 - 200 cfs). Below irrigation diversions on the Pine River, however, certain stretches of the stream are usually dewatered. The mean monthly inflows into Navajo Reservoir can vary from 6 to 2,000 cfs. Historically, water quality of the Pine River is high despite some irrigation and M&I return flows in the lower portion of the system (Reclamation, 2000a).

Piedra River Arm of the Reservoir

The Piedra River's streamflow is attributed mostly to melting snowpack. Streamflow varies annually, with peak flows up to 1,500 cfs during the spring runoff. Flows are reduced to 70 - 100 cfs midsummer through fall. The mean annual flow for the Piedra River is about 416 cfs. The water quality of the Piedra River is considered relatively good (Reclamation, 2000a).

Methodology

This study measured potential impacts in terms of (1) nutrient concentration changes within the reservoir, (2) noticeable changes in biological productivity, (3) changes in trophic state indices, (4) substantial changes in reservoir temperature profiles and stratification, (5) DO concentrations, and (6) suspended sediment fractions.

The study also measured general physical conditions and water quality parameters of Navajo Reservoir, which include nutrients, physical and chemical profiles, biological productivity, light penetration, TSS and TDS, total organic carbon, major ions and trace metals.[56] These variables were selected to provide information on key physical and

[56] Trace metals included aluminum, arsenic, barium, boron, cadmium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, strontium, vanadium, and zinc.

chemical characteristics of Navajo Reservoir, including mixing processes, nutrient dynamics, trophic state variables, and general water quality. The complete technical discussion of methodology is included in volume II of this EIS.

Releases of water from Navajo Reservoir that correspond to limnological sampling dates are shown in table III-16. Samples were collected on a quarterly basis (January, April, August, and November of 2000).[57] These surface and bottom samples were collected in January, April, and November 2000, and, in addition, samples were taken from the surface, bottom of the epilimnion (upper, warmer water), top of the hypolimnion (lower, colder water), and near the bottom during August.

Table III-16.—Summary of effects on limnological indicators from proposed alternatives compared to the No Action Alternative

Indicator	No Action	250/5000	500/5000
Nutrients (mg/L)	(Preceding nutrient summary data for 2000 table)	SNA[1]	SNA
Biological Indicators	(Preceding table showing chlorophyll summary for Navajo Reservoir and two figures showing phytoplankton and zooplankton structures for the reservoir)	SNA	SNA
Trophic State Index	(Preceding table comparing Navajo Reservoir trophic state indices to similar reservoirs)	SNA	SNA
Temperature (˚C)	3.7 - 23.4	SNA	SNA
Dissolved Oxygen (mg/L)	2.28 - 10.06	SNA	SNA
Secchi depth (meters) (light penetration)	0.30 - 5.60	SNA	SNA

[1] Similar to No Action.

Lastly, physical and chemical profiles were collected at each sampling location at intervals from the surface to near the bottom for general chemistry and physical variables (temperature, DO concentration, pH (measure of alkalinity/acidity), conductance, turbidity, oxidation-reduction potential, and Secchi depth.

[57] Samples were collected as surface grabs from the lake surface and by using a Kemmerer sampler at other depths.

Impacts Analysis

The water quality of Navajo Reservoir is expected to remain within historical limits, and no adverse impacts have been identified for the No Action and action alternatives.

No Action Alternative

The water quality of Navajo Reservoir is expected to remain within historical limits and no adverse impacts have been identified with respect to nutrients, biological productivity, trophic state, temperature, DO concentrations, and/or sedimentation. Releases seen during this study ranged from 504.2 to 765.2 cfs during the limnological sampling events, which remains within historical operation.

250/5000 Alternative (Preferred Alternative)

Reduced flows (250/5000 Alternative) from Navajo Dam's main outlet works could suggest that at certain times of the year more water may reside in live storage. If so, temperature profiles (thermoclines) may be more pronounced in the deeper portions of the reservoir. Otherwise, impacts to the other limnological variables would be similar to those of the No Action Alternative.

500/5000 Alternative

Impacts would be similar to those of the No Action Alternative in that historical reservoir operations (from 1973 to 1991) have been quite similar to this alternative.

SOCIOECONOMICS

This section addresses the potential impacts to social and economic sectors that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect local economies?

Overview

Scope

The primary area of direct impact includes all or parts of San Juan Counties in New Mexico and Utah, and Archuleta County, Colorado; Navajo Nation Lands; and the Jicarilla Apache, Ute Mountain Ute, and Southern Ute Indian Reservations. Impacts to American Indian Tribes and Tribal nations are included in the ITA section of this EIS. Other counties outside this scope may be negligibly affected, and as a result have not been included in this analysis.

Summary of Impacts

No Action and 500/5000 Alternatives: Impacts could result from the uncertain future development of NIIP, the development of the ALP Project, and impacts from the Jicarilla Apache Nation third-party contract with PNM for the San Juan Generating Station.

250/5000 Alternative: Local economies associated with water use, such as recreation and tourism below Navajo Dam, could be adversely affected. Over the long term, this alternative would benefit water development and agricultural support industries in the affected area and local communities.

Impact Indicators

Impacts were identified as a result of any changes in:

- Direct, indirect, and induced gross sales revenues of a county
- The number of jobs within a county
- Total county tourism/recreation receipts
- Total county agricultural crop sales
- The income and number of employees of local businesses dependent on riverflows

Affected Environment

The sections below discuss the existing socioeconomic conditions in the areas potentially affected by changes in releases from Navajo Dam. The descriptions provided use the most current data available at the time that this EIS was written. Census information collected in the year 2000 had not been completely tabulated and analyzed; however, current population numbers that were available have been used. In addition, each potentially affected State and county provided information and data in differing formats and levels of detail which occasionally prevented specific comparisons between affected areas.

The most significantly impacted area comprises three counties in three States, each of which borders stretches of the San Juan River: San Juan County in northwestern New Mexico, San Juan County in southeastern Utah, and Archuleta County in Colorado, which contains part of Navajo Reservoir. The Navajo, Ute Mountain Ute, Southern Ute Indian, and Jicarilla Apache Reservations, parts of which are located in counties adjacent to the primary affected area, would also be impacted by the proposed action, as discussed in greater detail in the ITA and EJ sections in this chapter.

Economically, the impacted areas rely on the diverse industries of mineral extraction and recreation/tourism, and, to a smaller extent, on agriculture. San Juan County, New Mexico, was developed as a result of livestock ranching, but the development of the county's oil and gas deposits from 1970 through the 1990s brought economic gain. San Juan County, Utah, was also developed as a result of livestock ranching, but uranium mining predominated in the 1950s and the creation of Lake Powell in the 1960s made tourism one of the county's most significant economic resources (Utah Economic Development Department, 1999). Archuleta County developed as a result of such traditional western commodities as minerals, cattle, and timber, but since the 1970s the county has been in transition to a more tourism-related environment (Colorado State Information Services, 1999).

San Juan County, New Mexico

Tourism/Recreation.—Tourism in San Juan County, New Mexico is most active during the summer months. Fishing, water-skiing, sailing, boating, and parasailing are available on the San Juan River and Navajo Reservoir, as well as on a number of lakes in the area.

Tourists can also mountain bike, hike, backpack, horseback ride, and hunt for big game, upland birds, and waterfowl. Quality trout fishing on the San Juan River below Navajo Dam attracts anglers from all over the United States and many foreign countries. Prehistoric and historic sites include Aztec Ruins National Monument, Salmon Ruins, Aztec Museum, and Pioneer Village. Travel and tourism expenditures in San Juan County amounted to more than $100 million in 1998.

San Juan County, New Mexico

Major industries: Government, services, mining, and trade (major retail hub)

Major employers: Navajo Nation, San Juan Generating Station, and Four Corners Power Plant

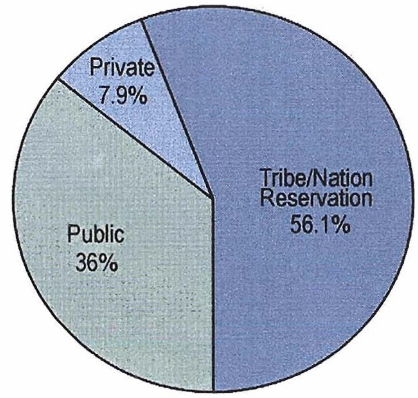
Largest municipality: Farmington, population 37,844

County population: 113,801

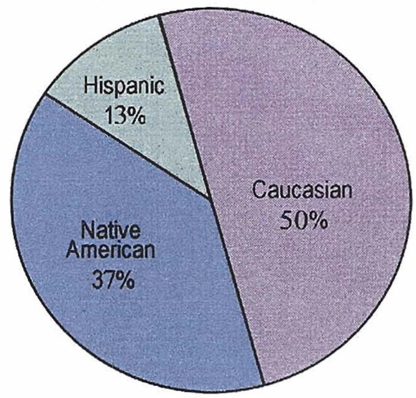
Average growth rate: About 3 percent 1990-2000 (National average 1.01 percent)

Per capita income: \$16,749 (14th of 33 counties in 1997; about two-thirds of State and National average)

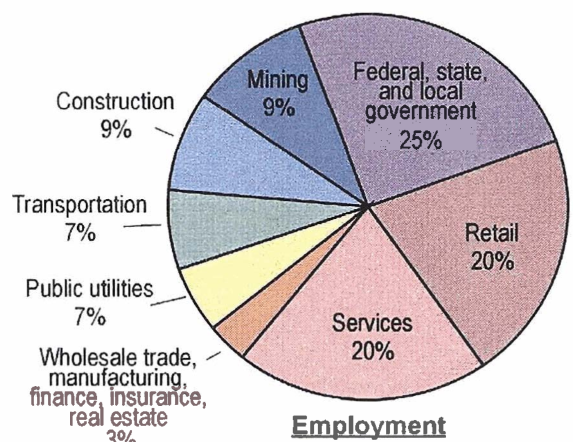
Unemployment rate: 9.7 percent (1997); (New Mexico was 6.2 percent [1997])



Lands
(3,530,240 total acres)



Demographics



Employment
(51,289 people employed)

Figures III-10 through III-12.—Lands, demographics, and employment (San Juan County, New Mexico).

Agriculture.—The 1997 agricultural census of San Juan County estimated there were approximately 666 farms in the county totaling about 1,857,223 acres of land, including crop production and range operations. About 85 percent of these farms were composed of fewer than 179 acres. Total cropland amounted to 84,000 acres, of which 68,500 acres were irrigated and about 61,000 were harvested. The agricultural sector employed about 1,300 in 1997, which represents about 3 percent of the total workforce, and payroll earnings for this sector were $28,388,000, or a little more than 2 percent of the county's total earnings (USDA, 1997).

San Juan County ranks eighth in agricultural production among New Mexico counties, with cash receipts from all farm commodities of $70,409,000 (USDA, 1997). Agriculture makes up about 4 percent of county gross receipts and less than 1 percent of total retail sales. Services, mining, and wholesale and retail trade are the predominant industries.

Retail Sales.—San Juan County serves as the major retail hub for the neighboring counties in both New Mexico and Colorado. While largely dependent on the oil and gas sectors, San Juan County is developing a strong service base.

Table III-17 shows the gross receipts of retail sales in 1997.

San Juan County, Utah

Tourism/Recreation.—Extensive summer tourism in San Juan County centers on the area's natural environment. Recreational activities include river rafting, kayaking, fishing, hiking, rock climbing, and mountain biking. Thousands of tourists per year travel to nearby national parks, monuments, and recreation areas, including Natural Bridges, Arches, Monument Valley, Glen Canyon, and Canyonlands. The creation of Lake Powell in the 1960's has continued to make tourism one of the county's most important economic resources.

Travel and tourism expenditures in 1997 totaled almost $44 million. The tourist industry includes Monument Valley Lodge, Halls Crossing Resort and Marina, local commercial river rafting and tour companies, and several smaller enterprises.

Agriculture.—There were 1,673,079 acres of farmland countywide in 1997, according to the Census of Agriculture for that year. Of the 231 farms in 1997, 115 were considered full-time operations, most of them involving livestock production.

San Juan County, Utah

Major industries: Tourism and education

Major employers: San Juan School District, tourism, Navajo Nation

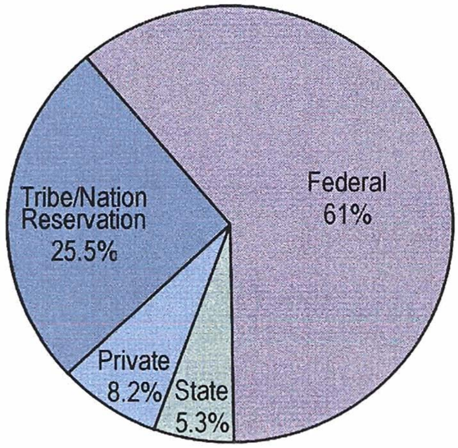
Largest municipality: Blanding, population 3,516 (1998)

County population: 13,561 (1.7 people per square mile)

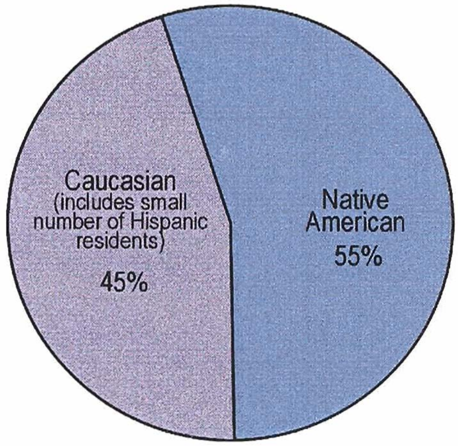
Average growth rate: 0.8 percent (1990s) (National average 1.01 percent)

Per capita income: $11,080 (lowest among Utah counties; 55 percent of State average and 46 percent of National average)

Unemployment rate: 8.2 percent (1997) (second highest in State, where average was 3.8 percent that year)



Lands
(5,005,561 total acres)



Demographics

Figures III-13 and III-14.—Lands and demographics (San Juan County, Utah).

Principal crops grown are wheat, barley, oats, and alfalfa. Cash receipts from all farm commodities amounted to more than $9 million. In 1997, the agricultural sector employed 0.5 percent of the total workforce and payroll earnings for this sector were $151,000, representing less than 1 percent of the county's total earnings (USDA, 1997).

Retail Sales.—San Juan County retail sales totaled more than $102 million in 1998. Table III-18 compares the sales amounts and proportions of the major various retail sales sectors in 1998.

Table III-17.—Comparison of retail sales sectors in San Juan County, New Mexico (1997)

Industry	Sales ($)	Percent of total
Agriculture	2,217,000	0.1
Mining	525,663,000	23.9
Construction	249,819,000	11.3
Manufacturing	94,341,000	4.3
Transportation, communication, and utilities	101,593,000	4.6
Wholesale trade	446,578,000	20.3
Retail trade	783,113,000	35.5
Total retail sales	2,203,324,000	100.0

Source: New Mexico Department of Economic Development.

Table III-18.—Comparison of retail sales sectors in San Juan County, Utah

Industry	Sales ($)	Percent of total
Mining	12,779,000	12.5
Construction	3,541,000	3.4
Manufacturing	2,817,000	2.8
Transportation and public utilities	10,458,000	10.2
Wholesale trade retail sales	10,561,000	10.3
Building materials and farm equipment	2,753,000	2.7
General	385,000	0.4
Food stores	10,807,000	10.6
Auto and service stations	4,896,000	4.8
Apparel and accessories stores	263,000	0.3
Home furnishing stores	827,000	0.8
Eating and drinking places	3,252,000	3.1
Miscellaneous stores	5,174,000	5.1
Finance, insurance, and real estate	819,000	0.8
Hotels and other lodging places	10,479,000	10.2
Services other than lodging	13,913,000	13.6
Other industries	8,635,000	8.4
Total retail sales	102,359,000	100.0

Source: Utah State Tax Commission.
Note: Agriculture is not included because it is not a major retail sector in county economy.

Archuleta County, Colorado

Tourism/Recreation.—Tourism has replaced timber and wood products industries as the major economic industry. Archuleta County's tourism centers on the area's natural environment, with the hot springs located in Pagosa Springs as an example. Winter sports are a major attraction at Wolf Creek Ski Area near Pagosa Springs. Other recreational activities include golf, fishing, hunting, and hiking, along with camping and water-related activities at Navajo Reservoir. Tourism and travel spending in the county amounted to more than $26 million in 1997.

Agriculture.—There were 112,670 acres of farmland countywide in Archuleta County. Of the 206 farms in 1997, 125 were involved in livestock production. Principal crops grown are pasture, grass hay, alfalfa, and a small amount of wheat. In 1996, the agricultural sector employed 5 percent of the total workforce and payroll earnings for this sector were $768,000, representing about 1 percent of the county's total earnings (USDA, 1997).

Archuleta County ranks 48th in agricultural production among 63 Colorado counties, with a cash receipt from all farm commodities of $6,921,000 (USDA, 1997). Agriculture makes up less than 5 percent of county gross receipts and about one-half of 1 percent of total retail sales.

