WATER RESOURCES MANAGEMENT PLAN

Curecanti National Recreation Area

National Park Service
United States Department of the Interior

WATER RESOURCES MANAGEMENT PLAN

Curecanti National Recreation Area

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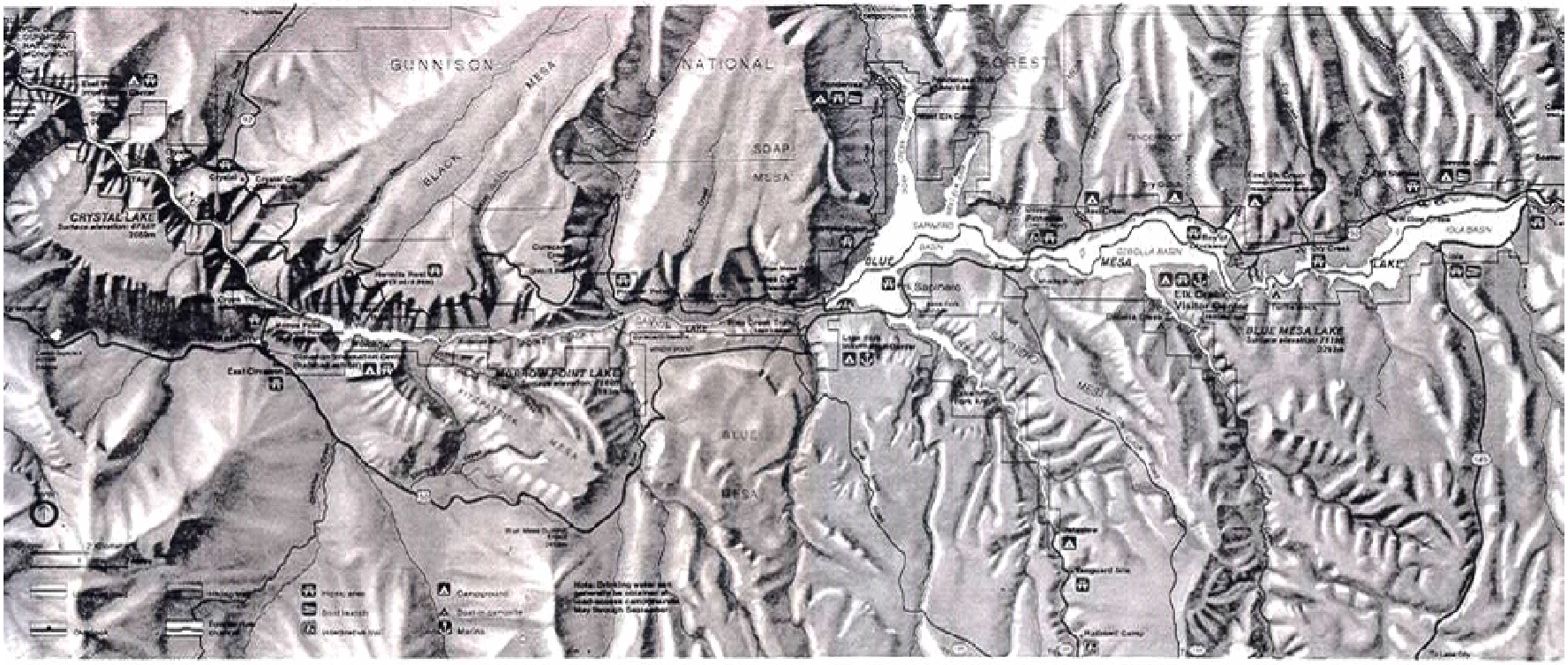
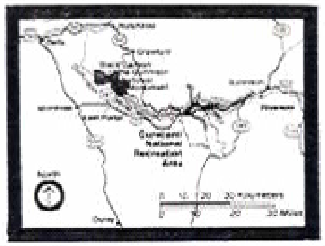
Table of Contents

TABLES

FIGURES



GURE 1



PARK MAP
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1. INTRODUCTION

1.1 Purpose of the Plan

This Water Resources Management Plan describes the water resources of Curecanti National Recreation Area (Curecanti NRA) and the issues affecting them. This plan is a compilation of management actions in the form of project statements, summaries of completed tasks as identified and assigned in NPS (1995b) and the Water Resources Study Plan (Curecanti NRA, 1995), and management alternatives which address watershed-related issues.

Curecanti National Recreation Area encompasses the Aspinall Unit of the Colorado River Storage Project (see Figure 1). Under the authority of Section 8 of the Colorado River Storage Project Act of April 11, 1956, the Secretary of Interior was directed to "investigate, plan, construct, operate, and maintain... public recreational facilities..." The purpose of Curecanti NRA is derived from this legislation and is stated as follows: "To conserve the scenery, the natural, historic, and archeological objects and the wildlife, and to provide for public use and enjoyment of lands withdrawn or acquired and water areas created by the projects by such means as are consistent with their purpose." P.L. 84-485 (70 Stat. 105) Chapter 203.

No enabling legislation has been passed for Curecanti NRA, and thus Curecanti NRA operates under a Memorandum of Agreement (1965) between the National Park Service and the Bureau of Reclamation (BoR) stating that the Service is responsible for administration of lands and waters in the Aspinall Unit area for purposes of providing recreation. The BoR has complete authority over the operation and maintenance of the three reservoirs, Blue Mesa, Morrow Point, and Crystal, including releases made to fulfill project purposes of hydropower, irrigation, and flood control. In light of this Memorandum of Agreement, Curecanti NRA recognizes its need to focus on providing recreational opportunities while insuring preservation of its water and natural resources.

National Park Service policy requires that a unit of the National Park System develop and implement a land and water use management plan called a General Management Plan. In 1995, Black Canyon of the Gunnison National Monument and Curecanti NRA combined administrations. Legislation for Curecanti NRA and Black Canyon of the Gunnison National Monument (Black Canyon of the Gunnison NM) which would enable and change to National Park status, respectively, is pending. These two unit's have jointly developed a General Management Plan to update and replace an earlier 1980 document for Curecanti NRA and a 1983 document for the Black Canyon of the Gunnison NM. This document identifies management actions which guide the park in satisfying public needs for recreation while preserving the area's natural and cultural resources.

National Park Service policy also requires that a unit of the National Park System develop and implement a Natural and Cultural Resources Management Plan (RMP). The present document (NPS, 1995a) replaces a_1984 version, and the new version serves as a strategic planning document in effective management and preservation of park resources including plants, wildlife, water, paleontological and cultural resources.

This Water Resources Management Plan is being developed as an action plan to complement the General Management Plan and the Natural and Cultural Resources Management Plan. It is very similar to the RMP, but focuses on water resources and issues related to water resources. Project statements developed in this plan are integrated into the RMP.

1.2 Recreation Area Purposes
As noted above, Curecanti NRA operates under a 1965 Memorandum of Agreement between the National Park Service and the Bureau of Reclamation for the purpose of providing recreational opportunities at the three reservoirs of the Aspinall Unit. In doing so, Curecanti NRA is also responsible for protecting natural and cultural resources which exist within its boundaries.

1.3 **Significant Resource Values**
Approximately 25% of Curecanti NRA consists of water resources in the form of reservoirs, rivers, streams, and springs. Albeit protection and management for recreational opportunities is the purpose of the park, these water resources are especially important as aquatic habitat and as a means of supporting riparian vegetation that lines the river, stream, and spring courses. Significant riverine habitats for the federally listed Colorado squawfish *(Ptychocheilus lucius),* humpback chub *(Gila cypha),* razorback sucker *(Xyrauchen texanus),* and the bonytail chub *(Gila elegans)* exist immediately downstream of Curecanti NRA and Black Canyon of the Gunnison River National Monument (Black Canyon NM).

The fishery at Curecanti NRA consists of stocked and non-native species including kokanee salmon *(Oncorhynchus nerka),* rainbow trout *(Oncorhynchus mykiss),* brown *(Salmo to tta)* and lake trout *(Salvelinus namaycush).* Also present in Morrow Point Reservoir are stocked cutthroat trout *(Oncorhynchus clarki pleuriticus)* from Trapper's Lake, CO. The tributaries to the reservoirs support rainbow trout *(Oncorhynchus mykiss),* brook trout *(Salvelinus fontinalis),* cutthroat trout *(Oncorhynchus clarla),* and brown trout *(Salmo trutta).* Nongame species found in the reservoir system include western white sucker *(Catostomus commersoni)* and the longnose sucker *(Catostomus catostomus).* Clean water which can support an adequate food base for these fish is absolutely necessary for the continuation of this type of fishery.

Waterfowl and shorebirds abound during spring and fall migration; the exposed mudflats during the fall and spring, and the open water areas provide food for a number of species. The bald eagle *(Haliaeetus leucocephalus)* thrives in the park during the winter, and during the summer great blue herons utilize the open waters of the Gunnison River and Blue Mesa Reservoir for their food resource.

The riparian areas along the drainages that enter the reservoir system can harbor over seven different species of willows, three species of cottonwoods, and numerous other shrubs, forbs, and grasses. Mule deer and elk, an occasional moose, mink, weasels, and numerous other species rely on these riparian areas and the attendant water features for their existence.

1.4 Objectives of Curecanti's Water Resources Management Plan
The following objectives were developed in the April 12 & 13, 1994 water resources scoping meeting designed to identify water resource issues at Curecanti National Recreation Area. Sound management of Curecanti's_ water resources require that the National Park Service:

1) Maintain or restore the natural high quality water in reservoirs and tributaries in order to support park purposes including fish and wildlife habitat, recreation and scientific study.

2) Recognize and anticipate the significance of potential reservoir level changes resulting from flows for endangered fish species, flows for the Black Canyon of the Gunnison Monument, and for hydropower production.

3) Participate in, initiate, and instigate basin discussions and projects that may affect Curecanti NRA's water quality and quantity.

4) Promote, create, restore, and maintain habitat for native fisheries in and outside park boundaries.

5) Insure that park development and operations do not adversely affect park water resources and water dependent environments.

6) Recognize the significance of natural aquatic and riparian resources, identify and preserve wetlands, and manage them in a manner that will preserve their natural functions and integrity.

7) Acquire appropriate information to understand and manage water-related resources.

8) Address water issues related to public health and safety including flood hazards, acceptibility by Federal Drug Administration standards of fish for human consumption, and general water quality.

9) Acquire and maintain water rights for Curecanti NRA such as park headquarters, visitor centers, campgrounds, marinas, etc. in accordance with state law.

1.5 Federal Legislation Influencing Water Resources Management

Legislation and memoranda of agreements or understandings which influence the management of water resources include:

- The National Park Service Organic Act (16 U.S.C. Sec. 1 et seq.) directs the Service to preserve park resources for future generations while allowing for public enjoyment.

- Section 8 of Colorado River Storage Project signed on April 11, 1956 P.L. 84-485 CRSP 1956, 1979 directs the Secretary of the Interior to "investigate, plan, construct, operate, and maintain 1) public recreation facilities...to conserve the scenery, the natural, historic, and archaeological objects, and the wildlife on said lands, and to provide for public use and enjoyment of the same and of the water areas created by these projects".

- Memorandum (February 17, 1958) from the Director of the National Park Service to the Secretary of Interior requesting that a Memorandum of Agreement with respect to funding be developed to expedite implementation of Section 8 of the Colorado River Storage Project.

- A Memorandum of Agreement approved on February 11, 1965 between the Bureau of Reclamation and the National Park Service notes that

  > "the Bureau shall retain complete authority over and responsibility for construction, operation and maintenance of the Blue Mesa, Morrow Point, and Crystal Dams and Reservoirs for primary project purposes together with all engineering works in connection therewith... the Service shall administer all lands and waters within the project area, providing for recreation therein."

The National Historic Preservation Act (16 USC 470 et seq) (1966) acknowledges the importance of the nation's cultural resources. The Park Service "will preserve and foster appreciation of the cultural resources in its custody" (NPS, 1988). To that end, all actions proposed in this water resources plan

will be evaluated for compliance with this and other cultural resource protection mandates prior to initiation of the project.

The National Environmental Policy Act (42 USC 4371 et seq) (NEPA) requires that any major federal action which may significantly affect the environment including the human environment be reviewed via the NEPA process. Any actions proposed within this document will be evaluated with regards to the NEPA process. This may include review of such actions as re-introduction of Colorado native cutthroat *(Oncorhyncus clarki* pleuriticus) and management of the Gunnison River floodplain.

The Federal Water Pollution Control Act (the Clean Water Act 33 U.S.C. 1251, et.seq.) was passed in 1972. Having undergone two major revisions in 1977 and 1987, the Act is up for renewal. The Act had set goals for fishable and swimmable waters by 1983 and no further discharge of pollutants into the nation's waterways by 1985. To an extent, these goals have been attained via two main programs. A major grant program made available funds to construct municipal sewage treatment facilities. A second program limited the amounts of pollutants that could be discharged. The National Pollutant Discharge Elimination System (NPDES), a permit system for point-source dischargers, reflects the programs "effluent limitation" approach. The Environmental Protection Agency has set limits for pollutants that may be released based on available technology and cost of treatment for various industrial categories.

The Act also recognizes state primacy in managing and regulating the nation's water quality. The states implement water quality protection, as promulgated by the Act, through water quality standards. Standards are comprised of classifications which represent designated uses for prescribed stream segments. Uses for the State of Colorado include the following categories: drinking water, fish and wildlife propagation, agriculture, and recreation. Identified standards include physical, chemical, and biological characteristics that when applied to a segment will insure protection of the designated uses on that segment. These standards also serve as the basis for water quality based treatment, and establish goals for enhancement of water quality on specific stream segments. Adequacy of these standards is assessed on a triennial basis by the states. The revised standards are then forwarded to the Environmental Protection Agency for approval.

One of three levels of protection are afforded any particular stream segment. As the absolute foundation, designated uses are protected. Degradation of the water quality cannot extend beyond a level detrimental to the designated use or uses. A second tier of protection is afforded those segments where water quality exceeds that which is needed to support swimming and fishing. Only limited degradation can occur in these waters, and only after an antidegradation review that disallows substantial impacts to water quality. Social and economic aspects of the impacts are considered in evaluating the activity which may impact the stream segments. The last tier of protection calls for no degradation of the stream segment once it has been designated as such. The Outstanding Waters designation in the State of Colorado safeguards the state's highest quality waters.

The Clean Water Act with the 1987 amendments introduced new initiatives with emphasis on nonpoint source pollution control programs, toxics controls, and management of coastal and near-coastal waters. In addition, the Act, in Section 404, protects wetlands as these have been interpreted to be waters of the United States. The Act is complex, and presently faces renewal. With regards to this plan, the Act induces the park to take part in triennial reviews, to continue with monitoring programs, to map wetlands, and encourage maintenance of high quality waters upstream of its boundaries.

The Safe Drinking Water Act (44) CFR parts 141-144) (1974 and Amendments 1986) applies to developed public drinking water supplies. It sets minimum national standards and requires regular testing of drinking water for bacterial contamination, metals, volatile organics, and nitrates. At the bequest of the supplier, some testing can be waived. Individual park units, as deemed by the NPS's Public Health Management Guideline (1993a), must assure "that water supply systems are properly operated and maintained...". At Curecanti NRA, tests for total coliform and residual chlorine where applicable, occur on a schedule developed and required by the State of Colorado for systems serving the public. The park has been able to waive tests for certain organics and has also proved that all drinking water wells do not tap into surface water sources (Greg Walker, Utility Systems Operator, pers. comm. 1994).

The Endangered Species Act (1973) requires that all entities using federal funding must consult the Secretary of Interior on activities that potentially impact endangeredspecies. It requires agencies to protect endangered and threatened species as well as designated critical habitats.
At Curecanti NRA, only a few species associated with water or riparian areas are listed. The bald eagle *(Haliaeetus leucocephalus)* which winters in the Gunnison Basin uses the waters within Curecanti NRA as habitat. Downstream of Curecanti NRA and Black Canyon of the Gunnison NM, four endangered fish fall under the auspices of the Endangered Species Act. The Colorado squawfish *(Ptychocheilus lucius),* humpback chub *(Gila cypha),* razorback sucker *(Xyrauchen texanus),* and the bonytail chub *(Gila elegans)* are the species included in the Recovery Program for the Endangered Fishes of the Upper Colorado. This program as it progresses may impact the operation of the Aspinall Unit; the Biological Opinions for the Dolores and Dallas Creek Projects reserve up to 148,000 acre-feet of water stored in Blue Mesa for the US Fish and Wildlife Service to use to mitigate depletive impacts of those projects. High, medium, and low flow releases have been studied for five years since 1992 to determine extent of habitat, reintroduction possibilities, and impacts to reproduction of the endangered fish species in the Gunnison River. Lastly, one plant species considered a Category 1 (candidate species for formal listing) , *Gilia pensteminoides,* inhabits canyon riparian areas and is known to occur in the lower canyons of Curecanti Creek.

1.6 Executive Orders Influencing Water Resources
Floodplain Management (E.O. 11988)([3CFR 121(Supp 177)] addresses protection and management of floodplains. The objective of this executive order is to "...avoid, to the extent possible long- and short-term adverse impacts associated with the occupancy and modifications of floodplains, and to avoid direct and indirect support of floodplain development whenever there is a practical alternative." In effect, this order directs Curecanti NRA to avoid development in floodplains and to adhere to the Floodplain Management Guidelines (NPS, 1993b). Specifically, upstream of the reservoir system within park boundaries, the Neversink and Cooper Ranch areas offer a vestige of a pre-settlement alluvial flood plain. Management, as directed by both the executive order and the NPS guidelines, necessarily consists of allowing the river to function in a natural manner to the consternation of some county residents. _

The Protection of Wetlands Executive Order (E.O. 11990)[3CFR 121 (Supp 177)] directs federal agencies to "...avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands whenever there is a practical alternative...". This order stipulates that we avoid impacts to wetlands, and_since the issue of this order, Curecanti NRA has strictly adhered to avoiding impacts to natural wetlands, and has complied with the 404 permitting process outlined in the Clean Water Act (1987).

Recreational Fisheries (E.O. 12962) directs the improvement of the quality, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities. Specifically, the Order requires that federal agencies identify recreational fishing opportunities that are limited by water quality and habitat degradation, and to promote restoration of viable, healthy, and, where feasible, self-sustaining recreational fisheries. The intent of the Order requires that the NPS and BoR work cooperatively, and develop partnerships with the Colorado Division of Wildlife to avoid losses of fishery resources, and to restore and enhance these fisheries where practical, and when within the context of the agencies missions and policies. To that end, this document proposes the development of a Fisheries Management Plan (Section 4).

1.7 State Water Resources Legislation

Colorado Water Quality Control Act (5 CCR 1002-8)(CRS 1973, 25-8-1-2(2)) intent is noted in the following:

> It is further declared to be the public policy of this state to conserve state waters and to protect, maintain, and improve the quality thereof for public water supplies, for protection and propagation of wildlife and aquatic life, and for domestic, agricultural, industrial, recreational, and other beneficial uses; to provide that no pollutant be released into any state waters without first receiving the treatment or other corrective action necessary to protect the legitimate and beneficial uses of such waters; to provide for the prevention, abatement, and control of new or existing water pollution; and to cooperate with other states and the federal government in carrying out these objectives.

Discussion of this Act as it pertains to waters within Curecanti NRA is presented via Tables 2-3 which provide classifications, uses and designations for stream segments.