Retail Sales.—Archuleta County experienced retail sales totaling more than $118 million in 1997. Table III-19 compares the sales amounts and proportions of the various retail sales sectors in 1997. Food stores (19 percent) and retail building materials and farm equipment (18 percent) had the strongest sales, followed by other miscellaneous retail industries (12 percent), and services other than lodging and retail eating and drinking places (each at 8 percent).

Methodology

The socioeconomic analysis presented in this section discusses potential direct, indirect, and induced impacts that could occur in the three counties previously identified.[58]

---

[58] Direct effects are production changes created by the initial or first-round expenditures for goods and services. Indirect effects result from secondary spending related to initial industries' sales. Induced effects are changes in economic activity resulting from household spending of income earned directly or indirectly from the initial expenditure.

Archuleta County, Colorado

Major industries: Tourism and recreation

Major employers: Service, retail, and construction

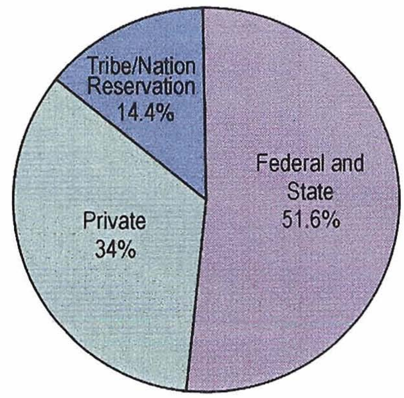
Largest municipality: Pagosa Springs, population about 1,800

County population: 9,142

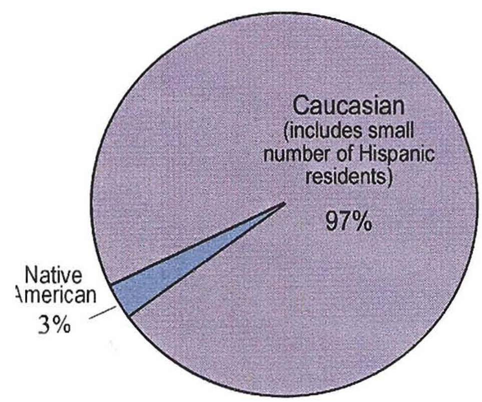
Average growth rate: 8.3 percent (1990s) (National average 1.1 percent)

Per capita income: 14,741 (58th out of 63 State counties; 51 percent of State average; and 61 percent of National average)

Unemployment rate: 5.2 percent (1997) (State was 3.3 percent)



Lands
(872,960 total acres)



Demographics

Figures III-15 and III-16.—Lands and demographics (Archuleta County, Colorado).

The movement of goods and services within a regional economy and expenditures outside the region can be estimated using models which reflect production requirements for goods and services within the proposed area of impact. This analysis utilized a computer-based modeling program[59] to calculate direct, indirect, and induced effects of the economic activity. All values are presented in 1999 dollars and revenues are considered to have been received in 1999. The model used is described in technical attachments included in volume II.

[59] IMPLAN Professional (Version 2.0).

Table III-19.—Comparison of retail sales sectors in Archuleta County, Colorado, in 1997

Industry	Sales ($)	Percent of total
Agriculture	621,000	1.0
Construction	5,288,000	4.0
Manufacturing	2,391,000	2.0
Transportation and public utilities	7,258,000	6.0
Wholesale trade retail sales	5,344,000	5.0
Building materials and farm equipment	20,845,000	18.0
Food stores	22,820,000	19.0
Auto and service stations	8,671,000	7.0
Apparel and accessories stores	1,218,000	1.0
Home furnishing stores	3,337,000	3.0
Eating and drinking places	9,562,000	8.0
Finance, insurance, and real estate	823,000	1.0
Hotels and other lodging places	6,431,000	5.0
Services other than lodging	9,298,000	8.0
Other industries	14,174,000	12.0
Total retail sales	118,081,000	100.0

Source: Region 9 Economic Development District, 1999.

Estimated impacts for all industries on a per-county basis were measured using total output, total value added, employee compensation and jobs. Total value added is a fairly reliable measurement of total income or benefit associated with employment in all industries in the county economy. Also analyzed are impacts to employee compensation and total jobs. Table III-20 provides the baseline data from which impacts were measured for the three counties.

Information on fishing, rafting, and related expenditures was collected from State and local governments, visitor bureaus, fishing and river rafting guides, and restaurant, lodging, and retail store owners from Navajo Reservoir to Mexican Hat, Utah on the San Juan River.

In any county regional impact analysis, only out-of-county and out-of-State visitor expenditures are considered as a net gain in revenues, incomes, and employment. In-county resident fishing expenditure are not considered when calculating impacts because it is

Table III-20.—Baseline data for Archuleta County, Colorado, San Juan County, New Mexico, and San Juan County, Utah

County	Output for all industries (1999 dollars)	Total value added for all industries (1999 dollars)	Total employee compensation for all industry sectors (1997)	Total jobs (1997 data)
Archuleta County, Colorado	277,984,000	161,393,000	68,565,000	4,299
San Juan County, Utah	276,819,000	161,465,000	103,841,000	5,346
San Juan County, New Mexico	3,992,651,000	2,364,783,000	1,205,444,000	49,933

assumed that anglers would make the same local expenditures on some form of recreation if fishing on the river did not exist. Out-of-State anglers would presumably make their fishing expenditures in their home locality if the San Juan River were closed or did not exist.

Impacts Analysis

In general, only those resource areas that would be impacted socioeconomically by the alternatives are discussed. The primary impact area comprises the two San Juan counties through which the San Juan River flows in New Mexico and Utah before entering Lake Powell.

Overall, the county economy may be so diversified that changes in specific sectors such as recreation and tourism have very insignificant impacts on the county output; however, local areas that have limited economic bases (like the small communities and towns along the San Juan River) can be particularly impacted.

Providing and maintaining recreational/tourism opportunities that bring people into these areas does make a significant difference to local incomes and employment. Improving economic activity in these rural areas has been and continues to be a longstanding public policy objective.

For the 250/5000 Alternative (Preferred Alternative) (Flow Recommendations), water supplies to users would remain intact, maintaining those resources without adverse impact. Based on observations during the Summer Low Flow Test, the areas of major socioeconomic impact under the Preferred Alternative would include river recreation uses and hydropower generation at the City of Farmington power plant. Under the No Action and 500/5000 Alternatives, some existing and future major economic development would be jeopardized to an undetermined extent, and additional income and employment impacts would be expected. The economic analysis for this EIS does not include future non-binding or unspecified water development projects for Indian and non-Indian uses because their economic impacts have not been finalized.

No Action Alternative

The area would not continue to follow the economic course which is currently being pursued but existing water uses with a Federal nexus that are subject to Section 7 of the ESA would be required to consult with the Service. The following could be jeopardized: Future development of agricultural land on the Navajo reservation; M&I water supplies; and water settlements of the Ute Mountain Ute and Southern Ute Indian Tribes and the Jicarilla Apache Nation.

Navajo Indian Irrigation Project (NIIP).—In San Juan County, New Mexico, NIIP has currently developed 65,000 acres (Blocks 1–8), but under the No Action Alternative, Blocks 9–11—consisting of an additional 45,630 acres—may not be developed. In addition, water supply that was transferred to the NIIP from the Fruitland and Hogback Projects for completion of NIIP Blocks 7 and 8 under an earlier consultation may no longer be available. This would effectively revert the NIIP to the irrigated area of Blocks 1–6 for a total acreage of 54,500, leaving the project 56,130 acres short of full development. This could result in an estimated future loss of $40.3 million in annual gross crop revenues for that county (table III-21).

Table III-21.—Projected lost annual crop revenues (gross) without future completion of NIIP

Crop	Acreage	Revenue/acre ($)	Lost crop revenue[1] ($)
Alfalfa	8,420	618	5,203,251
Winter wheat	19,084	322	6,145,112
Corn	12,349	422	5,211,109
Dry beans	9,542	467	4,456,161
Potatoes	6,736	2,857	19,243,609
Total	56,130		40,259,243

[1] Rounded.

As a result, total output not realized annually for the county could be $55,086,000 which is about 1.3 percent of the total county output. Lost additional income that would have been generated in the county annually is estimated to be $14,488,000, which is about 1.2 percent of total employee compensation in the county, with the lost opportunity of adding 921 jobs. This reduced employment opportunity would be particularly detrimental to the Navajo Nation and the region, which is categorized by the Federal Government as an area of high unemployment.

Animas-La Plata Project (ALP Project).—Under the No Action Alternative the planned development of the ALP Project may not be able to continue without reconsultation under ESA. This could result in possible impacts on projected water development capital expenditures,[60] not including construction costs for and revenues from non-binding end uses. Unspecified losses to non-Indian M&I water development would also occur. Specific details and estimates for non-completion of the ALP Project and the associated impacts to La Plata County, Colorado, can be referenced in the ALP Project FSEIS (Reclamation, 2000a).

Jicarilla Apache Nation Third-Party Contract with PNM.— Under the No Action Alternative the Jicarilla Apache Nation third-party contract with PNM supplying water to the San Juan Generating Station (SJGS) could be at risk because of the need for ESA reconsultation. It is doubtful that the water supply to SJGS would be interrupted; however, if it was, the following resulting impacts could be realized:

- ❑ The direct impact of employment loss of approximately 400 jobs at SJGS with another 400 jobs at the Broken Hill Proprietary, Ltd., coal mines that supply coal to the generating station.
- ❑ Loss of power generated for more than 30 western utilities, municipalities and cooperatives; replacement sources of electricity to meet their needs, at possibly higher costs (Reclamation 2001c).
- ❑ Adverse impacts to the local economy would also be expected with the accompanying loss of personal incomes and expenditures.

250/5000 Alternative (Preferred Alternative)

Socioeconomic impacts under the Preferred Alternative are measured in the following areas:

[60] These water development capital expenditures of $227 million were projected by Reclamation in the ALP FEIS. In January 2003, the ALP cost estimate increased significantly.

- Recreation/Tourism
- San Juan River Fishing in Navajo State Park–Out-of-State anglers
- San Juan River Rafting—Commercial rafting outfitters and private boating
- Agriculture

Recreation/Tourism.—The following analysis describes some of the local economic impacts of expenditures by recreationists on local business activity, household income, and employment, primarily in San Juan Counties, New Mexico and Utah. Impacts to recreation at Navajo Reservoir from operational changes at the dam were determined to be negligible.

San Juan River Fishing – Navajo State Park.— Most fishing on the San Juan River takes place between Navajo Dam and the Hammond Diversion, predominantly in the 4.4 miles designated by NMDGF as the Quality Waters Section, where large numbers of anglers come to fish from all over the world. Only the regional impacts of fishing in the quality waters and part of the regular waters downstream were analyzed for this document.

Out-of-State Anglers.—Two separate estimates of out-of-State angler expenditures were provided. Angler expenditures were estimated at $400 per trip per person based on a study done in 1994.[61] Expenditures estimated at $462 per trip were provided by fly fishing outfitters and guides. Per trip estimates were based on one day of fishing and expenditures as identified in figure III-17.

An average annual estimate of out-of-State anglers specific to this stretch of the river was taken from surveys conducted by NMDGF from 1997 thru 2001. The surveys identified that an average of 61.4 percent of anglers using the Quality Waters Section and 11.4 percent using the regular regulation waters were from out of State. This percentage is applied to the angler day estimate (53,800) provided by the NMDGF.[62]

Currently, an annual direct expenditure of $11,026,000 in the local economy results from out-of-State river visitation, estimated at 27,565, by applying the Visitors Bureau-estimated $400 expenditure per out-of-State anglers (see Methodology section). Using guides' and outfitters' $462 estimate per trip (figure III-17) results in local annual expenditures of

[61] Personal communication with Farmington Visitors Bureau, February 2000.
[62] Estimates of angler use on the San Juan River are based on standardized pressure counts taken by NMDGF several times a month at 11 a.m. on any given day chosen for sampling.

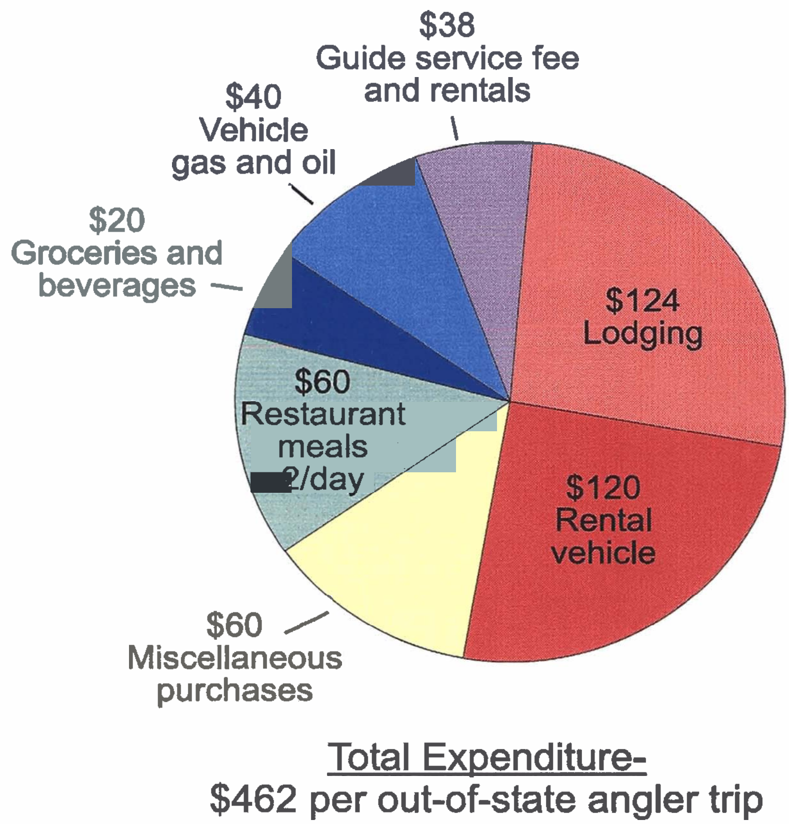


Figure III-17.—Total expenditure.

$12,735,000. Approximately $15,627,000 to $18,049,000 (direct, indirect, and induced impacts) to the local economy in total output occurs as a result of out-of-State anglers' fishing expenditures on the San Juan River in San Juan County, New Mexico.

The recreation section identifies the difficulty in predicting changes in recreation use because of the variable factors that affect angler use. However, for the purpose of this analysis, it was assumed that there is a linear correlation between recreation and trout habitat as suggested in the Recreation section of this chapter, the following range in losses in direct angler expenditures and associated indirect, induced, and employment impacts could be experienced in San Juan County.

Using the estimated reduction in angler use (described in the "Recreation" section) and applying the estimates of out-of-State anglers, losses in out-of-State angler use ranging from 2,800 to a maximum of 9,400 angler days could be expected to result in losses of $1.83 million to $6.16 million in total output and from 40 to 134 jobs for San Juan County, New Mexico. This amounts to less than a 1 percent reduction in the sectors of transportation, wholesale, and retail trade in the county, which would not be significant. However, these losses—when considered in smaller communities such as Navajo Dam or the larger City of Farmington–would be considered significant.

Accompanying a reduction in the number of anglers on the San Juan River there would be an impact on the revenues generated from the sale of both resident and non-resident fishing licenses by the NMDGF. Fishing license fees are as follows: annual resident, $17.50; annual nonresident, $39; 1-day resident or nonresident, $8; or 5-day resident or nonresident, $16.

Additional revenue would be lost to NMSPD as a result of reduced sales of day-use permits and camping fees at managed sites and campgrounds along the river. Current day-use permits are sold for $4 each and overnight camping is $10 per night. Rough estimates of losses are difficult to determine because of a lack of data on license sales (resident, non-resident), the duration of the license (1 day, 5 day, or annual), and use permits. However, based on a range of from 10 to 34 percent loss in out-of-State anglers of 2,800 to 9,400 under the 250/5000 Alternative and using the $8 nonresident 1-day license fee and the $4-day use permit fee, approximately $22,400 to $75,200 in license fees and an additional $11,200 to $37,600 in day use fees (based on 1 day of fishing per angler) could be lost to the two State agencies.

Commercially guided fly fishers are a small component of San Juan River anglers and impacts to this group are included in the out-of-State fishing impacts because of a lack of specific data. However, commercially guided fly fishers do expend larger sums of money because their trips are not taken as frequently as those of local resident fly fishers and they may not travel with all the necessary fly fishing equipment.

San Juan River Rafting.—

Commercial Rafting Outfitters.—Most commercial rafting trips begin on the San Juan River approximately 4 miles west of Bluff, Utah, at the BLM's Sand Island campground and boat launching facility. A lesser number of trips originate at the Montezuma Creek launch site upstream from Bluff and from Mexican Hat, Utah. A total of 11 licensed outfitters are permitted (BLM) to commercially operate water craft on the San Juan River from Sand Island to the Clay Hills takeout. Trip lengths vary from single-day to 9-day float trips on the river. The small community of Bluff (population 320) is economically tied to the tourist, river, and land recreation industries and is somewhat dependent on those industries. Mexican Hat (population 600) is economically dependent in the same ways, but also has some income and employment from mineral extraction industries. Any change to these industries would have a significant direct impact on these small communities because outfitters, lodging, restaurants, and retail establishments are heavily dependent on river recreationists.