1.8 Local Planning Regulations

Gunnison County Land Use Resolution (1984, Amended 1994) stipulates how development in the county may occur if lands are subdivided. The county has little control over subdivision of lands into sections equal to or greater than 35 acres; however, the Land Use Resolution does offers some control over subdivisions of smaller acreage via noting the probable degree of impact to the environment and socio-economic atmosphere as a result of the subdivision.

Over 45% of Curecanti NRA's boundary abuts private property. Presently, the county is witnessing the development of these adjoining properties in the form of recreational vehicle campgrounds, single-family homes, and other types of subdivisions. New developments seek permits for buildings and individual septic systems. The county and state regulations regarding individual sewage disposal systems affect possible impacts to the waters of Curecanti NRA.

Gunnison County Regulations for Special Development Projects (1990, Amended 1994) stipulate that large projects_ on private lands which may drastically impact the environment and socio-economic climate of the county may fall under near NEPA-like regulation. Any major actions on private property near the park may fall under the auspices of this regulation at the discretion of Gunnison County.

1.9 Identification of Water Resource Issues and Recommendations for a Water Resources Management Plan

Through a scoping process begun in April of 1994, sixteen issues or areas of concern were identified as needing action. The issues are thoroughly discussed in Curecanti National Recreation Area Water

Resource Scoping Report (NPS, 1995b). This management plan provides management actions or discussion of actions taken to deal with these issues and assessment needs as outlined below.

- Development of a cyclical water quality monitoring program for potential threats to reservoirs and tributaries from grazing, mining, logging, and development. The program would also include assessment of impacts from Curecanti NRA's, the concessionaire's, and the BoR's operations. The program will also develop an appropriate means of monitoring the two lower reservoirs, Morrow Point and Crystal for chemical as well as biological features. The program would include measurement of biological, chemical, and physical parameters and be based on the base funding available for the program which exists presently.
- Review of the appropriateness of an Outstanding Waters designation for the three reservoirs.

- Assessment of the reservoirs' abilities to support standing crops of native and/or stocked fish to meet existing angler demands.

- Assessment of the ongoing studies related to the re-operation of the Aspinall Unit. This will include assessment of satisfaction with the BoR's "target level" management plan and its affects on recreational activities on the reservoirs.

- Assessment of visitors' needs regarding launching of boats, success with fishing, boat-in campsite access, and other recreational opportunities as they relate to reservoir levels.

  Coordination of information exchange and for executing solutions to various problems. The park participates in discussions concerning the operation of the Aspinall Unit, serves on the liaison committee of the Upper Colorado National Water Quality Assessment Program (NAWQA) , and has organized a water quality forum for the basin. A hydrologist position at Curecanti NRA would enable the park to continue its participation in the above capacity and to implement and analyze the data from the water quality monitoring program at Curecanti NRA.

- Examination of the contaminant levels in fish in order to examine ecosystem and human health implications, and to promote the introduction of Colorado native cutthroat trout *(Oncorhyncus clarki pleuriticus)* to the area's tributaries.

- Engineering assessment of stormwater and park operations runoff from the maintenance parking lot.
- Management of the Gunnison River floodplain above Blue Mesa Reservoir.

- Wetland delineation for Curecanti NRA at a scale adequate for interpretation and management needs.

- Development of a GIS product that defines landownership and activities, soil erosivity, and geology in an effort to pinpoint significant problem areas.

- Development and implementation of a watershed inventory, incorporating BLM and US Forest Service methodologies, which is utilized to manage erosion and sediment transport, and maintain high water quality.

- Assessment of the park's status in meeting level I, inventory and monitoring requirements, NPS-77.

- Review of flood plain assessments conducted for developed sites at Curecanti NRA, and with the assistance of the WRD, conduct additional floodplain assessments as directed by the outcome of the recent General Management Plan.

- Review of drinking water treatment systems noting the types of treatment systems for individual wells and the Elk Creek source.

- Assessment of Curecanti NRA water rights including a 500 ac-ft use of water from Blue Mesa Reservoir.

2. Description of the Hydrological Environment and Water Related Resources

2.1 **Surface Water**

The Curecanti NRA boundary surrounds but a small part of a much larger watershed including some 5120 square miles. This watershed referred to as the Gunnison Basin includes the Gunnison River, the Uncompaghre River, and the North Fork of the Gunnison River and all their respective tributaries (Figure 2). The watershed (less than 2000 square miles) which impacts Curecanti NRA directly is the Upper Gunnison Basin (Figure 2) and encompasses the Gunnison River drainage and its immediate tributaries.

Table 1. Aspinall Unit Storage Allocations.

	Blue Mesa	Morrow Point	Crystal
Total capacity (ac-ft)	940,700	117,165	25,273
Active capacity (ac-ft)	748,430	42,090	12,928
Inactive capacity (ac-ft)	81,070	74,910	4,645
Dead Storage (ac-ft)	111,232	165	7,700
Surcharge (ac-ft)	0	4,130	5,490
Maximum Elevation (ft) -	7519.40	7,160	6755.00
Maximum Depth (ft)	342	400	X100
Surface Acreage (ac)	9000	800	300

Source: Bureau of Reclamation, AOP notes, April 21, 1994; NPS, General Management Plan, Curecanti NRA, 1980

Curecanti NRA encompasses the Aspinall Unit of the Colorado River Storage Project (CRSP). The Gunnison River, which was dammed beginning in 1965 to create the Blue Mesa Reservoir, is tributary to the Colorado River. The reservoirs,-comprised of Blue Mesa, Morrow Point, and Crystal, store approximately 1,084,146 acre feet. Blue Mesa is the largest reservoir with some 941,000 acre feet of water and a surface acreage of approximately 9000 acres; Morrow Point surface acreage totals approximately 800 and Crystal Reservoir 300 acres (NPS, 1980). Table 1 provides information on individual reservoir surface acreage and storage capabilities.
The Elk Creek Visitor Center is located 16 miles west of the town of Gunnison, and the park extends some 50 miles to the west (Figure 1). A short segment of the Gunnison River lies within park boundaries to the east of Blue Mesa Reservoir. This area supports wet meadows originally hayed and grazed circa 1880's until August 1989. Also an extensive riparian area extends along the Gunnison River supporting various willow species and narrowleaf cottonwood (Populus angustifolia). Blue Mesa Reservoir's shoreline perimeter is 98 miles long and bordered by an extensive sagebrush-steppe plant community. Several drainages flow from the south and north into Blue Mesa (Figure 2). With the exception of Cebolla Creek, Lake Fork of the Gunnison River, and possibly Soap Creek, these drainages contain small creeks with either low perennial flows, intermittent, or ephemeral flows. The two lower reservoirs, Morrow Point and Crystal, are surrounded by steep cliffs covered only intermittently by mixed conifer and deciduous tree and shrub communities. The tributaries reaching these reservoirs tend to have much steeper gradients. The Cimarron River, tributary to Crystal Reservoir, however, is gently sloped and carries a tremendous amount of sediment (turbidity ranging from 13 to 300 NTU) particularly during spring runoff (NPS, unpublished data). The lower two reservoirs reside in areas cutting through Precambrian granite and metamorphic units, in contrast to the Mesozoic sedimentary materials which rise above Blue Mesa Reservoir; Cenozoic volcanics overlie these Mesozoic sedimentary rocks. Evidence of Precambrian metamorphics also exist at the most eastern end of Blue Mesa Reservoir (Westwater Associates, 1991).

Generally, the Gunnison River, providing over 50% of the inflow to Blue Mesa, is of good quality and classified by the Colorado Water Quality Control Commission as Aquatic Life Cold 1, Recreation 1, Water Supply and Agriculture (Tables 2 and 3). The Aquatic Life Cold Class 1 classification denotes waters which support a wide variety of cold water biota. Recreation 1 waters have a maximum fecal coliform count of 200 colony forming units per 100 milliliters (based on a geometric mean of representative stream samples); these waters are suitable for primary contact including such activities as swimming, kayaking, rafting, and water-skiing. The Water Supply and Agriculture classifications denote that the waters are suitable for such purposes. These waters are not outstanding state or national resources, but do exhibit high quality, and yield to the anti-degradation review process, a process which allows degradation of water quality if economic or social development benefits override the benefit of existing water quality. These classifications make derogation of the water quality as a result of development difficult, but possible in an effusive economic climate.