As discussed in the "Recreation" section of this chapter and based on BLM estimates, approximately 11,165 river users made an average of 1,225 boating trips, with about 9.1 boaters per trip.[63] BLM permit records indicate that commercial outfitters provided river trips for an estimated 3,908 river recreationists out of the total 11,165 river users during the 1999 season (May through September).

Private Boating.—Private river users are also an important component in the local economy. BLM permits issued to private boaters amounted to an estimated 7,257 river users in 1999.

Rafting Summary.—The analysis in the "Recreation" section in this chapter concluded that the overall quality of rafting would decline; however, current use figures are not projected to change during the core season of June, July, and August because demand at present far exceeds the supply of permits and attempts would be made to maintain flows above 500 cfs. Therefore, it is anticipated that there would not be a net economic impact to rafting.

Agriculture.—Favorable regional impacts for agriculture are significant under the 250/5000 Alternative that provides for future water development in the Basin. With the opportunity to develop future water supplies in the Basin, the NIIP could be fully developed. Cropping patterns on the currently developed lands consist of alfalfa, wheat, barley, corn, and potatoes. It is anticipated that these same crops would also be planted and in the same percentages on the undeveloped blocks. Based on these percentages and the acreage to be developed, estimates were made of the annual crop revenues that would be generated as a result of existing and future development.[64] Table III-22 displays the projected annual cropping pattern, acreage, and gross crop revenue to be generated by future development of NIIP lands.

[63] Use estimation numbers were obtained from permits issued to river recreationists by the BLM. River permits are restricted to 1,225 trips per year. User numbers are divided into commercial permits and private permits. Commercial permits are issued to licensed outfitters who arrange and provide raft trips for profit to the public; they comprise about 35 percent of the BLM trip permits issued each year, and were about 429 for 1999. Private permits issued to the public (who provide their own boats and necessary equipment) make up the remaining 65 percent of the permits issued, or about 796 permits. (A more detailed explanation of the permitting process is contained in the "Recreation" section in this chapter).

[64] Per acre revenues were determined based on New Mexico State University crop enterprise budgets representative of crop production in the area. Gross income per acre was multiplied times the acreage for future development of Blocks 9–11 to arrive at a total revenue generated which could then be applied to the agricultural production sectors of IMPLAN to determine the indirect and induced impacts to the region (San Juan County, New Mexico).

Table III-22.—Additional crop revenues (gross) from completion of NIIP ($)

Crop	Acreage	Revenue/acre	Total revenue/crop
Alfalfa	6,845	618	4,230,210
Winter wheat	15,514	322	4,995,508
Corn	10,038	422	4,236,036
Dry beans	7,757	467	3,622,519
Potatoes	5,476	2,857	15,644,932
Total	45,630		32,729,205

Total output for San Juan County, New Mexico, would increase annually by an estimated $44,783,000, which is about 1.2 percent of the total county output. Additional income generated annually in the county is projected to be $11,778,000, which is about 1 percent of total employee compensation within the county, with an estimated increase in employment of 749, an approximate 2 percent increase in total jobs. Additional employment and income would occur if future development of NIIP-related projects occurs, such as the potato processing plant and associated cogeneration, powerplant, and feed yard. Positive employment impacts would be particularly beneficial to the Navajo Nation and the region, which has high unemployment.

500/5000 Alternative

It is anticipated that there would be limited positive impacts to the local economies of San Juan Counties, New Mexico and Utah, and Archuleta County, Colorado, with implementation of the 500/5000 Alternative.

Recreation/Tourism.— Because the minimum flows of 500 cfs are consistent with flows experienced during the last few years, minimal recreation-related economic impacts would be expected.

Agriculture.— This alternative would not meet the Flow Recommendations, so future agricultural development may be restricted. It could put completion of NIIP (Blocks 9–11) in doubt because the conditions for the NIIP (Blocks 9–11) as provided in the latest NIIP ESA consultation could not be fully implemented.

Animas-La Plata Project (ALP Project).—Under the 500/5000 Alternative the development of ALP Project may not be able to continue. This could result in possible loss of projected water development capital expenditures, not including construction costs for non-binding end uses.[65] Unspecified losses to non-Indian M&I water development would also occur. Specific details and estimates for delay or non-completion of the ALP Project and the associated impacts to La Plata County, Colorado, can be referenced in the ALP Project FSEIS (Reclamation, 2000a).

Jicarilla Apache Nation Third-Party Contract with PNM.— Under the 500/5000 Alternative, water provided by Jicarilla Apache Nation through their third-party contract with PNM could require ESA reconsultation. Impacts under this alternative would be the same as those under the No Action Alternative.

Other Socioeconomic Impacts

Socioeconomic impacts include monetary impacts for resources identified in other sections in this EIS. Monetary impacts were identified in the "Diversion Structures," Water Quality," and "Hydropower" sections in this chapter.

Diversions

Water diverters along the San Juan River from the dam to the confluence of the Animas River may be economically impacted, but the overall impact would be much less than the impacts to other resources. Under the No Action Alternative, there would be no impacts. However, the 250/5000 Alternative (Preferred Alternative/Flow Recommendations) would require that impacted diverters expend up to a total of $16,000 or more each year to repair water diversion works, including cofferdams and headings of canals, damaged from high-flow releases up to 5,000 cfs from Navajo Dam. Under the 500/5000 Alternative, up to $7,000 or more each year would need to be expended to repair diversion works, including cofferdams and headings of canals, damaged from high-flow releases of up to 5,000 cfs from Navajo Dam (see "Diversion Structures" section in this chapter).

Water Quality

At the present time, Bloomfield is in the process of upgrading its plant to comply with anticipated stricter New Mexico water quality standards. These stricter standards, in concert with the Preferred Alternative, could result in a loss of approximately $60,000 annually from the inability to continue treating El Paso Natural Gas waste water. (See the "Water Quality" section in this chapter.)

[65] These water development capital expenditures of $227 million were projected by Reclamation in the ALP FEIS. In January 2003, the ALP cost estimate increased significantly.

Hydropower

The reduction of flows in the San Juan River under the 250/5000 Alternative would result in the City of Farmington having to buy replacement power for generation lost at their hydrogeneration power plant amounting to an annual average of $5.32 million based on a 10-year average of power replacement costs. This loss could expand to about $7.04 million annually if the power plant has to be taken out of service to prevent damage that would jeopardize the integrity of the equipment. Under the 500/5000 Alternative, cost of replacement power based on a 10-year average power replacement cost would amount to an estimated $3.16 million annually in expenditures by the city. Because of the magnitude of these replacement power costs, operation of the power plant under either of these alternatives may result in the City of Farmington having to increase rates to cover the loss in revenue or to replace or upgrade equipment at the Navajo Dam power plant for more efficient hydropower generation at lower flows through the penstocks.

SPECIAL STATUS SPECIES

This section addresses the potential impacts to special status species that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect special status species?

Overview

Scope

This scope includes special status species and their habitat along the San Juan River from the Navajo Reservoir area to Lake Powell.

Summary of Impacts

No Action Alternative: Would adversely affect endangered fish species, while not affecting other listed species.

250/5000 Alternative: No substantial adverse effects are anticipated to threatened or endangered species or other special status species. The flow regime should improve habitat downstream of Navajo Dam, and overall the action is not likely to adversely affect the southwestern willow flycatcher and bald eagle. The new flow regime should also improve habitat conditions for endangered fish.

Overall, endangered fish species, and native fish species such as the roundtail chub and the bluehead sucker would benefit from the alternatives that provide a more natural hydrograph; however, lower flows upstream from Farmington may adversely affect special status species such as the roundtail chub and bluehead sucker, under the 250/5000 Alternative, and water quality would occasionally be lowered.

500/5000 Alternative: Would provide less protection to endangered species than the 250/5000 Alternative, but would benefit other native fish above Farmington.

Impact Indicators

For endangered fish, failure to acceptably meet the Flow Recommendations criteria would be considered as an adverse impact. For protected plant and terrestrial wildlife species, the indicators used to determine impacts include the presence and potential loss of a federally listed or candidate species, or loss or degradation of their habitat or their designated critical habitat.

Affected Environment

Special status species include threatened or endangered species officially listed and protected under the ESA and species of concern for which further information is needed to determine their conservation status.

The Service's Region 2 (2001a) has provided the following list of endangered, threatened, and candidate species of concern that could potentially be affected by the project alternatives:

Bald eagle (*Haliaeetus leucocephalus*)	Threatened
Interior least tern (*Sterna antillarum athalassos*)	Endangered
Southwestern willow flycatcher (*Empidonax trailii extimus*)	Endangered
Colorado pikeminnow (*Ptychocheilus lucius*)	Endangered
Razorback sucker (*Xyrauchen texanus*)	Endangered
American peregrine falcon (*Falco peregrinus anatum*)	Species of concern
Arctic peregrine falcon (*Falco peregrinus tundrius*)	Species of concern
Black tern (*Chlidonias niger*)	Species of concern

White-faced ibis (*Plegadis chihi*)	Species of concern
Yellow-billed cuckoo (*Coccyzus americanus*)	Species of concern
Roundtail chub (*Gila robusta*)	Species of concern
New Mexico silverspot butterfly (*Speyeria nokomis nitocris*)	Species of concern
San Juan checkerspot butterfly (*Euphydryas anicia chuskae*)	Species of concern
San Juan tiger beetle (*Cicindela lengi jordai*)	Species of concern

The Service Region 6 added the following species (Service 2001c):

Navajo sedge (*Carex specuicola)*	Threatened
Mexican spotted owl (*Strix occidentalis lucida)*	Threatened
Bonytail (*Gila elegans)*	Endangered
Humpback chub (*Gila cypha)*	Endangered
California condor (*Gymnogyps californianus)*	Endangered
Black-footed ferret (*Mustela nigripes)*	Endangered
Gunnison sage grouse (*Centrocercus minimus)*	Species of concern

The Navajo Nation (2001) has also provided a list of species of special concern that could occur within the impact area. Species include the golden eagle, bluehead sucker, mottled sculpin, southwestern willow flycatcher, peregrine falcon, roundtail chub, bald eagle, Colorado pikeminnow, northern leopard frog, razorback sucker, yellow-billed cuckoo, bighorn sheep, and alcove rock daisy.

The Service (1991a) concurred with a request from Reclamation that consultation on the operation of Navajo Dam and Reservoir under the ESA be extended while research was conducted on flow needs of endangered fish in the San Juan River. During the research period, which extended from 1991 to 1997, Reclamation provided research flows to mimic a natural hydrograph. Following the research period, a report on flow recommendations was prepared (Holden, 1999). A biological assessment on the effects of the Preferred Alternative on listed and special status species was prepared by Reclamation pursuant to the ESA and is included in volume II of this EIS. The Service has prepared a biological opinion (Service, 2006) on the Preferred Alternative and this is also included in volume II. The Service concluded that the Preferred Alternative may affect, but not likely to adversely affect the bald eagle and the southwestern willow flycatcher. The Service also concluded that the new flow regime would benefit endangered fish although continuing river regulations and depletions would adversely affect them.

Threatened or Endangered Species

Colorado Pikeminnow and Razorback Sucker

The Colorado pikeminnow and razorback sucker are both endangered and native to the San Juan River. Critical habitat has been designated for both species on sections of the river downstream from Farmington. A small reproducing population of pikeminnow occurs in the river downstream from Farmington; successful razorback recruitment has not been documented in the river in many years. Experimental stocking of both species began in the mid-1990s.

Colorado pikeminnow habitat extends from Lake Powell upstream to River Mile (RM) 158.4; primary use is between RM 119 and 148 (Service, 2000c) (figure III-1). Five diversion structures between Farmington and the Utah State line were originally identified as potential barriers to fish movement in the San Juan River. Fish passage has been provided at the Hogback diversion and the Public Service Company of New Mexico's San Juan Generating Station diversion and the Cudei Diversion has been removed. The studies are now in progress to assess the need for fish passage at both the Arizona Public Service Company weir and the Fruitland Diversion. Potential spawning areas have been located at River Miles 132 and 131.15 during radio telemetry studies. Successful reproduction was confirmed in the river in 7 years between 1987 and 1996 by the collection of larval and young-of-year pikeminnow (Service, 2000c). The populations of both species are being augmented by experimental stocking, and ponds have been established in the Basin to grow the fish to appropriate stocking size.

Small concentrations of razorback sucker have been reported in the inflow area in the San Juan arm of Lake Powell. One specimen was documented from the river near Bluff, Utah, in 1988, but overall, this species is extremely rare in the San Juan River. Experimental stocking began in 1994 and these fish have been observed in spawning condition. Larval fish are now collected between Bluff and Montezuma Creek (Service, 2000c). The razorback's current distribution in the San Juan River, including introduced fish, is from Lake Powell to near the PNM diversion.

Loss of habitat, competition from non-native fish, and migration barriers may all be factors in the fishes' decline. Habitat of the fish in the San Juan River includes a complex mix of low-velocity habitats such as eddies, pools, and backwaters adjacent to swifter run and riffle habitats. A natural hydrograph (high spring flows, low base flows) is important in maintaining the habitat, and one of the main effects of Navajo Reservoir under historic pre-1991 operations has been to reduce high spring flows while increasing base flows. Spring peaks between 1963 and 1991 decreased by an average of 45 percent compared to pre-dam peak flows, while base flows increased. Also, habitat of the endangered fish species in the San Juan River was reduced when Navajo Reservoir and Lake Powell were filled in the 1960s, and reductions of water temperatures in the river due to releasing cold water from near the bottom of Navajo Reservoir may be a factor limiting recovery of the species.

The Flow Recommendations criteria are designed to benefit the endangered fish by addressing flow magnitude, duration, and frequency. The recommendations mimic the natural hydrograph with a peak in late May or early June followed by low base flows, and help maintain the complex habitats used by the endangered fish. Additional information on the fish and their needs is in the Flow Recommendations (Holden, 1999).

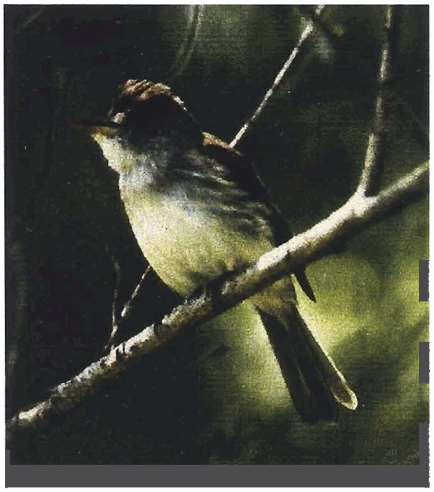
Recovery goals have been developed so that the status of recovery of the fish can be determined in an objective fashion.

Bald Eagle

Bald eagles, which are a threatened species, occur around Navajo Reservoir and along the San Juan River, primarily as winter residents. No bald eagle nesting is known to occur in the New Mexico portion of the project area (Reclamation, 1999b) but an active nest occurs in Colorado on private lands north of Navajo Reservoir. Winter concentration areas occur around Navajo Reservoir and some of its tributaries. Winter concentration areas have been designated along the Piedra, San Juan, and Pine reservoir arms in Colorado, and in several areas around the reservoir in New Mexico. Food sources include fish and carrion. Night roost sites consisting of undisturbed cottonwood groves or ponderosa pine groves, from which eagles disperse daily for feeding, are important factors in maintaining wintering populations.

Southwestern Willow Flycatcher

The southwestern willow flycatcher is a small, migratory passerine bird that has lost habitat due to water diversions and flood plain channelization, introduction of non-native vegetation, livestock grazing, and nest parasitism by brown-headed cowbirds. The birds nest in dense riparian vegetation, with a nesting period from May through July. Potential habitat occurs in the inflow areas of Navajo Reservoir and along the San Juan River.


Southwestern willow flycatcher.

Along the San Juan River, habitat is dominated by tamarisk and Russian olive; native willow stands also occur. Studies reported by Johnson and O'Brien (1998) indicate that the lower river in Utah is primarily used by migrating birds and as such serves as an important stopover to replenish strength for the continued migration to breeding grounds. However, the river area does provide potential nesting habitat that may be used in the future.

In 1997, one nesting pair was documented along the San Juan in New Mexico downstream from Shiprock. Nesting was confirmed in this area again in 1998 but not in 1999 (BIA, 1999 and CUP, 2001). Migrating willow flycatchers have been observed along the river from

Navajo Dam downstream in New Mexico during 2004 and 2005 surveys, but nesting was not detected. Similarly, birds were observed along the Piedra River inflow area of Navajo Reservoir in 1999 but were not confirmed to be nesting (Reclamation 1999b).

Interior Least Tern and Black Tern

The interior least tern is a small, migratory, piscivorus tern associated with shallow waters of lakes and rivers and is considered endangered. These birds are primarily found in the Mississippi Basin, although a breeding population occurs at Bitter Lake National Wildlife Refuge in Chaves County New Mexico. Nesting occurs in late May. The NMDGF reports infrequent sightings in San Juan County.

The interior least tern is not known to depend on the habitats along the San Juan River and Navajo Reservoir potentially affected by alternatives and thus should not be impacted.

The black terns would most likely be encountered in the project area during spring migration. Habitat includes lakes and reservoirs; nesting occurs in large cattail marshes adjacent to open water. Populations have been declining due to losses of habitat and possibly pesticides.

Species of Concern

Roundtail Chub and Bluehead Sucker

A small population of roundtail chub exists in the San Juan River downstream from Navajo Dam and also occurs in tributaries such as the La Plata and Mancos Rivers (BIA, 1999). The species also occurs in the San Juan River above the reservoir (Reclamation, 1999). Loss of habitat and competition from non-native fish are probably factors in their low populations in the San Juan River. Olson (1965) attributed low numbers to changes in water temperatures below Navajo Dam and early efforts to remove nongame fish from the river. Bluehead suckers tend to occur more frequently in the upper reaches of the San Juan River and occur both upstream and downstream of Farmington. Blueheads also occur in tributaries feeding Navajo Reservoir.

Mottled Sculpin

Mottled sculpin have been collected between RM 155 and 178 in the San Juan River and the species is common to abundant in the Animas River and tributaries upstream from Navajo Reservoir.

Gunnison Sage Grouse

The Gunnison sage grouse currently occurs in eight isolated populations in western Colorado and southeastern Utah, but does not occur in the project impact area. The species has been in decline, presumably due to habitat loss and fragmentation. Habitat includes large expanses of sagebrush with a diversity of grasses and forbs and healthy riparian areas.

American and Arctic Peregrine Falcon

These two species occur in Colorado and New Mexico, with nesting of the American peregrine falcon occurring in both States. There are no known nests around Navajo Reservoir (Reclamation, 1999b). Potential nesting habitat occurs on cliffs along the San Juan River, while riparian areas in the project region provide migration and foraging habitat.

Golden Eagle

The golden eagle uses a variety of habitats in the Basin, including the San Juan River corridor. Nesting occurs on cliffs or large trees. Primary foods include small mammals and carrion, although birds and fish can be included.

White-Faced Ibis

The white-faced ibis typically nests in colonies in dense marsh habitats and feeds in shallow water and flood-irrigated fields. Nesting does not occur in the impact area and the species is considered a casual migrant (BIA, 1999 and Reclamation, 1999b). However, nesting has been confirmed in Montezuma County, Colorado, just north of the impact area, indicating that nesting in the area is possible.

Yellow-Billed Cuckoo

The yellow-billed cuckoo would be considered a rare summer resident in the impact area. Populations have declined significantly throughout the species range; a major factor has probably been the loss of mature riparian forests. Loss of prey insects to pesticides is also believed to be a factor. Protection of riparian areas is critical to this species. Surveys of portions of the San Juan River in 1997 and 1998 indicated that the birds are present in small numbers during migration and there is some evidence of breeding (Johnson and O'Brien, 1998). Sites where birds have been observed generally consist of dense Russian olive, tamarisk, and willow with an associated stand or overstory of cottonwoods; no birds were observed in sites with little vegetative understory. Factors that adversely affect populations along the river may include grazing, oil/gas exploration, and agricultural practices (Johnson and O'Brien, 1998).

California Condor

The California condor has been introduced to northern Arizona and may occasionally occur in the area.

Mexican Spotted Owl

The Mexican spotted owl inhabits canyon and montane forest habitats in a range that includes southern Utah, Colorado, New Mexico, and Arizona.

Northern Leopard Frog

The northern leopard frog is associated with wetlands and waterways along the San Juan River, including the extensive wetlands immediately downstream from Navajo Dam.

Bighorn Sheep

Desert bighorn sheep can use the river for drinking and some use of riparian areas can occur, but overall this is a canyon and upland species. It is found along the lower river.

Black-Footed Ferret

There are no recent reports of black-footed ferret in the project area. Its potential habitat consists of grasslands and prairie dog towns.

New Mexico Silverspot and San Juan Checkerspot Butterflies and San Juan Tiger Beetle

These insect species are native species with limited distribution. Populations are affected by habitat losses and, in some cases, collection.

Navajo Sedge and Alcove Rock Daisy

The sedge has a specialized habitat of seeps-springs on sandstone cliffs in the lower end of the project area. The rock daisy is found in sandstone alcoves along the Colorado River in Utah.

Methodology

Existing literature on species was reviewed, including studies specifically conducted for Navajo Reservoir operations. Hydrologic modeling, described earlier in this chapter, was used to determine river flow changes, reservoir elevation changes, and the degree to which endangered fish Flow Recommendations criteria were met under the alternatives considered. Informal consultation was also conducted with Colorado and New Mexico wildlife agencies and with the Service.

Impacts Analysis

The sections below summarize information on special status species and their habitat in the impact area, and the results of impact analyses. Additional information is available in the biological assessment located in volume II.

No specific mitigation measures are proposed for special status species. The Preferred Alternative is designed to create more natural river conditions that should have an overall benefit to these native species. The effects of changed flows and other recovery actions for the endangered fish would be monitored to determine if flow regimes should be modified in the future.

No Action Alternative

Under the No Action Alternative, river conditions would be similar to those that occurred from 1973-1991, and riparian habitat conditions would remain similar to those that presently occur. High spring flows to create and maintain endangered fish habitat would occur at a lower frequency and magnitude than needed for fish recovery. Table II-3 and figure III-2 show that this alternative would meet flow recommendation criteria significantly less than would the action alternatives. Potential benefits of cottonwood regeneration along the river would be reduced because higher spring flows assist regeneration.

The Colorado pikeminnow, razorback sucker and other native fish would be adversely impacted under the No Action Alternative, and other species associated with riparian areas such as the southwestern willow flycatcher and yellow-billed cuckoo also may be negatively affected.

250/5000 Alternative (Preferred Alternative)

As discussed in chapter II, it is anticipated that flexibility would exist during the irrigation season under this alternative. This would reduce impacts associated with low summer flows during an interim period; however, impacts discussed below would be expected to occur in the long term.

In general, the more natural hydrograph seen in the Preferred Alternative should support more natural conditions along the river, which would be favorable to native species that include special status species. Cottonwood regeneration should be maintained or improved by a slight degree, while scouring losses of riparian shrubs from island areas and some bank areas would also occur. Periods of very low flow upstream from Farmington in summer months under the 250/5000 Alternative (the Preferred Alternative) may stress riparian vegetation and wetlands associated with the river corridor; however, many of these wetland areas are supported by groundwater inputs from irrigation near the river that should not be adversely affected.

The southwestern willow flycatcher may be affected by loss of any riparian habitat along the San Juan River or by reservoir operations that stress existing riparian habitats that occur in reservoir inflow areas such as the Piedra and San Juan arms of the reservoir. Stresses on riparian vegetation between the dam and Farmington due to low flows would be greatest under the Preferred Alternative. Long-term effects on habitat due to a more natural hydrograph under the Preferred Alternative are more difficult to project, but high spring flows should have an overall beneficial effect on riparian areas and should discourage human encroachment. The Service has agreed that the flycatcher may be affected but not likely adversely affected.

The Colorado pikeminnow and razorback sucker would be affected by changes to Navajo Dam operations. The 250/5000 Alternative provides a more natural hydrograph than does the No Action Alternative, and thus would meet Flow Recommendations and benefit the fish and their critical habitat by restoring more natural river function. The Service (2006) concurs with this but points out that ongoing operations of the dam can have negative effects, for example, the lowering of river temperatures during the summer.

The Flow Recommendations criteria are designed to maintain and improve habitat for these fish. The degree to which an alternative meets the Flow Recommendations criteria is a good indication of which alternative would best meet the fishes' needs. Table II-3 and figure III-2 indicate that the 250/5000 Alternative meets or exceeds the Flow Recommendations criteria for peak flows, and target base flows would also be met under this alternative.

Water quality changes in the San Juan River are discussed earlier in this chapter. Under the Preferred Alternative, flow reductions to 250 cfs and future water development would tend to concentrate pollutants in the river, some of which are of concern to the fish including trace elements such as selenium and polycyclic aromatic hydrocarbons (PAHs). Simpson and Lusk (1999) studied contaminants in the river and concluded, however, that the concentrations of contaminants in biota inhabiting the mainstem river were not consistently correlated with flow levels. Additional research is needed to determine the relationship between water quality and endangered fish recovery.

Of the special status species that are not officially listed as threatened or endangered, the roundtail chub, mottled sculpin and bluehead sucker are the most likely to be affected. The more natural hydrograph downstream from Farmington under the 250/5000 Alternative may benefit these species by providing more natural habitat conditions. Upstream from Farmington, adverse effects are possible because of reduced habitat and water quality associated with lower flows, but this would probably be more than offset by habitat improvements due to the high spring releases.

The bald eagle is not expected to be adversely affected by the Preferred Alternative. Increased spring peaks along the San Juan River should maintain and possibly enhance regeneration of cottonwood trees which are important winter habitat. In addition, the periodic high spring flows may discourage human encroachment into flood plain areas, indirectly benefitting the eagle's habitat. Increased river flows would cause more loss of mature trees to bank erosion, possibly offsetting this benefit. Food supplies in the waterways affected should not be adversely impacted.

Suitable habitat of the terns, peregrine falcons, golden eagle, white-faced ibis, Gunnison sage grouse, California condor, black-footed ferret, Mexican spotted owl, bonytail, humpback chub, bighorn sheep, and Navajo sedge should not be affected by the Preferred Alternative.

The Preferred Alternative is not anticipated to adversely affect the yellow-billed cuckoo. While the more natural hydrograph under the 250/5000 Alternative may scour some of the riverbank riparian areas, the flows also may be more conducive to maintenance and establishment of important cottonwood groves along the river.

Reduced summer flows between Navajo Dam and Farmington under the Preferred Alternative may adversely affect leopard frog habitat, particularly in the extensive wetlands just downstream from Navajo Dam.

The 250/5000 Alternative would have a net beneficial effect on the endangered Colorado pikeminnow and razorback sucker and would not adversely affect special status insect species, although a more natural riparian area along the San Juan River may be beneficial.

500/5000 Alternative

The 500/5000 Alternative would not fully meet the Flow Recommendations criteria for endangered fish species, as shown in table II-3 and figure III-2. Peak flows provided under this alternative would provide better conditions than the No Action Alternative, but base flows would more frequently exceed the recommended base flow target range of 500-1,000 cfs below Farmington.

This alternative would have little effect on other species considered. Riparian species could benefit as this alternative would provide a more natural hydrograph than the No Action Alternative.

VEGETATION AND WILDLIFE RESOURCES

This section addresses the potential impacts to vegetation and wildlife resources that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect vegetation and wildlife resources, including wildlife habitat?

Overview

Scope

The analysis includes Navajo Reservoir and the following sections of the San Juan River: Navajo Dam to Archuleta, New Mexico; Archuleta to the Animas River confluence near Farmington, New Mexico; and the Animas River confluence to Lake Powell, Utah/Arizona.

Summary of Impacts

No Action Alternative: Few adverse impacts are projected to wildlife and no adverse impacts are expected for wetland/riparian vegetation associated with the reservoir or downstream from the dam.

250/5000 Alternative: No major losses of riparian habitat are expected, though long-term reduction in vegetation vigor may occur above the Animas River confluence. This potential loss could reduce riparian habitats for some wildlife species immediately downstream from the dam. Reduced water levels in Navajo Reservoir could adversely affect riparian vegetation around the reservoir.

250/5000 and 500/5000 Alternatives: Minor impacts could occur to riparian vegetation and supported wildlife habitat at reservoir inflow areas. Benefits to cottonwood regeneration may occur associated with a 5,000 cfs release, and may eventually provide habitat for wildlife.

500/5000 Alternative: The effects to riparian vegetation and wildlife habitat below the dam would be inconsequential.

Impact Indicators

For Navajo Reservoir, a rapid, long-term decline in reservoir elevation during the growing season would be considered an indicator of adverse conditions to wetland/riparian vegetation that supports wildlife habitat near reservoir inflow areas. Similarly, downstream from Navajo Dam, any long-term flow reduction below existing levels in the growing season could indicate an impact to water sources supporting riparian vegetation and associated wildlife habitat.

Affected Environment

Navajo Reservoir

Vegetation and wildlife associated with Navajo Reservoir are primarily supported by upland plant species dominated by stands of pinyon pine and juniper, which constitute the dominant vegetative mix associated with Navajo Reservoir. Other upland vegetation near the reservoir includes sagebrush, greasewood, Gambel oak, serviceberry, mountain mahogany and chokecherry (Reclamation, 1999b). Wildlife found in these areas includes large ungulates, mostly mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*); large carnivores, primarily mountain lions (*Felis concolor*); and smaller carnivores such as the coyote (*Canis latrans*) and bobcat (*Lynx rufus*).

Small mammals include the desert cottontail (*Sylvilagus audoboni*), black-tailed jackrabbits (*Lepus californicus*) and the locally common Gunnison's prairie dog (*Cynomis gunnisoni*); small birds (primarily passerines); and a number of reptile species including several species of lizards and snakes. Several raptors are also common, including the red-tailed hawk (*Buteo jamaicensis*), golden eagle (*Aquila chrysaetos canadensis*), American kestrel (*Falco tinnunculus*) and Swainson's hawk (*Buteo swainsoni*) (Reclamation, 1999b). The federally listed bald eagle (*Haliaeetus leucocephalus*) (threatened) is also commonly found, mostly during the winter.

Other limited wildlife habitats near or adjacent to the reservoir are composed of wetland/riparian vegetation that is locally abundant and associated with inflow areas, especially the Piedra and San Juan Rivers arms of the reservoir. Wetland/riparian vegetation within these two areas is composed of native willow and broad-leaf cottonwood trees. Salt cedar, an invasive non-native plant, rarely occurs in these areas. The Pine River arm of the reservoir supports some riparian vegetation but in much smaller numbers than in the other two arms. Broad-leaf cottonwood trees are the most common riparian plant found in this area of the reservoir. These habitats are occupied by numerous species of wildlife, including many identified above. In addition, these are the areas in which it is likely to find neotropical birds species, numerous small rodents such as deer mice (*Peromyscus spp.*), and aquatic-loving mammals such as muskrat (*Ondatra zibethica*) and beaver (*Castor canadensis*).

Navajo Reservoir also supports habitat for a variety of waterfowl, including Canada Geese, (*Branta canadensis*) mallard duck (*Anas platyrhynchus*), common merganser (*Mergus merganser*), American coot (*Fulica americana*) and common goldeneye (*Bucephala clangula*). Waterfowl are far more common during the fall and winter and are also more concentrated near inflow areas.

San Juan River

Navajo Dam to Archuleta, New Mexico.—This 6.6-mile stretch of river between Navajo Dam to Archuleta supports an important wetland/riparian zone providing habitat to numerous wildlife. Many of the wildlife species listed above can also be found down-stream of Navajo Dam. This portion of river is also unique in that it maintains several wetland areas, especially within the first two miles downstream of the dam. Excavations for material for Navajo Dam created low areas connected to the river that have developed into an extensive wetland. This wetland complex, composed of willows, cattails, salt cedar and several less common wetland and riparian plants, supports a unique ecosystem allowing for several wildlife species to thrive that are otherwise not found in the area, due primarily to the warm water conditions provided in the summer. The northern leopard frog (*Rana pipiens*) is an example of a species benefitting from this limited habitat as it is commonly found within this wetland but is otherwise extremely rare on the river. Also commonly found within this wetland are beavers and muskrats. In addition, this wetland complex supports habitat, including breeding and nesting habitat, for numerous species of waterfowl, including the species identified as using Navajo Reservoir. Other species of waterfowl identified within this section of river are ring-billed gull (*Larus delawarenis*), gadwall (*Anas strepera*), northern pintail (*Anas acuta*), American widgeon (*Anas americana*), green-winged teal (*Anas crecca*) and bufflehead (*Bucephala albeola*) (Reclamation, 1998).

Numerous raptors are also commonly found along this section of river, including the bald and golden eagles and the red-tailed hawk. Migrating willow flycatchers (*Empidomax traillii*) and other neotropical birds have also been seasonally identified utilizing this portion of the river. Other wildlife commonly found within this reach are the mule deer and, to a lesser extent, elk.

Archuleta to the Animas River.—Most of this section of river is in private ownership, and significant areas have been cleared of wetland/riparian vegetation, thereby reducing wildlife habitat, to allow for the expansion of agriculture, ranching, and commercial development. Numerous diversions deplete river flow throughout this reach, the greatest impact occurring during the irrigation season. Flow depletions from the river would have an adverse effect on riparian vegetation by lowering the water table. This effect, however, is more than offset by the positive effect irrigation return flows in this reach of river have on elevating groundwater levels in many areas between where the water is used and the river.

Wetland/riparian vegetation existing along the San Juan River throughout this reach includes broad-leaf cottonwoods, willow, salt cedar and Russian olive. While there remain extensive riparian areas, wildlife quantity and diversity are very limited because of human intrusion. Still, there are some wildlife species that have benefitted, including beaver, striped skunks (*Mephitus mephitus*), raccoon (*Procyon lotor*), muskrat, and other small mammals. Deer are also fairly common, having become acclimated to human presence. Most of the animal species identified as occurring in the upper section of the river occur through this reach as well, but, for the most part, in lower numbers.