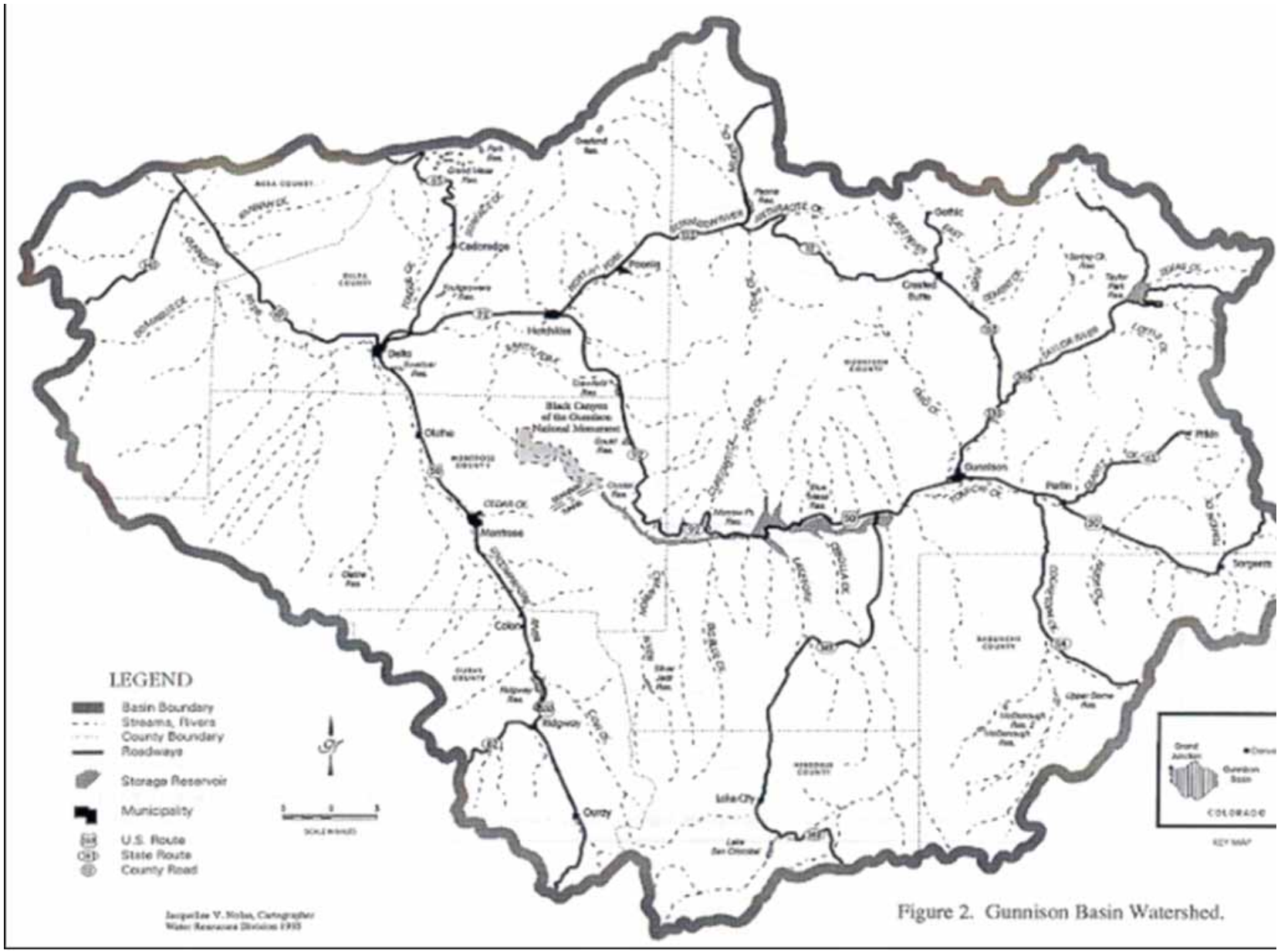


Figure 2. Gunnison Basin Watershed.

Table 2. **Colorado Designated** Use **Classifications,** Numeric Water **Quality Standards** for **CURE** Surface Waters.

[Data **from State** of **Colorado** (1993)]

Designation	Classifications	Numeric Standards					
-	-	Physical/ Biological	Inorganic mg/L		Metals µg/L		
Segment 15.	Gunnison River, mainstem from the confluence of the East River and Taylor Rivers to the inlet of Blue Mesa Reservoir.						
High Quality 2	Aquatic Life Cold 1 Recreation 1 Water Supply Agriculture	D.O=6.0mg/L D.O.(sp) = 7 .0mg/L pH=5-9.0 F .Coli =200/100ml	NHs(ac)=TVS **NH3(ch)** =0.02 C12(ac)=0.019 C12(ch) =0.011 CN=0.005	S=0.002 B =0.75 NO2=0.05 NO3=10 CI =250 SO4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch) =TVS CrIII(ac)=50(Trec) CrVI(ac/ch) =TVS Cu(ac/ch) =TVS	Fe(ch)=300(dis) Fe(ch) = 1000(Trec) Pb(ac/ch)=TVS Mn(ch) =50(dis) Mn(ch) =1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch) =TVS Se(ac) = 10(Trec) Ag(ac) =TVS Ag(ch)=TVS(tr) Zn(ac/ch) =TVS
Segment 26.	Blue Mesa, Morrow Point and Crystal Reservoirs and those segments of the Gunnison River which inter-connect those reservoirs.						
High Quality 2	Aquatic Life Cold 1 Recreation 1 Water Supply Agriculture	D.O=6.0mg/L D.O.(sp) =7.0mg/L pH=5-9.0 F.Coli=200/100m1	NH3(ac)=TVS NH3(ch) =0.02 Clz(ac)=0.019 Cl2(ch)=0.011 CN=0.005	5=0.002 B=0.75 NO2=0.05 NO3=10 C1=250 SO4=250	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch) =TVS CrIII(ac)=50(Trec) CrVI(ac/ch) =TVS Cu(ac/ch) =TVS	Fe(ch)=300(dis) Fe(ch) = 1000(Trec) Pb(ac/ch) =TVS Mn(ch) =50(dis) Mn(ch)=1000(Trec) Hg(ch)=0.01(Trec)	Ni(ac/ch) =TVS Se(ac) = 10(Trec) Ag(ac) =TVS Ag(ch)=TVS(tr) Zn(ac/ch) =TVS
Segment 28.	All tributaries to waters of Segment 26 which are not on Gunnison and **Uncompaghre** National Forest lands, except for those listed in Segment 29.						
UP	Aquatic Life Cold 2 Recreation 2 Agriculture	D.O.=6.0mg/L D.O.(sp)=7.0mg/L 01=6.5-9.0 F. Coli.=2000/100ml					

Abbreviations used: ac=acute; Ag=silver; As=arsenic; B=boron; Cd =cadmium; Ch=chronic; C1=chloride; Cl2=residual chlorine; CN=cyanide; CrIII=trivalent chromium; CrIV=hexvalent chromium; Cu=copper, dis=dissolved; D.O.=dissolved oxygen; F.Coli.=fecal coliform bacteria; Fe=iron; mg/L=milligram per liter; Hg=mercury; Mn=manganese; Ni=nickel; NHs=un-ionized ammonia reported as nitrogen; NO2=nitrite reported as nitrogen; NO3 =nitrate reported as nitrogen; Pb =lead; S =sulfide as undisassociated H2S (hydrogen sulfide); Se= SO4=sulfate; sp=spawning; tr=trout; Trec=total recoverable; TVS=table value standard *(see Appendix I for specific table value standards);* UP=use protected; Zn=zinc; 200/100m1 =200 bacterial colonies per 100 milliliters of sample (

Table 2. (Cont'd.) Colorado Designated Use Classifications, [Data from State of Colorado (1993)]			**Numeric Water Quality Standards for CURE Surface Waters.**				
Designation	Classifications		Numeric Standards				
	-	Physical/ Biological	Inorganic mg/L		Metals µg/I,		
Segment 29. Mainstem of S. Beaver, S. Willow, Steuben, East Elk, including all tributaries, lakes and reservoirs, from their source			Red, Pine, Blue, Curecanti, Stumpy, Cimarron and Crystal Creeks, and Corral Gulch to their confluence with water described in Segments 26 except for those in wilderness areas.				
n/a	Aquatic Life Cold 1 Recreation 2 Agriculture	D.O.=6.0mg/L D.O.(sp)=7.O pH=6.5-9.0 F. Coli. =	NH3(ac)= NH3(ch)= C12(ac) =0.019 Clz(ch)=0.011 CN=0.00	S=0 B= NO NO C1 SO 4=2 50	As(ac)=50(Tr Cd(ac)=TVS(Cd(ch) =TVS CrIII(ac)=50(CrVI(ac/ch) Cu(ac/ch) = TVS	Fe(ch)=300(di Fe(ch) = Pb(ac/ch) Mn(ch) Mn(ch) Hg(ch)=0.01(T rec)	Ni(ac/ch) =TVS Se(ac)=10(Trec) Ag(ac) =TVS Ag(ch)=TVS(tr) Zn(ac/ch) =TVS
Segment 30. Mainstem of the Lake Fork of the Gunnison includingmainstem of Henson Creek, mainstem			all tributaries, lakes and reservoirs from the source except for those in wilderness areas, of Palmetto Creek, and the North Fork of Henson Creek.				
High Quality 2	Aquatic Life Cold 1 Recreation 2 Agriculture	D.O.=6.0mg/L D.O.(sp)=7.O pH=6.5-9.0 F.	NH3(ac)= **NH3(ch)** C12(ac) =0.019 Cl2(ch)=0.011 CN=0.00	S=0 B= NO NO CI SO 4=2 50	As(ac)=50(Tr Cd(ac)=TVS(Cd(ch)=TVS CrIII(ac) CrVI(ac/ch) Cu(ac/ch) = TVS	Fe(ch)=300(di Fe(ch) Pb(ac/ch) Mn(ch) Mn(ch) Hg(ch)=0.01(T rec)	Ni(ac/ch) =TVS Se(ac)=10(Trec) Ag(ac) =TVS Ag(ch)=TVS(tr) Zn(ac/ch) =TVS

Abbreviations used: ac=acute; Ag=silver; As=arsenic; B=boron; Cd=cadmium; Ch=chronic; Cl=chloride; Cl2=residual chlorine; CN=cyanide; CrIII=trivalent chromium; CrIV=hexvalent chromium; Cu=copper, dis=dissolved; D.O.=dissolved oxygen; F.Coli.=fecal coliform bacteria; Fe=iron; mg/L=milligram per liter; Hg=mercury; Mn=manganese; Ni=nickel; NH3=unionized ammonia reported as nitrogen; NO2=nitrite reported as nitrogen; NO3=nitrate reported as nitrogen; Pb=lead; S=sulfide as undisassociated H2S (hydrogen sulfide); Se=selenium; SO4=sulfate; sp=spawning; tr=trout; Trec=total recoverable; TVS=table value standard *(see Appendix 1 for specific table value standards);* UP=use protected; Zn=zinc; 200/100m1 =200 bacterial colonies per 100 milliliters of sample (expressed as a geometric mean of representative samples); µg/L=microgram per liter.

Table 3. Table Value Standards (concentrations in µg/L unless noted).

Table Value Standards - Footnotes

Parameter"	Table Value Standards (2)(3)
Ammonia	Cold Water Acute = 0.43/FT/FPH/2(4) in mg/L Warm Water Acute = 0.62/FT/FPH/2(4) in mg/L
Cadmium	Acute = e("28nn(hardness)]-2.905) Chronic = e(o.7852[In(hardness)]-3.490) (Trout) = e(1.128[1n(hardness)]-3.828)
Chromium III	Acute = e(0.819[1n(hardness)]+3.688) Chronic e(o.819[1n(hardness)]+1.561)
Chromium IV	Acute = 16 Chronic =11
Copper	Acute = e(0.9422[In(hardness)]-1.4634) Chronic = e(0.8545[In(hardness)]-1.465)
Lead	Acute = e(1.6148[In(hardness)]-2.8736) Chronic = e(1.417[1n(hardness)]-5.167)
Nickel	Acute = e(0.76[In(hardness)]+3.33) Chronic = e(0.76[In(hardness)]+1.06)
Selenium	Acute = 135 Chronic = 17
Silver	Acute = e(1.72[1n(hardness)]-7.21) Chronic = e(1.72[ln(hardness)]-9.06) Trout = e(1.72pn(hardness)]+10.51)
Uranium	Acute = e(l.102[In(hardness)]+2.7088) Chronic = e(1.102[In(hardness)]+2.2382)
Zinc	Acute = e(0.8473[ln(hardness)]+°.8604) Chronic = e(0.8473[In(hardness)]+0.7614)

Metals are stated as dissolved unless otherwise specified.

Hardness values to be used in equations are in mg/L as calcium carbonate. The hardness values used in calculating the appropriate metal standard should be based on the lower 95 per cent confidence limit of the mean hardness value at the periodic low flow criteria as determined from a regression analysis of specific data. Where insufficient site-specific data exists to define the mean hardness value at the periodic low flow criteria representative regional data shall be used to perform the regression analysis. Where a regression analysis is not appropriate, a site-specific method should be used. In calculating a harness value, regression analyses should not be extrapolated past the point that data exist.

Both acute and chronic numbers adopted as stream standards are levels not to be exceeded more than once every three years on the average.

(3) $FT = {}_{10}.03(20\text{-}TCAP);$

(4) TCAP less than or equal to T less than or equal to 30

$FT = 10.03(20\text{-}T);$

0 less or equal to T less than or equal to TCAP

TCAP = 20° C cold water aquatic life species

present TCAP = 25° C cold water aquatic life

species absent FPH = 1; 8 less than pH less

that or equal to 9

$FPH = \frac{1+10^{(7.4\ Ph)};}{\text{less than } 1.25}$ 6.5 less than or equal to pH or equal to 8

FPH means the acute pH adjustment factor; defined by the above formulas.
FT means the acute temperature adjustment factor, defined by the above formulas.
T means temperature measured in degrees Celsius
TCAP means temperature CAP; the maximum temperature which affects the toxicity of ammonia to salmonid and non-salmonid fish groups.

NOTE: If the calculated acute value is less than the calculated chronic value, then the calculated chronic value shall be used as the acute standard.

The three reservoirs are classified as Aquatic Life Cold 1, Recreation 1, Water Supply and Agriculture, and are anti-degradation reviewable. The following creeks flowing into the three reservoirs are classified as Aquatic Life Cold 1, Recreation 2, Water Supply and Agriculture: N. Beaver Creek, S. Willow Creek, Steuben Creek, East Elk Creek, Cebolla Creek, Red Creek, Pine Creek, Blue Creek, Stumpy Creek, Cimarron Creek, Crystal Creek, and Corral Gulch. All other tributaries to the reservoirs are classified as Aquatic Life Cold 2, Recreation 2, and Agriculture (State of Colorado, 1995).

2.2 **Ground Water**

Little information is available regarding groundwater in the park unit other than that associated with tests for drinking water. As noted in the scoping report (NPS, 1995b), total coliform, radionuclide, inorganic and organic, and nitrate data have been collected. Coliform bacteria are rarely, if ever, detected from the drinking water sources. Influences from surface water are non-existent. Tests for radionuclides and organics including volatile compounds were less than limits of detection. Inorganic testing revealed that the ground water is dominated by the calcium and bicarbonates species (NPS, unpublished data).

Because few wells are located to the west of Blue Mesa Reservoir with the exception of the Cimarron area, little is known about the ground water associated with the pre-Cambrian formation which predominates the landscape west of Blue Mesa Reservoir. Fractures in this formation may hold water, and hence release it to any of the steep drainages which dissect the canyon walls. The park suspects that the ground water quality is in equilibrium with the rock substrate. However, as a result of agricultural activity on the lands next to the canyon walls, the park believes some infiltration of contaminants in the form of nitrates, pesticides and herbicides into the ground water occurs.
Presently, the park is more concerned with surface runoff into the Morrow Point Reservoir and Crystal Reservoir, and will continue to direct its monitoring efforts towards that end through a GIS-based watershed assessment project outlined in the problem statement section (Section 4.).

2.3 **Climate**

The Gunnison Valley is famous for its low temperatures; surprisingly, not the winter lows, but instead the summer lows dictate the nationwide records. The valley's growing season rarely exceeds 90 days, and typically is abbreviated by killing frosts around July 4. Over the period of record, 1961-1990, the average annual precipitation was 10.2 inches, average annual temperature was 36.1°F. Estimated annual average maximum and minimum temperatures are 86°F and -30°F, respectively (Nolan Doeskan, Colorado Climate, tabulated and raw data, Colorado State U., pers. comm., 1995).

Curecanti NRA is located between two physiographic provinces, the Colorado Plateau and the Southern Rocky Mountain. This location results in snow at the upper end of the Gunnison Basin comprising the greatest form of precipitation. The high mountains in the basin can receive up to 10 feet of snow. Typically, most snow falls in the months of February and March, and May and June are typically driest with precipitation at less than 2 inches. Later in the summer, during the end of July and throughout August, the Gunnison Basin experiences monsoon conditions where morning skies are clear, and the afternoon produces thunderstorms. September through December are relatively dry months.

3. **Water Resources Management Program**

3.1. Water Resources Issues and Proposed Actions

In its introduction, the Curecanti NRA Water Resources Scoping Report (NPS, 1995b) offers five broad categories of water-related issues that a water resources management plan may effectively offer or procure solutions for this park unit. The broad categories are: 1) Reservoir levels including minimum levels, annual fluctuating levels, and timing of reservoir level increases and decreases; 2) Upstream impacts which include urbanization, and a multitude of extractive activities on private and public land; 3) Impacts within Curecanti NRA ranging from parking lot runoff to drinking water and sewage management; 4) Flood plain Management on the Gunnison River; and 5) Participation in Basin Water Resource Issue Identification and Resolution. Additionally, Section 1.7 discusses very specific issues and impacts to Curecanti NRA water resources as developed in the scoping report. The following section will briefly describe those issues and discuss actions, proposed actions, or refer the reader to a set of problem statements at the end of this document.

3.1.1 Water Quality Monitoring Program

Water is one of the main resources in Curecanti NRA. Increased upstream urbanization, potential re-operation of the Aspinall Unit, park and concessionaire operations, and extractive operations on surrounding public and private lands can impact the quality of these waters. Much literature exists regarding water resources in the Gunnison Basin. A review of this literature exists in NPS (1995b and 1995c).

One means of measuring impacts to the park's water from upstream sources and within park sources is an extensive water quality sampling program. Curecanti NRA has maintained a monitoring program since 1981 with a one year hiatus in 1986. The 1981-1985 program was developed by Roger Andrasick, Resource Management Specialist at Curecanti NRA. The Bureau of Reclamation contracted data analysis for Blue Mesa Reservoir which culminated in "Blue Mesa Reservoir, Colorado: A Historical Review of its Limnology 1965-1985" (Cudlip et.al., 1987). The stream and lower reservoir data have never been analyzed. Table 4-8 provide a synopsis of data available for all stream sites during this period. Tables 9-11 provide a summary of data for the Morrow Point and Crystal Reservoirs; at these sites only pH, dissolved oxygen, specific conductance, temperature, clarity, and chlorophyll a were measured.

A second period of sampling was begun in 1987 by Wayne Valentine, Resource Management Specialist at Curecanti NRA. This program centered on monitoring water quality at sites where potential threats were perceived. In 1992, Curecanti NRA requested technical assistance to review its water quality monitoring program. The Curecanti NRA Scoping Report (NPS, 1995b) discusses the progression of this request and notes in Tables 2 and 3 of the report the types of threats to the park's water resources.

These tables are again presented in Appendix A with corrections made for the Bay of Chickens sites. One product of technical request is the NPS Water Resources Division's " Water Quality Data and Interpretation: Curecanti National Recreation Area (1995d) in which the 1987-1993 Blue Mesa Reservoir and tributary data are analyzed. The document relates that:

♦ Few alarming water quality impacts were detected for this period.
♦ Cimarron Creek appears to be one of the few creeks that introduces water of reduced quality to the reservoir system. High suspended and dissolved solids, nutrients and bacteria are present in this stream.
♦ Flow, alkalinity, hardness, turbidity, and suspended solid measurements should be taken when samples are taken.

Table 4. Surface Water Quality of Stream Sites, 1981-1985, Curecanti National Recreation Area, Ranges for Parameters.