Animas River to Lake Powell.—This 180-mile section of river maintains the most natural hydrologic conditions in the San Juan River downstream of Navajo Dam, primarily because of the influence of the Animas River, which is largely unregulated. This section of river supports areas of riparian vegetation of varying size; the extent is largely dependent on historic and ongoing land use practices. Overgrazing by livestock is one of the major factors adversely impacting riparian vegetation. Over the last 100 years, much of the native vegetation has been displaced by non-native vegetation. As the river flows downstream, non-natives become more prevalent, with Russian olive becoming the most common riparian plant found along the river. Salt cedar is also common, with willows and broad-leaf cottonwoods found less commonly. Natural recruitment by cottonwoods appears to be rare, while large, decadent cottonwood trees are infrequently found, most typically located well away from the existing channel and many times associated with intermittent flowing arroyos.

Wildlife utilizing riparian areas associated with the river are limited because of the lack of habitat diversity and the impact of over-grazing within a large percentage of the riparian zone. Many of the wildlife species identified above can be found within this section of river, but in reduced numbers. The riparian zone does likely provide a bridge allowing for the seasonal migration of neotropical birds to upstream breeding areas (this would include the federally protected southwestern willow flycatcher).

Methodology

Existing literature on wildlife resources associated with Navajo Reservoir and the San Juan River was used to obtain pertinent, useful information. Vegetative communities associated with Navajo Reservoir have been generally identified and quantified by using satellite imagery (Reclamation 1999b). Wetland/riparian vegetation mapping of the San Juan River was done in 1996-97 from Navajo Dam to Archuleta (Reclamation, 1998). These data were used, in part, to infer habitat types that are known to support numerous wildlife species. Also, a limited waterfowl study was done during the 1996-97 Winter Low Flow Test documenting the seasonal use of the San Juan River by waterfowl and shore birds. In addition, wildlife use on the river was estimated based on field observations from Navajo Dam to Farmington.

Impacts Analysis

Navajo Reservoir

No Action Alternative.—Under the No Action Alternative, reservoir levels would remain higher throughout the growing season (April - October) as compared to the action alternatives (see figure II-3). This would benefit wetland and riparian areas that have developed in the inflow areas of the reservoir such as the Pine River and San Juan arms. These higher levels would help maintain existing wildlife habitat.

250/5000 Alternative (Preferred Alternative).—Reservoir levels would average 10 feet lower during the growing season under this alternative. The reduced water levels could adversely affect wetland/riparian vegetation and associated wildlife habitats in the inflow areas discussed above. This alternative would also be less beneficial than the No Action Alternative to the establishment of cottonwood trees around the reservoir perimeter.

500/5000 Alternative.—Impacts would be similar to those of the 250/5000 Alternative, although reservoir fluctuations would be greater as larger minimum releases would be maintained from the dam. As with the 250/5000 Alternative, wildlife habitat in reservoir inflow areas could be adversely impacted.

San Juan River

No Action Alternative.—

Navajo Dam to Archuleta, New Mexico.—Under the No Action Alternative, there would be few effects on wildlife resources in this reach of the river. Higher year-round flows would continue to supply water to the valuable wetlands in the first few miles downstream from Navajo Dam. In the long term, reduced high spring flows could impair regeneration of cottonwoods that are valuable to wildlife.

Archuleta to the Animas River.—Few impacts to vegetation supporting wildlife habitat would occur under the No Action Alternative. Higher base flows might be beneficial; however, reduced spring flows could result in less cottonwood regeneration and more encroachment into the flood plain by human activities.

Animas River to Lake Powell.—Animas River flows would help provide a more natural hydrograph in this reach, benefitting the riparian areas and the wildlife they support, although benefits would be less than under the action alternatives.

250/5000 Alternative (Preferred Alternative).—As discussed in chapter II, there is anticipated flexibility in summer releases under the 250/5000 Alternative. This could reduce impacts in an interim period; however, impacts discussed below are expected to occur in the long term.

Navajo Dam to Archuleta, New Mexico.—The wetland riparian vegetation providing wildlife habitat along this section of river is most likely entirely tied to the river for its water supply. During the Winter Low Flow Test, this section of river was monitored to assess changes in water surface elevations associated with a flow reduction from the dam from 500 cfs to 250 cfs. The reductions associated with a 250 cfs release were relatively small; however, any long-term change in hydrologic flow regimes could result in both a potential reduction in the wetland/riparian quantity and quality. The kinds of impacts that would result would likely occur over several years after long-term reductions in flow below 500 cfs occurred during the growing season. It is unlikely that any major loss of riparian wildlife habitat would occur from implementing the 250/5000 Alternative; nevertheless, the large wetland complex located within the first 2 miles below the dam would be the single largest concern because of its total reliance on the river's hydrology. However, while releases from Navajo Dam would be as low as 250 cfs under the 250/5000 Alternative, these releases would not occur all the time. Flow releases throughout any given year would be variable and would range from 250 to 900 cfs as needed to meet target flows downstream from Farmington. No adverse long-term impacts to wetlands or wildlife are anticipated.

Archuleta to the Animas River.—This 37-mile stretch of river would probably not be impacted by reduced releases from the dam in that much of the riparian area providing wildlife habitat is supported by return flows. The specific wetland/riparian areas that are supported by hydrology other than the river have not been identified. Still, it is likely that once long-term releases of flow below 500 cfs were implemented, there would eventually be a reduction in the riparian area in some areas that rely on the river's hydrology for growth and maintenance. Higher spring flows may improve cottonwood regeneration in this reach and downstream.

Animas River to Lake Powell.—This section of river is not likely to be adversely impacted by implementing the 250/5000 Alternative. The influence of the unregulated Animas River below its confluence with the San Juan River would effectively offset the effects of reduced releases from Navajo Dam.

500/5000 Alternative.—

Navajo Dam to Archuleta, New Mexico.—Impacts would be similar to those of the 250/5000 Alternative; however, higher summer flows could reduce impacts to wetlands in the upper end of this reach.

Archuleta to the Animas River.—Impacts are not expected to occur.

Animas River to Lake Powell.—Impacts would be similar to those of the 250/5000 Alternative, although spring flows would occur for shorter periods. This would result in fewer beneficial effects to riparian area; however, the overall impact would be inconsequential.

LAND USE

This section addresses the potential impacts to land use that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect land use?

Overview

Scope

The scope includes lands in use around Navajo Reservoir and downstream of Navajo Dam along the San Juan River to Lake Powell.

Summary of Impacts

No Action Alternative: Future development of NIIP and other water projects might not occur.

250/5000 Alternative: ESA compliance would be in place to allow future development of NIIP.

500/5000 Alternative: There may not be full development of NIIP.

Impact Indicators

Adverse effects on the use of lands within the impact area.

Affected Environment

Navajo Reservoir

Lands under the jurisdiction of Reclamation around and below Navajo Reservoir are jointly managed by State and Federal agencies for multiple uses, including mineral extraction, grazing, wildlife, and recreation. In New Mexico, most of the land adjacent to the reservoir and outside of the Navajo State Park is managed by BLM. Recreation-based lands within Navajo State Park are managed by the CDPOR and NMSPD.

Other public lands adjacent to the reservoir include State lands managed by NMDGF and New Mexico State Land Office; in Colorado, Southern Ute Indian lands are managed by the Tribe. Private lands border much of the Navajo Reservoir boundary in the Arboles, Colorado, vicinity and most of these lands remain in agriculture, with some developed as rural residential areas.

Current use of the area is predominantly for agriculture and recreation. Flood plain development is limited, based on governmental guidelines.

Indian Reservations

Navajo Nation Lands comprise the largest Indian reservation holdings within the study area. The latest Navajo Reservation Land Use Plan is dated March 2, 1961, and primarily inventories physical features, conditions, and resources at that time. An updated Land Use Plan is in progress but not ready for public release.

The Southern Ute Indian Reservation borders Reclamation lands on the Colorado side of Navajo Reservoir and the north end of the San Juan River. The Ute Mountain Ute Tribe has a small portion of land within the river corridor in the Four Corners area in Colorado.

San Juan Corridor

The San Juan Corridor is composed of various land uses including recreation, agriculture, grazing, oil and gas development, fish and wildlife, and other uses. Ownership is a mixture of Tribal, Federal, and private.

Methodology

Contacts were made with various State, county and local governmental agencies and Indian Tribes to discuss land use impacts from implementation of the No Action and action alternatives.

Impacts Analysis

Land use along the San Juan River within the impact area may not be affected by change in river flows under the No Action and action alternatives.

No Action Alternative

Under the No Action Alternative, land use activities are expected to remain within historical use, and no adverse impacts are projected except those identified under the "Socioeconomics" section in this chapter regarding completion of NIIP. Under this alternative, it is possible that no future development of 56,130 acres (Blocks 7–11) of NIIP would occur.

250/5000 Alternative (Preferred Alternative)

Under the 250/5000 Alternative, ESA compliance would be in place to allow future development of 45,630 additional acres (Blocks 9–11) of NIIP.

500/5000 Alternative

Under the 500/5000 Alternative, full development of NIIP may not occur.

CULTURAL RESOURCES

This section addresses the potential impacts to cultural resources that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect cultural resources?

Overview

Scope

The area of potential effect for Navajo Reservoir operations is within what archaeologists term the Navajo Reservoir Archaeological District.[66] Because the alternatives would not result in any adverse alterations of channel conditions downstream of the dam outside of the existing flood plain, the area of potential effect for cultural resources is limited to Reclamation's administrative boundary at and around Navajo Reservoir. It also does not include the inactive storage area in the reservoir, since standard reservoir operations rarely result in water levels lower than inactive storage.

Summary of Impacts

No Action, 250/5000, and 500/5000 Alternatives: There would be short- and long-term impacts to cultural resources within the reservoir area as a result of implementing any of the alternatives. However, none of the alternatives are likely to alter the flow regime in the San Juan River downstream of the dam to the point that riverbank cultural resources would be impacted.

[66] This is not a National Register District since the archaeology was done prior to passage of the National Historic Preservation Act (NHPA).

Impact Indicators

For cultural resources, a historic property is defined as one that meets one or more of the eligibility criteria for the National Register of Historic Properties (NRHP). These include prehistoric or historic archaeological sites or properties of historic interest or cultural significance to a community or ethnic or social group. These impacts would be considered adverse if they occurred to cultural resource sites that were protected under the National Historic Preservation Act of 1966, as amended in 1992 (NHPA),[67] the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), or Executive Order 13007, Protection of Native American Sacred Sites.

A significant environmental effect would occur if the action would disrupt or adversely affect eligible historic properties.[68] Adverse impacts to cultural resources include destruction, disturbance, inundation or vandalism.

Affected Environment

A study area was identified for salvage archaeology considerations for the construction of Navajo Dam. Surveys and excavations were conducted to mitigate the construction and filling of Navajo Reservoir between 1956 and 1962. At the time, the excavations constituted one of the largest mitigation projects ever conducted for a water project in the United States.[69] It yielded a contribution to the understanding of the prehistory and history of the area, resulting in the definition of a cultural sequence which now extends well beyond the reservoir itself. Known cultural traditions at the reservoir include the Archaic Period (3000 to 500 B.C.), several phases of the Pueblo Period (A.D. 1-1050), the Protohistoric/Early Historic Period (A.D. 1450-1870) and Euroamerican settlement (A.D. 1765-1960).

Cultural resources are physical or other expressions of human activity or occupation, including culturally significant landscapes, prehistoric and historic archaeological sites and isolated artifacts or features, historic structures, human burials, sacred sites, and traditional cultural properties (TCPs). TCPs are sites or areas of important cultural value to existing communities, and may not have actual physical remnants associated with their existence.

[67] It should be noted that, while significant impacts to cultural resources may be "resolved" through data recovery in compliance with applicable regulations and guidelines, such resolution would not reduce impacts to less-than-significant levels. As such, significant impacts which may be resolved would remain adverse.
[68] Sites within the Navajo Reservoir boundary have not been evaluated to determine their eligibility status. As a result, the impact analysis will assume that all sites may be eligible.
[69] Cultural resource mitigation was completed prior to passage of NHPA and emphasized cultural sites below the inactive zone of the reservoir.

Known cultural traditions in the project area are as follows:

Archaic

The Archaic period in the region is typified by a change from a big-game hunting emphasis to the hunting of smaller game and the intensive collection of plant foods. Most sites of this period date between 6000 B.C. to A.D. 1.

Pre-Puebloan and Puebloan

The majority of sites at the reservoir date to this time period.

The Basketmaker II period is characterized by the adoption of structures and features for habitation and storage of surplus foods. Basketmaker culture was named for its finely woven baskets and lack of pottery. Basketmaker II sites appear to date between A.D. 200 and 400.

The Basketmaker III period (A.D. 400 to 700) marks the beginning of a more sedentary agricultural lifestyle and the use of ceramics and adoption of the bow and arrow. This period also represents the beginnings of the typical Anasazi (Ancestral Pueblo) site layout.

The Pueblo I period (A.D. 700 to 900) is well represented with small hamlets scattered across the project area. It is during this period that surface structures, identified as pueblos, become increasingly common.

The Pueblo II and Pueblo III periods (A.D. 900 to 1300) are characterized by larger pueblos which usually include masonry roomblocks and larger semi-circular pit structures, called kivas. These are the ruins familiar to most modern visitors to the area, such as the sites on display at Mesa Verde National Park. The Pueblo III period is poorly represented in the Navajo Reservoir District and is the last vestige of Puebloan occupation in the area.

Protohistoric/Early Historic

Three contemporary Indian Tribes have trust lands in close vicinity to Navajo Reservoir. The Navajo, the Jicarilla Apache, and the Southern Ute began occupying the lands in and around Navajo Reservoir as early as the 1400s. Most of the sites at the reservoir of this time period are attributed to the Navajo.

The Navajo occupation of the Navajo Reservoir District is divided into three basic time frames: the Dinetah, Gobernador, and the Post-Gobernador. The Dinetah Phase applies to the era of the earliest Athapaskan-speaking groups. While the present-day Navajo consider the Navajo Reservoir District as their homeland (from which the name Dinetah is derived), archaeologists believe the Athapaskans entered the region in the 1400s and occupied the area for about 250 years. The Gobernador Phase applies to the area of acculturation following the Spanish reconquest of the region from 1692 through 1696, after the Pueblo Revolt of 1680. In the late 17th century, the Gobernador Navajo left the region, and they apparently did not re-enter the area until the Post-Gobernador period (mid-1800s), by which time the Navajo had fully adapted a pastoral lifeway. In 1868, a treaty was signed (and amended in subsequent years) which established the Navajo Indian Reservation immediately west of the Navajo Reservoir District.

The Jicarilla Apache are also Athapaskan speakers and their ancestors in the area may derive from the same stock as Dinetah phase. Their homeland is identified as the area extending between the Arkansas and Chama river valleys to the north and east of Navajo Reservoir. By 1700, the group distinguishable as the Jicarilla Apache had emerged. Beginning in 1874, an executive order was issued which set aside several reservations for the Jicarilla Apache, one of which included a portion of the present Navajo Reservoir. However, the Jicarilla never took up residence there. In 1887, an area immediately east of Navajo Reservoir eventually became what is now the Jicarilla Apache Nation Reservation.

Very little is known of the antiquity of the Colorado Ute Tribes. It is possible that the first Shoshonean speaking groups (of which the Utes are a part) entered southwestern Colorado as early as the 1200s from the north and west, coinciding with the Puebloan departure from the area. The first historical references to the Utes (from Spanish explorers) date to 1626, at which time their range extended to parts of northwest New Mexico. In the 1870s, the Southern Ute Indian Reservation (since divided into the Southern Ute and Ute Mountain Ute Indian Reservations) was established, and includes the Colorado side of Navajo Reservoir. In the 1960s, the Federal Government withdrew some Southern Ute Reservation lands for Navajo Unit project purposes.

Euroamerican Historic

By 1765, Spaniards from New Mexico settlements had visited the Navajo Reservoir region. In 1776, the Dominguez-Escalante expedition passed by what is now the upper end of Navajo Reservoir. In the decades following, Spanish and Mexican traders opened a trade route to California, known as the Old Spanish Trail, which follows the Dominguez-Escalante route through the project area. The trail continued to be used until 1848.

Beginning about 1870, emigrants of Hispanic descent began establishing settlements in the Navajo Reservoir region, including the towns of Rosa and Arboles. In the 1880s a railroad line was constructed through the area which connected Chama, New Mexico, to Durango, Colorado. However, in the 1950s, the towns and the railroad were abandoned in preparation for the filling of Navajo Reservoir. While mostly beneath the waters of Navajo Reservoir and/or having been removed at the time of abandonment, some remnants of the Euroamerican historic period can still be observed.