Location Date	BC1 6/5/82-8/21/85	CEB1 7/29/81-9/20/85	CB1A 5/1/84-8/20/85	CIM1 6/4/82-8/21/85	CIM2 7/29/81-8/21/85	CORI 4/5/82-8/20/85
Water temperature, °C	5.0-22.0 n=18	8.0-20.0 n=14	7.5-18.0 n=19	5.0-20.0 n=20	5.5-23.5 n=19	1.0-17.5 n=40
pH, standard units	7.0-8.5 n=16	7.1-9.4 n=14	6.20-8.27 n=15	7.0-8.7 n=19	7.3-8.7 n=19	6.5-9.4 n=40
Specific conductance, ttS/cm	30-200 n=18	70-310 n=15	**55-150 n=19**	75-830 n=19	85-775 n=19	25-225 n=40
Dissolved oxygen, mg/L	**5.5-12.5** n=17	5.0-9.5 n=14	5.9-16.0 n=19	5.0-11.2 n=19	5.5-12.6 n=18	2.3-13.8 n=40
Fecal coliform, #/100ml	*	*	*	*	*	*
Fecal streptococcus, #/100ml	*	*	*	*	*	*
Calcium, mg/L	*	15.0-39.0 n=4	11.6-22.1 n=3	*	*	*
Magnesium, mg/L	*	1.0-5.3 n=4	2.6-5.0 n=3	*	*	*
Potassium, mg/L	*	0.36-3.00 n=4	*	*	*	*
Sodium, mg/L	*	4.9-21.0 n=4	*	*	*	*
Total acidity, mg/L	*	1.99-19.00 n=3	0.49 n=1	*	*	*
Total alkalinity, mg/L as CaCO3	*	46.0-82.0 n=4	42.0-54.0 n=3	*	*	*
Hardness, mg/L as CaCO3	*	270 n=1	*	*	*	*
Chloride, mg/L	*	2.4-5.7 n=4	8.6-12.00 n=2	*	*	*
Sulfate, mg/L	*	11.0-20.0 n=4	13.6-26.8 n=4	*	*	*
Total Kjeldahl nitrogen, mg/L	*	0.99-0.99 n=2	*	*		
Organic nitrogen, mg/L	*	1.00 n=1	0.11-0.11 n=11	*	*	
Nitrate, total (as N) mg/L	*	0.10-0.23 n=3	0.10-0.10 n=11	*		
Ammonia, total (as N) mg/L	*	0.05-0.07 n=2	0.10-0.80 n=11	*	*	*
Total **phosphorus,** (as P) mg/L	*	0.11-0.16 n=3	0.03-0.42 n=11	*	*	*
Ortho-phosphate, (as P) mg/L	*	0.02-0.09 n=3	0.02-0.16 n=11	*	*	*

* indicates no data available; n indicates number of samples; site locations are described in Table 12.

Table 5. Surface Water Quality of Stream Sites, 1981-1985, Curecanti National Recreation Area, Ranges for Parameters.

Location Date	GR1 6/5/82-8/21/85	GR2 6/5/82-8/21/85	GR3 7/29/81-8/20/85	GR4 7/14/81-8/20/85	GR5 7/7/81-8/20/85	GR7 7/27/81-8/20/85
Water temperature, °C	5.0-15.0 n=21	4.0-20.0 n=25	3.5-17.5 n=47	4.5-21.0 n=66	4.5-23.0 n=64	5.0-21.0 n=64
pH, standard units	7.1-8.2 n=16	6.6-8.1 n=24	6.3-8.6 n=43	6.8-8.9 n=68	6.5-9.0 n=65	6.5-8.7 n=58
Specific conductance, p.S/cm	90-275 n=20	90-245 n=25	90-445 n=47	90-445 n=71	105-420 n=68	95-410 n=69
Dissolved oxygen, mg/L	4.8-13.4 n=19	5.5-11.2 n=23	4.2-12.8 n=47	4.9-13.0 n=64	5.0-11.8 n=63	4.6-12.8 n=39
Fecal coliform, #/100ml	*	*	*	0-3500 n=72	0-4000 n=68	1-2401 n=48
Fecal streptococcus, #/100ml	*	*	*	0-744 n=69	6-556 n=63	2-999 n=45
Calcium, mg/L	35.0-71.0 n=2	35.0-68.0 n=3	16.3-65.0 n=8	11.5-76.0 n=28		
Magnesium, mg/L	7.0-7.2 n=2	5.4-8.3 n=3	3.9-7.6 n=8	4.4-30.0 n=29	*	
Potassium, mg/L	1.9-2.0 n=2	1.7-2.0 n=3	0.5-2.0 n=5	0.1-4.0 n=26	*	
Sodium, mg/L	4.9-6.0 n=2	4.9-4.9 n=3	4.7-17.0 n=5	2.9-7.2 n=26	*	
Total acidity, mg/L	*	*	0.49-1.99 n=5	0.05-16.0 n=28		
Total alkalinity, mg/L as CaCO3	50.0-83.0 n=2	50.0-78.0 n=3	49.0-90.0 n=8	19.0-115.0 n=25		
Hardness, mg/L as CaCO3	*	42.0-84.0 n=2	78.0-90.0 n=3	7.9-100.0 n=8	*	
Chloride, mg/L	4.9 n=2	4.9-5.0 n=3	4.90-19.0 n=8	2.8-18.0 n=29	*	
Sulfate, mg/L	9.9-29.0 n=2	9.9-15.0 n=3	12.0-16.0 n=6	9.0-44.0 n=28	*	
Total Kjeldahl nitrogen, mg/L	0.90-1.00 n=2	0.99-0.99 n=3	0.99-0.99 n=2	0.99-1.00 n=9	*	*
Organic nitrogen, mg/L	*	*	0.09-0.47 n=11	0.0-2.71 n=28	*	
Nitrate, total (as N) mg/L	0.01-0.09 n=2	*	0.09-0.37 n=14	0.01-1.21 n=37	*	*
Ammonia, total (as N) mg/L	0.49 n=2	*	0.09-2.30 n=13	0.0-0.95 n=28	*	*
Total phosphorus, (as P) mg/L	0.05-0.09 n=2	0.05-0.06 n=3	0.03-0.5 n=15	0.0-0.18 n=37	*	*
Ortho-phosphate, (as P) mg/L	0.01-0.05 n=2	0.01-0.04 n=3	0.01-0.10 n=14	0.0-0.11 n=35		

* indicates no data available; n indicates number of samples; site locations are described in Table 12.

Table 6. Surface Water Quality of Stream Sites, 1981-1985, Curecanti National Recreation Area, Ranges for Parameters.

Location Date	CUR! 6/4/82-8/20/85	CYC1 6/5/82-8/21/85	CORI 4/5/82-8/20/85	DG1 4/5/82-8/20/85	EEC1 7/29/81-8/20/85	LF1 7/29/81-8/20/85
Water temperature, °C	4.0-20.0 n=31	10.0-19.0 n=14	1.0-17.5 n=40	**3.5-15.5** n=27	2.0-18.0 n=41	4.5-17.5 n=45
pH, standard units	6.5-9.0 n=30	6.8-8.3 n=13	6.5-9.5 n=40	5.7-8.4 n=26	6.4-8.4 n=40	6.2-8.4 n=40
Specific conductance,pS/cm	20-140 n=31	50-315 n=13	**25-225 n=40**	22-325 n=27	10-180 n=41	50-300 n=46
Dissolved oxygen, mg/L	5.4-17.8 n=31	5.3-10.2 n=13	2.3-13.8 n=40	5.2-9.60 **n=26**	4.0-10.6 n=39	5.0-16.2 n=44
Fecal conform, #/100ml	*	*	*	*	*	0-2999 n=35
Fecal streptococcus, #/100ml	*	*	*	*	*	3-218 n=35
Calcium, mg/L	*	*	*	*	*	9.5-59.0 n=7
Magnesium, mg/L	*	*	*	*		0.90-3.60 n=5
Potassium, mg/L	*	*	*	*	*	0.99-1.80 n=3
Sodium, mg/L	*	*	*	*	*	2.20-6.00 n=3
Total acidity, mg/L	*	*	*	*	*	0.03-40.0 n=4
Total alkalinity, mg/L as CaCO3	*	*	*	*	*	16.0-55.0 n=7
Hardness, mg/L as CaCO3	*	*	*	*	*	3.9-70.0 n=3
Chloride, mg/L	*	*	*	*	*	2.8-10.0 n=7
Sulfate, mg/L	*	*	*	*	*	10.0-46.9 n=7
Total Kjeldahl nitrogen, mg/L	*	*	*	*	*	0.09-0.10 n=13
Organic nitrogen, mg/L	*	*	*	*	*	0.10-1.00 n=12
Nitrate, total (as N) mg/L	*	*	*	*	*	0.48-1.00 n=3
Ammonia, total (as N) mg/L	*	*	*	*	*	0.10-1.00 n=13
Total phosphorus, (as P) mg/L	*	*	*	*	*	0.03-0.50 n=14
Ortho-phosphate, (as P) mg/L	*	*	*	*	*	0.01-0.24 n=13

* indicates no data available; n indicates number of samples; site locations are described in Table 12.

Table 7. Surface Water Quality of Stream Sites, 1981-1985, Curecanti National Recreation Area, Ranges for Parameters.

Location Date	MCI 6/5/82-8/21/85	NBC1 7/27/81-8/20/85	NWC1 **7/29/81-8/20/85**	PC1 4/5/82-8/20/85	RC1 7/29/81-8/20/85	SOAP 7/1/67 7/29/81-8/20/85
Water temperature,°C	5.0-19.5 n=10	3.0-26.00 n=44	3.0-19.5 n=41	1.0-17.0 n=42	2.0-19.5 n=41	4.0-18.0 n=17
pH, standard units	7.2-8.4 n=9	6.2-8.2 n=42	6.5-9.4 n=40	6.8-8.7 n=39	6.4-8.4 n=40	7.1-8.4 n=18
Specific conductance, p.S/cm	30-200 n=10	30-195 n=42	10-275 n=41	40-225 n=42	16-215 n=41	40-185 n=18
Dissolved oxygen, mg/L	6.7-13.2 n=9	4.6-10.2 n=43	3.5-9.38 n=40	4.2-15.6 n=42	4.4-12.0 n=40	5.3-12.3 n=16
Fecal coliform, #/100ml	*	*	*	*	*	
Fecal streptococcus, #/100ml	*	*	*	*	*	*
Calcium, mg/L	*	8.3 n=1	9.5-38.0 n=2	*	8.1-18.0 n=2	6.0-19.0 n=3
Magnesium, mg/L	*	1.5 n=1	1.9-7.0 n=2	*	1.6-3.0 n=2	1.2-2.9 n=2
Potassium, mg/L	*	0.18 n=1	0.54-5.80 n=2	*	0.36-2.9 n=2	0.9-1.3 n=2
Sodium, mg/L	*	1.9-2.2 n=2	3.2-45.0 n=2	*	3.5-8.6 n=2	2.6-15.0 n=2
Total acidity, mg/L	*	10.0 n=1	11.0 n=1	*	9.8 n=1	12.1 n=1
Total alkalinity, mg/L as CaCO3	*	31.0 n=1	36.0-135.0 n=2	*	26.0-92.0 n=2	26.0-72.0 n=3
Hardness, mg/L as CaCO3	*	*	*	*	*	
Chloride, mg/L	*	2.8 n=1	2.8-5.3 n=2	*	2.0-2.8 n=2	5.0-6.20 n=3
Sulfate, mg/L	*	0.20 n=1	2.7-18.0 n=2	*	0.6-9.9 n=2	7.2-9.9 n=3
Total Kjeldahl nitrogen, mg/L	*	0.69 n=1	0.28 n=1	*	0.27 n=1	0.27 n=1
Organic nitrogen, mg/L	*	1.07 n=1	*	*	0.93 n=1	0.05 n=1
Nitrate, total (as N) mg/L						
Ammonia, total (as N) mg/L	*	0.01-0.05 n=2	0.05-0.09 n=2	*	0.04-0.05 n=2	0.01-0.05 n=2
Total **phosphorus,** (as P) mg/L	*	0.09 n=1	0.09 n=1	*	0.06 n=1	0.02-0.50 n=1
Ortho-phosphate, (as P) mg/L	*	0.02 n=1	0.06 n=1	*	0.03 n=1	0.01 n=1

* indicates no data available; n indicates number of samples; site locations are described in Table 12.

Table 8. Surface Water Quality of Stream Sites, 1981-1985, Curecanti National Recreation Area, Ranges for Parameters.

Location Date	SC1 7/29/85-8/20/85	SBC1 4/13/82-8/20/85	SWC1 **4/5/82-7/17/85**	WEC1 7/29/81- 8/19/85
Water temperature, °C	2.5-24.0 n=44	5.5-21.0 n=12	7.0-19.0 n=18	4.4-16.0 n=17
pH, standard units	6.3-8.4 n=43	7.0-8.3 n=12	7.0-8.5 n=16	7.0-8.4 n=17
Specific conductance, µS/cm	25-210 n=42	110-400 n=12	240-625 n=18	30-103 n=16
Dissolved oxygen, mg/L	4.5-11.2 n=44	5.5-8.2 n=12	5.2-8.36 n=16	4.7-13.0 n=17
Fecal coliform, #/100ml	*	*	*	*
Fecal streptococcus, #/100ml	*	*	*	*
Calcium, mg/L	5.2-16.0 n=2	*	*	6.4-13.0 n=2
Magnesium, mg/L	1.1-2.0 n=2	*	*	1.6-1.8 n=2
Potassium, mg/L	0.18-3.0 n=2	*	*	0.40-1.8 n=2
Sodium, mg/L	2.1-8.6 n=2	*	*	2.8-6.8 n=2
Total acidity, mg/L	10.0 n=1	*	*	9.1 n=1
Total alkalinity, mg/L as CaCO3	23.0-64.0 n=2	*	*	20.5-52.0 n=2
Hardness, mg/L as CaCO3	*	*	*	*
Chloride, mg/L	2.6-5.7 n=2	*	*	3.4-4.8 n=2
Sulfate, mg/L	2.9-9.9 n=2	*	*	4.1-9.9 n=2
Total Kjeldahl nitrogen, mg/L	0.32 n=1	*	*	0.28 n=1
Organic nitrogen, mg/L	1.01 n=1	*	*	0.66 n=1
Nitrate, total (as N) mg/L	*	*	*	*
Ammonia, total (as N) mg/L	0.05-0.06 n=2	*	*	0.01-0.10 n=2
Total phosphorus, (as P) mg/L	*	*	*	0.02 n=1
Ortho-phosphate, (as P) **mg/L**	0.02 n=1	*	*	0.01 n=1

* indicates no data available; n indicates number of samples; site locations are described in Table 12.

Table 9. Mean ion concentrations in Blue Mesa Reservoir by year, 1974, 1975, and 1983 through 1985.

Parameter	1974	1975		1983		1984		1985	
	Mean (n=1)	Mean	s.d.'	Mean	s.d.	Mean	s.d.	Mean	s.d.
Acidity (mg/L)	*	*		7.8	6.2	6.8	4.7		
Alkalinity (mg/L)	76	91.4	10.5	74.8	6.4	72.2	9.8	68.9	2.1
HCO3 (mg/L)	93	*		74.8	6.4	*		68.9	2.1
CO3 (mg/L)	*	*		0	0	*		0	0
Calcium (mg/L)	28	*		46.8	20.4	20.7	2.4	15.0	8.2
Magnesium (mg/L)	4.8	*		5.7	0.9	5.2	1.2	4.4	1.6
Sodium (mg/L)	4.9	*		3.9	1.8	*		4.0	1.4
Potassium (mg/L)	1.2	*		1.6	0.5	*		1.8	0.6
Chloride (mg/L)	1.3	*		5.6	2.2	11.6	5.1	0.8	0.9
Sulfate (mg/L)	16.0	*		18.0	3.2	18.1	5.0	13.6	3.3
Boron (µg/L)	*	*		157	129	*			
Cyanide (µg/L)	*	*		5.7	3.0	3.0	4.0		
Fluoride (mg/L)	0.2	*		0.23	0.13	0.13	0.07	*	
Organic Nitrogen (mg/L)	*	*		0.8	0.2	0.1	0		
Total Kjeldahl Nitrogen (mg/L)	*	0.30	0.18	0.92	0.21	*		0.40	0.29
Nitrite-N (mg/L)	*	*		0.5	0	*		0.04	0.04
Ammonia-N (mg/L)	*	0.02	0.01	0.12	0.09	0.10	0	0.07	0.02
Nitrate-N (mg/L)	*	*		0.04	0.04	0.18	0.27	1.08	1.06
Nitrite-Nitrate-N (mg/L)	0	0.02	0.02	0.44	0.16	*			
Orthophosphate (mg/L)	0.01	*		0.04	0.04	0.03	0.02	0.14	0.24
Total Phosphorus (mg/L)	*	0.04	0.10	0.24	0.21	0.08	0.06	0.09	0.14

* indicates no data available; n indicates number of samples

Table 10. Surface Water Quality of Lower Reservoir Sites, 1981-1985, Curecanti National Recreation Area, Ranges for Parameters.

Location Date	CL1 6/5/82-	CL2 6/5/82-	CL3 6/5/82-	CL4 6/4/82-8/21/85	MLP1 6/4/82-	MPL2 6/4/82-8/21/85
Water temperature, °C	10.0-17.0 n=18	9.5-17.0 n=19	8.5-17.0 n=19	9.0-14.5 n=19	4.5-20.0 n=19	9.5-19.5 n=19
pH, standard units	6.6-9.2 n=18	6.5-8.0 n=18	6.4-8.4 n=18	6.6-8.7 n=18	6.8-8.4 n=18	7.2-8.4 n=18
Specific conductance,	90-250 n=19	90-225 n=19	90-275 n=19	90-225 n=19	90-200 n=19	85-200 n=19
Dissolved oxygen, mg/L	6.55-9.20 n=17	6.45-8.00 n=18	5.80-11.40 n=18	5.50-9.20 n=18	5.40-11.70 n=18	5.70-10.80 n=14
Chlorophyll a, µg/L	10.48	12.09	*	*	8.13	*
Secchi depth, m	0.5-4.5 n=7	0.5-3.0 n=9	0.3-2.0 n=7	*	0.5-5.5 n=10	0.75-3.0 n=9

Table 11. Surface Water Quality of Lower Reservoir Sites, 1981-1985, Curecanti National Recreation Area, Ranges for Parameters.

Location Date	MPL3 6/4/82-8/21/85	MPL4 6/5/82-8/21/85	MPL5 6/4/82-8/21/85	MPL6 6/4/82-8/21/85
Water temperature, °C	9.0-20.00 n=19	8.0-19.0 n=19	8.0-18.5 n=19	7.5-16.0 n=19
pH, standard units	7.0-8.5 n=18	7.2-8.4 n=18	6.5-8.0 n=18	6.5-7.7 n=18
Specific conductance, itS/cm	80-200 n=19	60-220 n=19	95-200 n=19	90-225 n=19
Dissolved oxygen, mg/L	5.80-8.50 n=18	6.00-9.80 n=18	5.30-10.0 n=18	5.0-11.8 n=18
Chlorophyll a, µg/L	8.62	*	7.4	*
Secchi depth, m	0.5-3.3 n=9	0.8-3.5 n=9	1.0-4.5 n=6	2

* indicates no data available; n indicates number of samples; site locations are described in Table 12.

Table 12. Site locations for Curecanti National Recreation Area water quality sampling program, 1982-1985.