Traditional Cultural Properties (TCPs)/Native American Graves Protection and Repatriation Act (NAGPRA)

Research conducted indicates that a number of Native American Tribes have ancestral and contemporary ties to the area. Archaeological data provide some information about prehistoric and historic aboriginal use of the region; however, each Tribe has its own account of the Tribe's traditional use of the area. Of the 15 Tribes consulted, 11 (Hopi, Jicarilla Apache, Navajo, Jemez, Nambe, Pojoaque, San Ildefonso, Santa Clara, Taos, Laguna, and Southern Ute) have expressed concerns and requested to be included in further consultations. The remaining four (Zuni, Tesuque, San Juan, and Picuris) have either stated they have no concerns or have not responded despite a good faith effort to consult. All 15 Tribes will be provided with the FEIS.

While direct evidence for the existence of burial sites in the area is lacking, knowledge of the cultural resources indicates a high likelihood of encountering human remains during archaeological excavation or construction activities. Burials on Puebloan archaeological sites are rather common and are to be expected.

Methodology

The No Action, 250/5000, and 500/5000 Alternatives were analyzed for their potential impacts at the reservoir according to hydrological projections (Alpine Archaeological Associates, 2000). Much of what follows is derived from those projections.

In a numerical ranking included in this section, the No Action and action alternatives are given scores which represent a crude index derived from the number of times that water is at a given elevation times the number of sites corresponding to that elevation (including an estimate that 40 percent of the sites are eligible) since wave action is the single most impacting factor affecting sites at reservoirs. Other factors, such as human impacts, are difficult to quantify and therefore are not a part of the index. A higher score equals higher impact to the resource.

Impacts Analysis

Many archaeological sites remain below the high water level of Navajo Reservoir, and are subject to exposure and impacts in the case of drawdown. The operation of Navajo Dam changes the water level in the reservoir, resulting in shore bank exposure which leaves the banks susceptible to increased wind and water erosion and vandalism. Archaeological, historical, and traditional cultural resources are exposed and impacted as a result.

Hydrology analysis predicts the reservoir elevations would reach approximately 6010 feet on a periodic basis, with the potential to be as low as 5,975 feet in extreme low water years. The frequency at which these levels would occur varies by alternative. Human activity around the reservoir is expected to continue and probably to increase over time, resulting in additional impacts to cultural resources. The alternatives are not likely to alter the flow regime in the San Juan River (downstream of the dam) to the point that riverbank cultural resources would be impacted.

A total of 143 archaeological sites, at one time or another, have been recorded within the drawdown zone[70] of Navajo Reservoir. Of those, two sites have been officially determined eligible to the NRHP, 117 are categorized as "need data,"[71] nine are categorized as "field eligible,"[72] and 15 have been categorized as "field not eligible."[73] The sites range from prehistoric/protohistoric artifact scatters to historic house foundations. The most common site types are Pueblo I and Pueblo II habitations (about 40 percent of the total site base). These typically contain masonry room blocks associated with pit structures.

Investigations by Reclamation in 1987 and 1992 (Alpine, 2000) have indicated that these sites are likely to have retained much of their integrity (especially pit features) but that integrity is presently being compromised to varying degrees due to wave action and exposure. Based on this, official eligibility determinations have yet to be conducted; however, it is assumed that for purposes of discussion, a fair proportion of sites are eligible for inclusion to the NRHP.

[70] The drawdown zone is approximately the 100-foot upper level of the reservoir, ranging from an elevation of 6085 to 5985 feet.
[71] Additional data are needed to determine eligibility to NRHP.
[72] Archaeologists in the field believe the site was eligible to the NRHP, but a determination was not made by the State Historic Preservation Officer (SHPO).
[73] Archaeologists in the field believe the site was not eligible to the NRHP, but a determination was not made by the SHPO.

No Action Alternative

Impact score: 4,042

The No Action Alternative would result in net impacts similar to those experienced from 1973-1991. A total of 106 known archaeological sites would be impacted in the drawdown zone, which ranges from 6084 feet to 6016 feet in elevation. The hydrology model indicates that water releases under this alternative would not result in levels as low as those identified under the action alternatives. Except in low water years, the typical pool elevations for the No Action Alternative fluctuate roughly between 6080 feet and 6060 feet. The high impact score reflects the relationship between the site density within a relatively narrow fluctuation zone and the number of fluctuations within that range. It may also be reflective of the fact that more archaeological surveys have been conducted in that zone.

250/5000 Alternative (Preferred Alternative)

Impact score: 3,539

The 250/5000 Alternative has a drawdown zone of 6,085 feet to 5,987 feet, and would impact a greater elevation range and a greater number of sites compared to the No Action Alternative. Except in low water years, the typical pool elevations for this alternative would fluctuate roughly between 6080 feet and 6045 feet. As compared to the No Action Alternative, pool elevation would fluctuate more widely, resulting in less wave action within narrow elevation zones. As a result, wave damage is more dispersed among a larger set of archaeological sites; thus, the total impact would be less than that for the No Action Alternative. A total of 132 known sites would be impacted.

500/5000 Alternative

Impact score: 3,846

The drawdown zone for the 500/5000 Alternative is 6085 feet to 5975 feet, which is the largest range of pool elevations of all the alternatives. Except in low water years, the typical pool elevations for this alternative would fluctuate roughly between 6080 feet and 6035 feet. Consequently, this alternative would affect the largest number of sites: 141 sites. The impact index reflects that, although more sites would be exposed under the 500/5000 Alternative, the overall impact would be slightly less than that for the No Action Alternative because less wave action would occur in high site-density areas.

Summary

Both the 250/5000 and 500/5000 Alternatives would slightly reduce impacts of wave action (by 12 percent and 5 percent, respectively) from the No Action Alternative. However, this would be offset by increased total numbers of sites exposed in the drawdown zone that would be subject to vandalism. As a result, all of the alternatives, to varying degrees, would result in adverse impacts to cultural resources. This is not a result of the Preferred Alternative; rather, it is characteristic of dam operation in a high site density environment. For this reason, a programmatic, long-term, response to the general operation of Navajo Dam (regardless of the alternative selected) is proposed rather than specific mitigation measures tied to the proposed action.

It is proposed that a Cultural Resource Management Plan (CRMP) be prepared. Prior to the development of the CRMP, certain baseline data concerning the means necessary to either preserve sites or to mitigate impacts needs to be collected. The initial steps and the provisions of the CRMP are to be developed by Reclamation as a part of its resource management planning efforts[74] rather than a part of the EIS. In brief, the programmatic approach is to include the following steps:

(1) Inventory and Evaluation: Complete an inventory of the entire typical drawdown zone (roughly defined as the 6,040 foot level and above) at the reservoir. This would include: a Site Significance Evaluation, which determines each site's condition and eligibility to the National Register; an Assessment of Threat, which determines any eligible site's nature and immediacy of possible threats from reservoir operation; and a Ranking of Site Value, which assesses site values with other sites identified in the Inventory.

(2) Preservation Assessment: Determine a site-specific treatment approach to decide on the most practical approach to preservation and/or mitigation at a given site.

(3) CRMP Preparation: Develop a plan that will detail the management of historic properties affected by reservoir operations. It will focus on specific sites and the most appropriate treatment measures as a result of steps 1 and 2.

(4) Implement Site Treatment: In this step, the site treatment plans established in the CRMP will be undertaken.

(5) Monitoring: Periodically monitor sites in the drawdown zone (by qualified archaeologists) to ensure that treatment measures are effective.

[74] Reclamation is preparing a Resource Management Plan for Navajo Reservoir that will address cultural and other resources.

Under NAGPRA, Reclamation is consulting with culturally affiliated Native American Tribes. A cultural affiliation determination is in progress. Native American consultations have included concerns with access to sacred sites defined under Executive Order 13007. These consultations are ongoing.

FLOOD CONTROL

This section addresses the potential impacts to flood control that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect flood control along the San Juan River?

Overview

Scope

The flood control analysis includes the flood plain of the San Juan River downstream from Navajo Dam.

Summary of Impacts

No Action Alternative: No adverse impacts to the downstream flood plain are predicted.

250/5000 and the 500/5000 Alternatives: The operation of the reservoir would include higher spring releases (5,000 cfs). These action alternatives have the potential to increase flooding downstream during spring releases, if high precipitation events occur concurrent with peak releases from Navajo Dam. As a result, adjustments to keep flows within channel capacity would be more difficult.

Impact Indicators

The approved safe channel capacity below the dam to the Animal River confluence in Farmington, New Mexico, is 16,000 cfs as described in the Report on Reservoir Regulation. However, the Corps has determined and advised Reclamation that the current channel capacity for this reach is

5,000 cfs and intends to gain approval of the draft Water Control Manual (WCM) upon completion of the EIS. Flows above the safe channel capacity would be considered an adverse impact.

Affected Environment

Flood control is an authorized purpose of the Navajo Unit, and the reservoir is currently operated to reduce flooding.

The Corps has flood control authority downstream of the dam and developed a draft WCM for Navajo Dam (1992) that limits flows to 5,000 cfs below the dam, to reflect current river channel conditions. Upon completion of the Navajo Reservoir Operations EIS, the Corps intends to gain approval of the draft WCM. The draft manual provides flood control guidance by limiting rates of water flow in specified sections of the San Juan River. It also designates reservoir water levels before and during the spring runoff in high water years. Before 1991, the dam was operated to stabilize river flows by reducing spring high flows and increasing summer, fall, and winter low flows.

By letter dated December 5, 2001, the Corps notified Reclamation of its determination that the current safe channel capacity for the San Juan River from Navajo Dam to the Animas River confluence at Farmington is 5,000 cfs.

Methodology

Existing data were used to assess impacts on flood control associated with each alternative and to determine whether alternative Navajo Dam operations would result in flows exceeding safe channel capacity.

Both Corps and Reclamation procedures were used in this analysis. Reclamation's procedures included review of its annual operating plan for the dam. This operating plan was modified to fall within the Corps' operating guidelines. Hydrologic modeling was used to assess anticipated changes to the riverflows and reservoir water levels.

Impacts Analysis

No Action Alternative

No adverse impacts to the downstream flood plain are predicted under the No Action Alternative. It should be noted that under certain hydrologic conditions Navajo Reservoir will spill, and flows above 5,000 cfs will occur. These flows will be above the safe river channel capacity.

250/5000 Alternative (Preferred Alternative)

Under the 250/5000 Alternative, the operation of the reservoir would include higher spring releases (5,000 cfs) and lower summer, fall, and winter releases. This action has the potential to increase flooding downstream during spring releases, if high precipitation events occur concurrent with peak releases from the dam. As a result, adjustments to keep flows within channel capacity would be more difficult. Under this alternative, fall spike releases for flood control would require careful coordination, timing, and planning among the Corps, Reclamation, the National Weather Service, and local entities or groups to avoid possibly causing flooding or other impacts from the dam releases.

500/5000 Alternative

Under the 500/5000 Alternative, impacts similar to those of the 250/5000 Alternative would occur.

NAVAJO DAM OPERATIONS AND MAINTENANCE

This section addresses the potential impacts to O&M that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect O&M activities at Navajo Dam?

Overview

Scope

The scope includes reservoir levels and proposed changes in operations at Navajo Dam and Reservoir.

Summary of Impacts

No Action, 250/5000, and 500/5000 Alternatives: Would have minimal impact on O&M.

Impact Indicators

Impacts could be considered adverse if predicted reservoir levels and releases exceeded the design capability of Navajo Dam.

Affected Environment

Current O&M activities at Navajo Dam are performed in accordance with the dam's standing operating procedures. The dam's designed capability is not exceeded under present operations.

Methodology

All impacts were evaluated using the following criteria:

- Interviewing the reservoir superintendent, Reclamation O&M staff, and emergency, local, State, and Federal water officials.
- Examining the hydrologic modeling results for reservoir water surface elevations and releases under the alternatives considered and comparing them to historical reservoir records.

Impacts Analysis

No Action Alternative

Analysis of hydrologic studies for the No Action Alternative showed the predicted reservoir levels were within historic fluctuations and flow releases would be well within the designed capability of the dam. Accordingly, there would be no adverse impacts to O&M activities.

O&M activities and practices at Navajo Dam are not expected to deviate from those currently performed at the dam. In addition, no impacts to dam O&M personnel staffing levels are anticipated.

250/5000 Alternative (Preferred Alternative)

Impacts under the 250/5000 Alternative would be similar to those of the No Action Alternative; however, some additional measures would need to be taken, as compared to the No Action Alternative:

- Increased observations would be conducted by O&M staff to assure operations are consistent with the Flow Recommendations. Flow criteria and flow status would also be considered in annual operating plan discussions. This measure is currently being implemented.
- Increased coordination would take place with O&M staff, various water users, and governmental agencies when periods of high tributary inflows occur simultaneously with high releases from the dam. This measure is currently being implemented.
- Installation of additional weather monitoring equipment may be needed to administer releases.

500/5000 Alternative

Impacts under this alternative would be similar to those under the 250/5000 Alternative.

Safety of Dams

This section addresses the potential impacts to safety of dams that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect the safety of Navajo Dam?

Overview

Scope

The scope includes Navajo Dam and downstream to the confluence of the Animas River.

Summary of Impacts

No Action, 250/5000, and 500/5000 Alternatives: Erosion of the upstream face of Navajo Dam may occur if areas without riprap are exposed due to excessive drawdown. This would likely occur under the 500/5000 Alternative but could also occur under the 250/5000 Alternative under conditions of extreme drought.

Impact Indicators

Impacts could be considered adverse if predicted reservoir levels and releases exceeded the design capability of Navajo Dam.

Affected Environment

Safety of Dams O&M activities are performed under general Reclamation policies and procedures.

A 1999 Risk Analysis resulted in this facility being classified as a high hazard dam (i.e., potential loss of human life).

A major recommendation from the risk analysis was the installation of an Early Warning System at the dam. This system would notify emergency personnel of potential safety problems. Because of the warning system, the loss-of-life potential has been reduced.

Methodology

Impacts were evaluated by:

- ❑ Interviewing the reservoir superintendent, Reclamation O&M staff, and emergency, local, State, and Federal water officials.
- ❑ Examining the hydrologic modeling results for reservoir water surface elevations and releases under the alternatives considered and comparing them to historical reservoir records.

Impacts Analysis

No Action Alternative

Analysis of the hydrologic modeling results indicated that historic reservoir level fluctuations and dam releases under the No Action Alternative would be well within the designed capability of the dam. Consequently, there would be no adverse impacts to dam safety.

250/5000 Alternative (Preferred Alternative)

Under the 250/5000 Alternative, no adverse impacts are anticipated because the dam's designed capability is not exceeded. Erosion of the dam face described below could occur but would be less likely than under the 500/5000 Alternative.

500/5000 Alternative

Under the 500/5000 Alternative, no adverse impacts are anticipated because the dam's designed capability is not exceeded. Water levels may fall below riprap levels, leading to erosion of dam embankment. This occurred in 1 of 65 years modeled.

HAZARDOUS MATERIALS

This section addresses the potential impacts to hazardous material sites that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect hazardous material sites?

Overview

Scope

The hazardous material sites in this analysis include oil and gas pipelines crossing the San Juan River, gas wells, sewage treatment facilities, and a Shiprock, New Mexico, radioactive material waste site adjacent to the San Juan River. The scope includes risks of flooding or other damage to sewage treatment facilities. It does not include impacts on stream water quality or associated wastewater discharge permits resulting from stream water quality standards for the San Juan River that are considered in the "Water Quality" section in this chapter.

Summary of Impacts

No Action Alternative: No impacts are projected on pipeline crossings, gas wells, sewage treatment facilities, or radioactive waste.

250/5000 Alternative: Impacts to pipeline crossings, gas wells, and sewage treatment facilities are not anticipated.

500/5000 Alternative: The impacts on pipeline crossings, gas wells, sewage treatment facilities and radioactive waste would be similar to those of the 250/5000 Alternative analysis.

Impact Indicators

Impacts were considered adverse if implementation of the No Action or action alternatives disturbed hazardous materials that would result in a health risk to the public or environment.

Affected Environment

The hazardous materials of most concern are petroleum products which are transported in pipelines under the river. Petroleum pipeline river crossings from Navajo Dam to the Hogback area upstream (east) of Shiprock are predominantly compressed natural gas (CNG) lines with a few liquified petroleum gas (LPG) lines. If pipeline exposure/ erosion occurred and the line was damaged, the CNG would be an airborne hazard, while the LPG would become a waterborne petroleum contamination hazard.

Another river crossing pipeline in the Hogback area carries crude oil from oilfields in Aneth and Bluff, Utah, and if damaged could present a serious downstream contaminant concern.

Other areas of concern include scattered gas wells in the riparian area from Navajo Dam to Shiprock and municipal sewage treatment facilities which may present a biohazard contamination to the river. In addition, there is a radioactive material waste site (Shiprock Uranium Mill Tailings Remedial Action [UMTRA] Project Site) located southeast of Shiprock on an elevated terrace about 50 feet above the San Juan River.

Methodology

Pipeline river crossing information was obtained from pipeline owners. In addition, city and county governments adjacent to the San Juan River were contacted to develop information on wastewater treatment facilities.

Information on the Shiprock radioactive material waste site was obtained from the ALP Project FSEIS (Reclamation 2000a).

Impacts Analysis

No Action Alternative

No impacts are projected under the No Action Alternative for pipeline crossings, gas wells, sewage treatment facilities, or radioactive waste because reservoir releases would be within the historic range.

250/5000 Alternative (Preferred Alternative)

Petroleum Facilities.—Flow releases from Navajo Dam would not impact gas well sites and pipelines within and adjacent to the river's flood plain. Pipeline owners that were contacted generally were confident that their river crossings have adequate protective depth and cover as they pass under the river and adjacent riparian areas.

Sewage Treatment Facilities.—Municipalities were contacted along the San Juan River regarding river flows' impacts to their sewage treatment facilities. The incorporated municipalities of Bloomfield, Farmington, and Shiprock noted that the integrity of their facilities has generally been unaffected by river flows since the construction of Navajo Dam, including the 5,000 cfs springtime peak releases from the dam made since 1991; therefore, implementation of the 250/5000 Alternative should have no effect.

Other unincorporated communities such as Blanco, Kirtland, Fruitland, and Waterflow, New Mexico, do not have established treatment facilities, but use individual treatment systems. No problems were noted during the Summer Low Flow Test and past springtime high flows. Hence, no adverse impacts are expected.

No sewage treatment facilities in Colorado near the San Juan River would be jeopardized. Unincorporated Utah communities such as Aneth, Montezuma Creek, Bluff, and Mexican Hat are near the San Juan River. Bluff uses individual treatment systems, and the other three communities use lagoons. The lagoon system at Montezuma Creek is located within approximately 50 yards of the San Juan River. The systems at Aneth and Mexican Hat would not be jeopardized by high river flows (San Juan County , Utah, personal communication, 1999).

Radioactive Waste.—A problem might exist at minimum flows with the contaminated groundwater in the Shiprock UMTRA Project Site area. Prolonged low flows could have the effect of concentrating, rather than diluting, contaminated ground-water interface inflows. The site, however, is downstream from the Animas River confluence in the river reach where the goal is to maintain flows above 500 cfs at all times. Thus, significant low flows would be reduced in the area compared to the No Action Alternative. Under current Department of Energy monitoring activities, any concentration changes would be identified.

500/5000 Alternative

The impacts under the 500/5000 Alternative on pipeline crossings, gas wells, sewage treatment facilities and radioactive waste are similar to those of the 250/5000 Alternative analysis.

SOILS

This section addresses the potential impacts to soils that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect soils?

Overview

Scope

This scope includes soils and erosion characteristics at Navajo Reservoir and along the San Juan River and its major tributaries below Navajo Dam.

Summary of Impacts

No Action Alternative: Few, if any, impacts would occur.

250/5000 and 500/5000 Alternatives: Short-term impacts would include, but would not be limited to, bank erosion along the San Juan River, increased shoreline erosion along the reservoir edge, small landslides along the reservoir edge from saturated conditions, and increased dust concentrations in large, exposed areas around the reservoir. However, long-term impacts to river bank erosion would not be substantial due to bank stabilization.

Impact Indicators

The following impact indicators were applied because of the value of avoiding displacement or degradation of soil resources. Potential soil impacts were considered adverse if they would result in:

- ❑ Soil stability hazards
- ❑ Substantial soil losses due to wind and water erosion

Affected Environment

Soil Types

Soils in the San Juan River valley are derived from alluvial material deposited by the San Juan River and from weathering products of local geologic formations deposited in alluvial fans from side streams. Soil materials typically include sandstone, shale, siltstone, and mudstone fragments. They typically are alkaline, vary in texture from clays to sands, and are poorly stratified. Soils range from poorly to well drained and from moderately rapid to moderately slow permeability (Blanchard et al., 1993). Soils found along the river usually have a higher cobble and gravel percentage, and range from lean clay to silty gravel in composition, with the majority being silty sand. Descriptions of soils found along the San Juan River from the dam to the Hogback area are summarized in table III-23.

Banks along the San Juan River generally consist of a fine-grain soil layer overlying a gravel and cobble layer. The fine-grain soil is usually deposited as overbank deposition during floods and is classified as lean clay, silt, or silty sand. The gravel layer indicates a river channel deposit and generally consists of a silty gravel with some cobbles. Flooding can deposit a series of fine sand and gravel lenses throughout the valley bottom. Terraces developed from older river elevations can be seen along the valley and are generally composed of silty gravel with cobbles. Bedrock along the river is generally shallow (within 20 to 30 feet of the river channel bottom).

Erosion

Bank erosion commonly occurs on the outside edge of meander bends along the river, where banks are exposed to the force of the river during high flows. Banks between the meander bends are generally less steep and more vegetated. Vegetation can play a key role in preventing erosion, with dense root masses holding soil together and preventing bank erosion.

Table III-23.—Properties of soil map units potentially affected by project implementation[1]

Map unit Name	Slopes, depth percent/ inches	Topographic position	Surface layer texture	Subsoil textures	Permeability	Available water capacity	Runoff or erosion hazard	Main uses
Alamosa loam	0-2% 60+	Valley floors, fans, bottom lands	Clay loam	Sandy and silty clay loams	Moderately slow	High	Slow to slight	Irrigated hay, pasture, rangeland
Archuleta-Sanchez complex[2]	12-65% 10-20	Hills, ridges, mountainsides	Organic matter and loam; clay loam and stony clay loam; sandy loam	Clay loam and very stony sandy clay loam	Moderate to moderately slow	Low to very low	Rapid to moderate	Wildlife habitat, livestock grazing, woodland, homesites
Horsethief-Uinta Rock Outcrop	5-65% 50+	Cuestas, hogbacks, mountainsides	Very stony clay loam	Extremely stony clay loam	Moderate	Low-moderate	Medium to moderate	Rangeland and wildlife habitat
Big Blue clay loam	0-6% 60+	Low terraces and valley bottoms	Clay loam	Silty clay	Slow	High	Slow to slight	Irrigated pasture and rangeland
Lazear-Rock Outcrop Complex	12-65% Shallow	Edges of mesas and breaks	Very stony loam	Loam	Moderate	Very low	Medium to moderate	Rangeland and wildlife habitat
Mikim loam	3-12% 60+	Alluvial fans and foothill valleys	Loam or sandy loam	Loam	Moderate	High	Medium to high	Irrigated field crops, pasture, unirrigated crops and rangeland
Plome fine sandy loam	3-12% 60+	Mountainsides and mesas	Organic matter and fine sandy loam	Clay loam	Moderate	High	Medium to moderate	Irrigated and unirrigated crops, woodland and rangeland
Sili clay loam	3-6% 60+	Upland valley bottoms and fans	Clay loam	Clay loam	Moderately slow	High	Medium to moderate	Irrigated cultivated crops and pasture
Vosberg fine sandy loam	3-8% 60+	Swales and upland foot slopes	Fine sandy loam	Clay loam and sandy clay loam	Moderate	High	Medium to moderate	Irrigated and unirrigated crops, wildlife habitat and rangeland
Zyme clay loam	3-25% Shallow	Ridges and hills	Clay loam	Clay loam	Slow	Low	Rapid to high	Livestock grazing and wildlife habitat
Zyme Rock Outcrop Complex	12-65% Shallow	Ridges and Hills	Clay loam	Clay loam	Slow	Low	Rapid to high	Livestock grazing and wildlife habitat

[1] From soil reports and maps of San Juan and La Plata Counties prepared by the NCRS.
[2] A complex is a map unit where both soils are of roughly equal dominance.

Some bank erosion occurs from Navajo Dam downstream to Blanco, New Mexico, but the river channel is generally entrenched and has dense vegetation along the bank to protect it in this reach.

A few side tributaries add fine sediment to the river during storms which cause increased bank erosion, but, in general, the river channel is in good shape. The river channel generally consists of gravel and cobbles with some fine sand.

Downstream of Blanco, New Mexico, several large tributaries add large amounts of fine sediment to the San Juan River. The largest tributary is Canyon Largo, which can add a significant amount of fine sediment into the river during thunderstorms. When fine sediment builds up in the river channel, the depth of the river decreases, causing the river to widen, which, in turn, increases bank erosion. From Canyon Largo downstream, the character of the San Juan River starts to change as it begins to meander and widen, with sand bars and islands occurring in the channel and increased erosion on the banks. The river channel becomes sandy with less gravel and cobbles exposed. Vegetation along the banks is less dense in some places, which increases the erosion potential for the area. Landowners are armoring the banks of the river with cobble riprap and other material to protect their property at higher flows. Below the confluence of the Animas River, bank erosion is less severe and the San Juan River is more stable.

Methodology

All short- or long-term, direct or indirect, or cumulative impacts were evaluated by:

- ❑ Researching the existing soil conditions from Federal and State agencies, web sites, and publications. A list of possible impacts was developed based on the information obtained from the research. The impacts included landslides, bank erosion along the San Juan River, shoreline erosion around the reservoir, and dust concentrations in exposed areas along the reservoir edge.

- ❑ Examining the hydrologic modeling results for reservoir water surface elevations and dam releases under the No Action and action alternatives and comparing them to historic reservoir water level fluctuations and releases.

- ❑ Conducting a survey by boat of most of the reservoir edge/rim. Erosion conditions, bedrock exposure, landslides, and other factors were noted. Photographs were taken for general conditions along the reservoir edge.

- Using a bank survey of the San Juan River which was conducted during the springtime peak release (5,000 cfs) in June 2001 and the low base flow release (250 cfs) during the Summer Low Flow Test in July 2001. Photographs and notes were taken of bank erosion and the general condition of the river during these times.

Impacts Analysis

Soil displacement from the operation of Navajo Reservoir under the No Action and action alternatives would occur through either water- or wind-caused erosion. Soil resources are valuable because of the variety of vegetation land uses they support; eroded soils can subsequently lead to secondary water and/or air pollution. Large soil disturbances—landslides—can expose hazards, while bank erosion along the river can cause loss of property or water quality degradation.

No Action Alternative

Under the No Action Alternative, few, if any, soil impacts would occur. Historical operation of the reservoir has resulted in a relatively stable reservoir level with little soil erosion around the reservoir edge. Downstream releases have been controlled to the extent that bank erosion has been low, vegetation has encroached on the river, and the river has become relatively stable.

The New Mexico Environment Department in its draft 2002 Section 305 (b) report has listed the San Juan River segment from Navajo Dam to Canyon Largo as "not supported" in its designated uses due to turbidity and bottom sediments. Streambank modification or destabilization is listed as a possible cause for this, as are resource extraction, vegetation removal, grazing, petroleum activities, and agriculture. River segments from the confluence of the Animas River to Canyon Largo and from the Chaco River confluence to the Animas River confluence are listed for bottom sediments, possibly caused by streambank modification or destabilization, resource extraction, vegetation removal, grazing, petroleum, and agriculture.

In the reaches of critical habitat for endangered fish species between Farmington and Lake Powell, soil erosion from the contributing drainage area adds sediments to the San Juan River during summer and fall thunderstorms, and this sediment creates extremely turbid flow conditions and results in large amounts of sediment being deposited in the river channel. Under the No Action Alternative, peak releases from Navajo Dam may not be sufficient to scour and transport this sediment down the river, in which case sedimentation of the river bottom may continue to provide habitats that are not conducive to spawning and rearing of endangered fish.

250/5000 Alternative (Preferred Alternative)

Under the 250/5000 Alternative, shoreline erosion around the reservoir would increase due to greater drawdowns. This alternative would cause adverse short-term impacts to river bank erosion and possible property loss downstream of Navajo Dam. During the high (5,000 cfs) flow tests in 1998 and 2000, bank erosion concerns were identified in numerous places (at least 20 sites) from the dam to Kirtland, New Mexico. Under this alternative, short-term impacts would occur from bank erosion in this stretch until the river stabilized itself or property owners stabilized the banks using best management techniques (berms, riprap, rock vanes, vegetation, and others). Associated costs would be borne by the land-owners. Long-term impacts from bank erosion would likely not be adverse due to stabilization of the banks.

In the reaches of critical habitat for endangered fish species between Farmington and Lake Powell, soil erosion from the contributing drainage area adds sediments, as discussed above. Under the 250/5000 Alternative, peak releases from Navajo Dam are anticipated to be sufficient to scour and transport this sediment down the river, in which case sedimentation of the river bottom would not occur and habitat conditions would be conducive to spawning and rearing of endangered fish. This alternative effectively manages the tributary sediment loads into the river.

500/5000 Alternative

Bank erosion at the reservoir could be greatest under the 500/5000 Alternative due to reservoir drawdown. This alternative would cause impacts to soils similar to those of the 250/5000 Alternative.

GEOLOGY

This section addresses the potential impacts to geology that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect geology?

Overview

Scope

The scope includes the San Juan River valley, in the San Juan structural Basin, and the Colorado Plateau.

Summary of Impacts

No Action, 250/5000, and 500/5000 Alternatives: No impacts to geologic resources are projected to occur.

Impact Indicators

The following indicators were used to evaluate the potential impacts to geologic resources. An impact would be considered adverse if one of the following were to occur as a result of changes in reservoir operation:

- Reservoir-induced seismicity resulting in dangerous conditions around the reservoir or damage to facilities
- An increase in erosion and sedimentation around the perimeter of the reservoir which affected operation of the dam or caused damage to equipment
- Catastrophic landslide damage to facilities around the reservoir, or catastrophic endangerment to human life
- The potential to restrict recovery of mineral resources

Affected Environment

Navajo Dam and Reservoir are located within the San Juan structural basin, which occupies approximately 7,700 square miles in the eastern part of the Colorado Plateau of northern New Mexico and southern Colorado. Bedrock around Navajo Reservoir consists of nearly horizontal beds of sandstone, shale, and siltstone of the San Jose Formation (formerly named the Wasatch Formation), which has a maximum thickness of about 2,000 feet at the center of the Basin. The closest zone of seismicity to Navajo Dam and Reservoir is found approximately 40 to 60 miles to the east.

The San Juan River area includes the broad, terraced San Juan River valley, which is characterized by unconsolidated clay, silt, sand, and gravel, and terrace gravel and cobble deposits. The clay, silt, sand, and gravel deposits probably do not exceed 100 feet in thickness and the terrace deposits generally do not exceed 30 feet in thickness (Blanchard et al., 1993). The bedrock encountered along the river includes sedimentary strata composed of interbedded sandstone, siltstone, mudstone, and shale from varying formations (table III-24).

Table III-24.— Varying formations along the San Juan River

<table>
<tr><th>System</th><th>Series</th><th>Formation</th><th>Features</th></tr>
<tr><td rowspan="2">Tertiary</td><td>Eocene</td><td>San Jose Formation</td><td>Navajo Reservoir, San Juan River</td></tr>
<tr><td>Paleocene</td><td>Nacimiento Formation</td><td>San Juan River, Bloomfield</td></tr>
<tr><td rowspan="8">Cretaceous</td><td rowspan="8">Upper Cretaceous</td><td>Ojo Alamo Sandstone</td><td>San Juan River</td></tr>
<tr><td>Kirtland Formation</td><td>San Juan River, Farmington</td></tr>
<tr><td>Lewis Shale</td><td>San Juan River</td></tr>
<tr><td>Cliff House Sandstone</td><td>San Juan River</td></tr>
<tr><td>Menefee Formation</td><td>San Juan River</td></tr>
<tr><td>Picture Cliffs Sandstone</td><td>San Juan River</td></tr>
<tr><td>Mancos Shale</td><td>San Juan River, Shiprock</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Jurassic</td><td rowspan="4"></td><td rowspan="4">Many different formations</td><td rowspan="3">San Juan River</td></tr>
<tr><td>Triassic</td></tr>
<tr><td>Permian</td></tr>
<tr><td>Pennsylvanian</td><td>San Juan River
Lake Powell</td></tr>
</table>

Methodology

- ❑ Researching the existing geologic conditions from Federal and State agencies, web sites, and publications (including landslide survey records). A list of possible impacts was developed from the information obtained. The possible impacts include landslides, shore erosion, reservoir-induced seismicity, and mineral resource recovery.

- ❑ Examining the hydrologic modeling results for reservoir water surface elevations and dam releases under each alternative and comparing them to historic reservoir water level fluctuations and releases.

- ❑ Conducting a survey by boat of most of the reservoir edge/rim. Erosion conditions, bedrock exposure, landslides, and other features, were noted. Photographs were taken for general conditions along the reservoir edge.

Impacts Analysis

No Action Alternative

No impacts are projected under the No Action Alternative. Any geologic resource impacts from the operation of the reservoir would fall within historic parameters. As a result, there would be no anticipated increase in erosion, sedimentation, landslide activity or potential restriction of mineral resource recovery. In addition, no active surface faults have been found within a relevant distance of the dam, so reservoir-induced seismicity is not expected to be a problem.

250/5000 Alternative (Preferred Alternative)

Impacts under the 250/5000 Alternative would be similar to those under the No Action Alternative.

500/5000 Alternative

Impacts under the 500/5000 Alternative would similar to those under the No Action Alternative.

AIR QUALITY

This section addresses the potential impacts to air quality that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect air quality?

Overview

Scope

This analysis centers on air quality in the Navajo Reservoir area.

Summary of Impacts

No Action, 250/5000, and 500/5000 Alternatives: No adverse impacts, short- or long-term, would occur to air quality.

Impact Indicators

An air quality impact would be considered adverse if one of the following were to occur as a result of changes in operation of the reservoir:

- ❑ Short- or long-term violation of any National or State ambient air quality standards
- ❑ Interference with any local air quality management planning efforts to attain and maintain air quality standards

Affected Environment

Navajo Reservoir lies within the Four Corners Interstate Air Quality Control Region with the closest ambient air monitoring sites located in Farmington, New Mexico and Ignacio, Colorado.[75] Based on data from these stations, the area north and west of Navajo Reservoir is currently designated in attainment (within acceptable limits) for all pollutant criteria. It is assumed that the Navajo Reservoir area is also in attainment for all pollutant criteria based on its being further away from industrial sites and power plants in the Four Corners area

[75] Air emissions are regulated under the Federal Clean Air Act (CAA), enacted to protect and enhance the quality of the nation's air resources. The CAA provides National Ambient Air Quality Standards (NAAQS) and New Source Performance Standards (NSPS), a permitting process to prevent adverse deterioration of air quality, visibility limitations for national parks and wilderness areas, and limits on emissions of hazardous substances. The EPA has established NAAQS for several pollutants, including carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone(O_3), lead (Pb), and particulate matter smaller than 10 microns in diameter (PM_{10}) (Title 40, Code of Federal Regulations [CFR], Part 50).

than are the monitoring sites. Most of the criteria pollutants are associated with power plants, factories, refineries, and other major sources that do not occur around Navajo Reservoir.

The major air pollutant at Navajo Reservoir is particle matter in the form of windblown fugitive (transitory) dust. Under normal conditions, blowing dust in the area depends greatly on wind speed and moisture content of the soil. Site visits indicate local dust sources are the exposed, drying lake bed at the reservoir's edge, vehicles driving on roads to oil/gas pads, recreational vehicles driving on dirt roads, and wind blowing over barren areas. Wind-blown dust can also come from far away, depending on regional weather conditions.

Some of the existing air quality impacts in the Navajo Reservoir area are from recreational ground and water vehicles, and depend on the location of recreation facilities and recreation management rather than on reservoir water level fluctuations.

Very little open area to produce fugitive dust exists around the reservoir; approximately 8 percent of the area is sandstone and shale slope, either barren or with a thin herbaceous cover, while 73 percent of the area is pinon-juniper woodland and sagebrush (Reclamation, 1999b). A large drawdown area of several thousand acres along the northern part of the reservoir has been exposed in past reservoir operations.

Methodology

Impacts were evaluated by the following measures:

- ❑ Local existing air quality material from various Federal and State agencies, web sites, and publications was examined. A list was developed from the information obtained. The impacts included fugitive dust from different sources (ground, roads, reservoir edge), vehicle or recreation exhaust and traffic patterns, and any nearby industrial sources;

- ❑ The hydrologic modeling results for reservoir water surface elevations and dam releases under each alternative were examined and compared to historic reservoir records. All model results showed the predicted reservoir water levels and dam releases were within historical range.

- ❑ The expected impacts on local and regional air quality were evaluated against Federal and local requirements for protecting public health (table III-25).

Table III-25.—Criteria pollutants and regulatory limits

Pollutant	Period	National[1]	New Mexico[2]	Colorado[3]
PM_{10}	24-hr average	[4]150 μg/m³	150 μg/m³	150 μg/m³
	annual	50 μg/m³	60 μg/m³	50 μg/m³
[4]$PM_{2.5}$	24-hr average	65 μg/m³	—	—
	annual	15 μg/m³	—	—
Sulfur dioxide	3-hr average	0.5 ppm	—	700 μg/m³
	24-hr average	0.14 ppm	0.10 ppm	—
	annual	0.03 ppm	0.02 ppm	—
Carbon monoxide	1-hr average	35 ppm	13.1 ppm	40 mg/m³
	8-hr average	9 ppm	8.7 ppm	10 mg/m³
Nitrogen dioxide	annual	0.053 ppm	0.05 ppm	100 μg/m³
Ozone	1-hr average	0.12 ppm	—	235 μg/m³
	8-hr average	0.08 ppm	—	—
Lead	annual	1.5 μg/m³	—	—

[1] Source: 40 CFR sections 50.4 through 50.12 (1999).
[2] Source: New Mexico Ambient Air Quality Standards 20 NMAC 2.03 (1996).
[3] Source: Colorado Ambient Air Quality Standards, Colorado Air Quality Control Commission (2000)
[4] The new $PM_{2.5}$ (particulate matter) standards have not been implemented.

Impacts Analysis

No Action

Hydrologic analysis predicts that reservoir water surface levels would be within the range of water levels experienced historically, and dust generated by changes in the reservoir level should be within historical parameters. Oil and gas exploration is expected to continue around the reservoir, and vehicles driving to service the pads and wells will continue to cause small, localized fugitive dust. Recreational use around the reservoir will continue as is and probably increase over time, with some intermittent and periodic increases in fugitive dust associated with the construction of new recreational facilities. Overall, no adverse impact on air quality is predicted.

250/5000 Alternative (Preferred Alternative)

Impacts on air quality under the 250/5000 Alternative would be slightly greater than under the No Action Alternative because lower average reservoir elevations would expose more soil to wind erosion.

500/5000 Alternative

Impacts on air quality under the 500/5000 Alternative would be greater than those under the No Action and 250/5000 Alternatives since reservoir elevations are lowest under this alternative.

NOISE

This section addresses the potential impacts to noise levels that could result from actions associated with the modified operations of Navajo Dam and Reservoir under the alternatives considered.

Issue: How would the No Action and action alternatives affect noise levels?

Overview

Scope

The analysis of noise encompasses Navajo Reservoir and the San Juan River and related formal and informal recreation sites.

Summary of Impacts

No Action, 250/5000, and 500/5000 Alternatives: No noise level impacts are projected from recreational use of the reservoir and from releases to meet Flow Recommendations criteria.

Impact Indicators

The indicators used to determine noise impacts centered on whether the following effects would be caused by changes in dam releases as a result of the alternatives:

- ❑ Noise generated that exceeded established ordinances or criteria
- ❑ Substantial increases in noise levels over existing noise levels in noise-sensitive areas
- ❑ Noise that would be disturbing or injurious to wildlife

Affected Environment

In general, the dominant sounds in the project area originate from natural sources— water, wind, and wildlife. Except for developed recreation areas at Arboles, Pine River, and Sims Mesa, the lands adjacent to the reservoir are relatively undeveloped and somewhat remote. Noise levels and patterns at the developed recreation areas and some of the more frequently used informal use areas (such as Colorado Cove, Frances Cove, Arboles Point, Miller Mesa, and Sambrito) are localized and typical of campground/day use recreation areas. The Navajo Reservoir Draft Resource Management Plan (RMP) (Reclamation, 1999b) identified several noise sensitive areas: Pine River and Sims Mesa Recreation Emphasis Areas, San Juan River downstream of the dam, Simon Canyon Recreation Area, Carracas Mesa and Negro Canyon Special Management Areas, and the Reese Canyon Research Natural Area. Beyond these formal and informal recreation areas, the most conspicuous noise producers are power boats and jet skis on the reservoir.

Localized traffic noise is generated from Colorado Highway 151 from Arboles to the upper Piedra Arm. State Highway 511 in New Mexico also generates localized vehicle noise as it enters Reclamation lands northwest of the Pine River Recreation Area and continues south across the dam to parallel the San Juan River. State Highway 511 in New Mexico generates localized vehicle noise along the entire stretch of the San Juan River. While often present, highway noise is obscured by topography and the sound of the river in many locations.

In addition, each day use area along the river has a dirt access road. Noise levels from these roads are localized and generally inconsequential. Traffic on the dirt roads within and near Reclamation lands is typically much lower in volume, lower in speed, and less continuous than traffic on major roadways.

Nonrecreation-related noise sources include the operation of various gas wells. Depending upon their distance from recreation sites, this machinery produces a noticeable background hum. Numerous gas and oil wells surround the reservoir; the noise produced by these wells can be loud and is generally localized, coming principally from generators. Where one or more large compressors are located at a site, the noise generated can be significant and best management plans are used to lower the noise levels. Noise from the wells is regulated by applicable noise specifications from the Federal Energy Regulatory Commission (FERC) and applicable State and county noise and land use regulations.

Methodology

The applicable noise specifications are set by FERC.[76] Since the noise level at oil and gas sites is expected to fluctuate up and down over a 24-hour period, the design criterion is for a maximum A-weighted noise level from the compressor at the nearest receiver of 48.5 dB(A).

The States of Colorado and New Mexico have laws and regulations that protect the public from noise becoming a public nuisance by limiting the amount of noise during the daytime and nighttime. These values range from 55dB(A) for residential areas during the daytime to 45 dB(A) during the nighttime. Commercial, light industrial, and industrial areas have higher values.

For evaluation of effects, a list of existing noise impacts was developed from a literature and web search and is provided in the "Affected Environment" section (above). The hydrologic modeling results for each alternative were compared to historical reservoir records. All model results showed the predicted reservoir levels were within the historical fluctuations. The existing noise impacts were compared to expected impacts and conclusions were drawn about significance.

Impacts Analysis

No Action Alternative

No adverse impacts are projected under the No Action Alternative because noise impacts in the reservoir area would depend more on management of the reservoir recreation facilities and the growth of oil and gas exploration than on dam operations. Recreational use is

[76] Noise levels are measured in decibels (dB), but to account for greater human sensitivity to sound in the midrange, a weighted "A" scale (dB[A]) has been derived. The daytime range is generally from 30 dB(A) to 90 dB(A), with the upper value represented by heavy truck traffic at a distance of 50 feet. In addition, the Federal Highway Administration Noise Abatement Criteria provide an L_{dn} value for outdoor noise, which is the level exceeded only 10 percent of the time in the noisiest hour of the day; 60 dB(A) values are for areas mandated for serenity and quiet and 70 dB(A) in active public use areas. The applicable FERC specification: 7C Filing requirements of an L_{dn}=55 dB(A) at the nearest receiver.

projected to increase, and noise from more visitors, recreational water vehicles, and traffic can be expected. Additional noise will occur from increasing oil and gas exploration wells and compressors. Long-term impacts to noise-sensitive areas have the potential to increase.

250/5000 Alternative (Preferred Alternative)

Impacts under the 250/5000 Alternative would be similar to those under the No Action Alternative.

500/5000 Alternative

Impacts under the 500/5000 Alternative would be similar to those under the No Action Alternative.

IV. Summary and Other Considerations

Introduction

The Council on Environmental Quality regulations for implementing NEPA require the determination of short- and long-term impacts, direct and indirect impacts, irreversible and irretrievable commitments of resources, and unavoidable adverse impacts. The regulations also call for the consideration of the relationship of the proposed action and its impacts to other projects and activities in the area. The relationship can be direct, indirect, or cumulative in nature. Connected actions are those actions which are interrelated with the proposed action; cumulative actions are those actions, which, when viewed with other proposed actions, have cumulatively significant impacts; and related actions are those actions which, when viewed with other proposed actions, have similarities to the proposed action that provide a basis for evaluation together, such as common timing or geography.

Short-term impacts of the proposed action would not be considered adverse; there is no construction associated with the project and short-term impacts are most often related to construction activities. In addition, some flexibility in reservoir releases exists, because water for present or future development is not currently being used. In the long term, flexibility will diminish; in drought years, flexibility may not exist at all.

The action alternatives would result in major long-term changes in release patterns from Navajo Reservoir and associated impacts would be long-term. Thus, changes to resources such as the trout fishery, hydropower, and recreation, discussed previously in this chapter, are considered long-term impacts. These changes are not necessarily irreversible or irretrievable and future efforts or changes in the status of the endangered fish may refine them. Physical or economical constraints, which might occur with a major construction project and that reduce the practicability of reversing a decision or proposed action, are not present on this project. The proposed alternative provides the best opportunity for Indian water supplies to be protected and developed.

It is also possible that administrative, legislative or judicial interventions may be required to fully address the cumulative impacts to Tribal water rights, not just from the more immediate action of re-operating Navajo Dam and Reservoir, but from a variety of activities that have occurred in the Basin over the past 150 years.

Connected or related closely to new operations of Navajo Dam are water developments on the San Juan River or its tributaries. The ALP Project is an example of a connected action; the initial catalyst for considering a change in operation of Navajo Dam was the result of ESA consultation for the ALP Project. As a conservation measure under the ALP Project as now planned, Reclamation has committed to operate Navajo Dam to mimic the natural hydrograph of the San Juan River to benefit endangered fish and their habitat by following the Flow Recommendations (Holden, 1999) and subject to completion of the Navajo Reservoir Operations EIS and Record of Decision. In addition, the completion of NIIP is related to reoperation of Navajo Dam. The reoperation of Navajo Dam provides the basis for ESA compliance for NIIP's and other projects' completion. Impacts of NIIP are cumulative to Navajo Reservoir re-operation, and hydrology studies for this EIS have taken this relationship into account.

The operation of Navajo Dam and Reservoir to mimic the natural hydrograph on the San Juan River is a key element in the strategy to facilitate recovery of endangered fish species while providing the primary mechanism that allows ESA compliance for continued water development. Other elements of the SJRBRIP, such as providing fish passage and endangered fish stocking, are related to the reoperation of Navajo Dam and together are designed to assist in the recovery of the endangered fish.

The cumulative effects of projects such as the ALP Project, completion of NIIP, and other new or existing water uses, such as the Florida, Mancos, and Dolores Projects, have been built into the analysis of impacts in the EIS. Hydrologic analysis for this EIS has taken into account diversions and depletions from these projects, and streamflow and reservoir content changes with reoperation of Navajo reflect these diversions and depletions. Thus, impacts to the trout fishery, irrigation diversions, recreation, hydropower, Indian Trust Assets, and other resources are based on foreseeable cumulative impacts. Table II-1 shows existing and future depletions that have been included in the hydrology analysis.

In addition, the EIS recognizes that additional depletions may occur in the future beyond those shown in table II-1. The proposed plan does not preclude future development of water, including possible future uses of Indian trust water, not listed in the table. The proposed plan is viewed as a key element in recovering endangered fish, which, in turn, can support future water development. Chapter II includes a section that discusses how these projects would be reviewed in terms of compliance with the ESA.

Resources Summary

Short-term impacts would not be considered adverse under the No Action, 250/5000, and 500/5000 Alternatives described in this EIS. The two action alternatives would result in major long-term changes in release patterns from Navajo Dam. These changes are not irreversible or irretrievable and SJRBRIP efforts may refine them. In addition, impacts may be reduced in the short term with the use of flexibility in reservoir releases, because water committed for present or future water development is not currently used.

The action alternatives, particularly the 250/5000 Alternative, would improve habitat conditions to help conserve endangered fish in the San Juan River in conjunction with other activities: fish passageways, nonnative fish control, and fish stocking. The 250/5000 Alternative and other SJRBRIP activities would support ESA clearance to complete water developments for the ALP Project, the NIIP (Blocks 9–11), NGWSP, JANNRWSP, and other unspecified minor depletions. This, in turn, would help meet Federal trust responsibilities to protect, maintain, and develop water uses under water rights reserved by or granted to American Indian Tribes or Tribal Nations.

Operational changes under the 250/5000 Alternative would have adverse impacts on an important trout fishery and associated uses and economic benefits. Other negative impacts would occur to water diversions, water quality, and hydropower production. More natural river flows under the action alternatives would benefit important riparian areas along the San Juan River.

Biodiversity

A change in biodiversity—variety of life forms—associated with the historical San Juan River occurred when Navajo Dam was constructed and placed into operation. The dam and reservoir physically altered the river and the surrounding terrain and modified the pattern of flows downstream. As is typical in connection with dams constructed in the southwest

United States, the San Juan River downstream of the dam became clearer due to sediment retained in the reservoir, and the water became colder, because it is released from a deep pool of water. Species of fish and other aquatic organisms, and those forms of life that existed along the river channel, were all affected to varying degrees. The conditions of the river immediately downstream of the dam became less favorable to the native fish species that live in warmer and turbid waters. The disruption of natural patterns of flow caused changes to the vegetation along the river banks by altering the previously established conditions under which the plants reproduced and were sustained.

In addition to the changes caused to the river by the dam, there were changes to how the lands in the area were used. Irrigation water provided by Navajo Dam enabled agriculture to be practiced on a large scale. That further affected the river and the native species dependent on the river both directly, through flow diversions, and indirectly, through changes in water quality, as a result of the water acquiring salts, pesticides, and fertilizers from the irrigated lands' return flows to the river. Also, over the last century, the river has experienced diversions for human consumption and use at towns and cities, resulting in a variety of return flows to the river, including industrial waste, stormwater runoff, and discharges from sewage treatment plants. Compounding these changes has been the appearance of non-native species of fish and plants, creating competition with native species.

The 250/5000 Alternative (Preferred Alternative) is expected to contribute to stabilizing native biodiversity in the San Juan River downstream of the dam. The Flow Recommendations criteria are intended to provide for restoration of more natural, pre-dam hydrologic and hydraulic conditions in the river downstream from Farmington and by so doing, to conserve the native razorback sucker and Colorado pikeminnow populations. It is expected that other species that are part of native biodiversity would also benefit.