Site	Location
BC 1	Blue Creek at Highway 50
CB1A	Cebolla Creek at Highway 149 bridge
CEB1	Cebolla Creek above confluence with Blue Mesa Reservoir
CIM1	Cimarron Creek below Squaw Creek: equivalent to CM10 of present sampling program
CIM2	Cimarron Creek above Benny's: equivalent to CM 12 of recent sampling program
CORI	Corral Creek above confluence with Morrow Point Reservoir
CUR1	Curecanti Creek above confluence with Morrow Point Reservoir
CYC1	Crystal Creek above confluence with Crystal Reservoir
DG1	Dry Gulch at campground
EEC1	East Elk Creek above confluence with Blue Mesa Reservoir at campground
GR1	Gunnison River at East Portal
GR2	Gunnison River below Morrow Point Dam
GR3	Gunnison River below Blue Mesa Dam
GR4	Gunnison River at Cooper Ranch Picnic Area
GR5	Gunnison River at Neversink Picnic Area
GR7	Gunnison River at Riverway Picnic Area
LF1	Lake Fork at Gateview Campground
MC1	Mesa Creek above confluence with Morrow Point Reservoir
NBC!	North Beaver Creek above confluence with Gunnison River
NWC1	North Willow Creek above confluence with Blue Mesa Reservoir
PC1	Pine Creek above confluence with Morrow Point Reservoir
RC1	Red Creek at campground
SOAP	Soap Creek above Ponderosa Campground
SC1	Steuben Creek above Blue Mesa Reservoir at access road
SBC 1	South Beaver Creek above confluence with Gunnison River
SWC1	South Willow Creek above confluence with Blue Mesa Reservoir
WEC1	West Elk Creek above confluence with Blue Mesa Reservoir
CL1	Crystal Reservoir at dam
CL2	Crystal Reservoir west of Crystal Creek
CL3	Crystal Reservoir at Long Gulch
CIA	Crystal Reservoir west of Mesa Creek
MPL1	Morrow Point Reservoir at dam
MPL2	Morrow Point Reservoir west of Round Corral Creek
MPL3	Morrow Point Reservoir west of Meyers Gulch
MPL4	Morrow Point Reservoir west of Blue Creek
MPL5	Morrow Point Reservoir west of Haypress Creek
MPL6	Morrow Point Reservoir west of Cottonwood Creek

♦ Morrow Point and Crystal Reservoir should be included in the sampling program and have been as of

1995.

♦ Future data be appended to Curecanti NRA's original database that was refined by WRD.

♦ The park continues to pursue collaborative efforts in addressing complex water resource issues.

To date a threats-based monitoring program continues. Curecanti NRA staff has developed a sampling protocol which includes sites, parameters measured, frequency, and types of analysis. Staff will continue to use the monitoring protocol (NPS, 1994) based on the recommendations in the WRD report (NPS, 1995d) and the following:

♦ The threats-based program continue on a cyclical basis, and that new sites will be adopted when prompted by imminent or potential threats to the water resources. Where appropriate, biological monitoring of macroinvertebrates will occur according to the methodology outlined in the monitoring protocol.

♦ Each year, when new sites are added to the program, a new list of sites and parameters will be attached to the protocol. The protocol will serve as the document which contains lists of all sites sampled within a sampling period.

♦ Sites with three or more years of associated data may be dropped if the threat has diminished or if a site which might provide more information could prove fundamentally important to the program.

♦ The person responsible for the water quality monitoring program become familiar with the protocol for monitoring (NPS, 1994) the Curecanti NRA Scoping Report (NPS, 1995b), NPS (1986), Hickman (1987), Cudlip et. al. (1987), Water Quality Data Analysis and Interpretation: Curecanti National Recreation Area (NPS, 1995d), and this Curecanti Water Resources Management Plan. Several of these documents contain similar or identical literature reviews. The scoping report identifies specific issues to date and the management plan provides guidance in dealing with the issues.

♦ Data management should include appending the WRD database with new data. To date the park uses Microsoft ACCESS, and the data are in the CURE database in the table Cure Water Quality. Data will be entered into these tables on a monthly basis and checked, on a monthly basis, by another individual. H2O is Curecanti NRA's original database, and ANALY and ARCHIVE were developed by the Water Resources Division to include STORET codes. Both of these files as well as the H2O file should be appended with new data. The ARCHIVE contains original data including the text "L" which signifies that a quantity is beyond limits of detection. The ANALY file contains a version of the database that is ready for analysis in that limit of detection values have been halved. The ARCHIVE file can be transferred to the Environmental Protection Agency's STORET database.

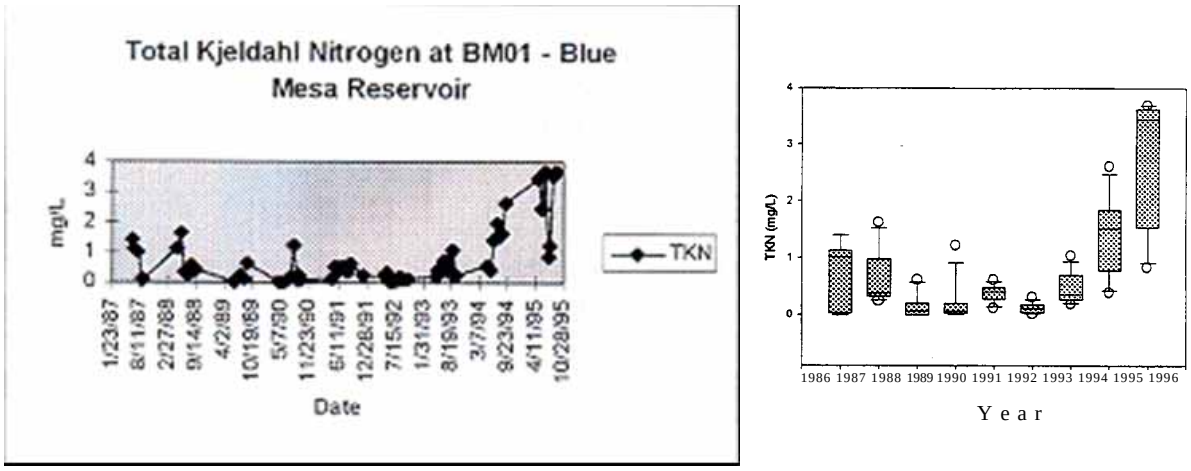
♦ All new sites will be located with the Geographical Positioning System and entered into the Geographical Information System. The 1981-1985, 1987-1992, and 1993-1994 sites are in Curecanti NRA's GIS database. The sites will also be located on a topographical map and photographed.

♦ A specific approach for monitoring Crystal and Morrow Point reservoirs and Cimarron and Squaw Creeks will be developed in a project statement in this document.

♦ Data analysis will also consist of preparing graphs and box & whiskers plots for each site for various parameters. This enables management to assess trends or problem areas. The water quality

database already provides a means of graphing data very easily. An example of this includes Total Kjeldahl Nitrogen data from Blue Mesa Reservoir site - BM01. This particular graph and plot reveal an increase in TKN in 1994 and 1995. .The 1995 water year exhibited above average inflow into Blue Mesa Reservoir which may have resulted in the increased TKN levels in the Lake Fork Arm site.

Figure 3. **Examples of Graphs and Plots for Water Quality Data**



3.1.1.1 Biomonitoring

Since 1993, Curecanti NRA has implemented a program to monitor macroinvertebrates on stream sites associated with water quality sampling. Curecanti NRA will continue with this program following the same protocol it has used through 1995. The protocol noted in NPS (1994) is based on the Rapid Assessment Protocol, Level III (U.S. EPA, 1989). A reference collection has been established and unidentifiable samples are sent to Dr. Boris Kontradieff at Colorado State University. Data are entered into table BENTHOS of the database WATER in the program ACCESS.

The purpose of this type of monitoring stems from the ability of invertebrates, whose most vulnerable stage of their life cycle occurs in water, to act as indicators of water quality. Trends in communities may be assessed by comparing years of data.

As noted in U.S.EPA (1989) pristine sites are selected so that they may be compared to sample sites. Curecanti NRA's sites are considered to be near pristine, or the water quality at these sites is considered to be good with the exception of Cimarron Creek (pristine systems with the same geology, soils, etc. do not exist in this area), and therefore, serve as the baseline information source.

3.1.1.2 Coordination with Other Agencies

Presently, Curecanti NRA coordinates collection of water quality data with two other agencies. The US Geological Survey (USGS) through their National Water Quality Assessment program (NAWQA) monitors water quality and quantity at sites above and below Curecanti NRA. Under a Memorandum of Understanding (1994) between the National Park Service and the US Geological Survey, two sites on the Gunnison River have been sampled as basic fixed sites since 1995 through 1998 depending on funding from both agencies. Samples are taken on a monthly basis with two additional extreme flow samples at the Gunnison River below the Gunnison Tunnel and seven times per year at the Gunnison River at Riverway site, which is located above Blue Mesa Reservoir. Ecological, bed sediment and tissue samples are also taken. Data from these sites is available to Curecanti NRA and Black Canyon of the Gunnison NM.

Curecanti NRA is participating in the Colorado Division of Wildlife River Watch Network, a program which involves middle and high schools, colleges, and other entities in monitoring the waters of Colorado. Curecanti NRA has incorporated sites on the Lake Fork of the Gunnison River at Red Bridge and Cebolla Creek at Powderhorn, Cimarron, and Curecanti Creek into its monitoring program. Curecanti NRA collects the samples and measures, in situ, pH, temperature, dissolved oxygen, and specific conductance. Curecanti NRA staff analyze the samples for alkalinity and hardness. Colorado Division of Wildlife analyzes samples for metals. Monitoring of these sites for basics, nutrients, and macroinvertebrates occurred in the 1995 season, and incorporation of the river watch protocol began in November of 1995. Curecanti NRA will receive data from this effort. In part, motivation for this coordination stemmed from a need that the Upper Gunnison River Water Conservancy District had expressed. The District's existing water quality monitoring program on the East River drainage could not include efforts on the Lake Fork of the Gunnison River and Cebolla Creek.

Curecanti NRA recognizes the need for a staff person with the ability to coordinate and participate in Gunnison Basin and Colorado River water issues. The staff person should have a background in water resources management with a depth of knowledge in hydrology. In this way, the park can maintain the monitoring programs outlined above, participate in basin- and park- wide planning efforts, and provide creative ways to solve problems associated with water resource issues.

3.1.1.3 Appropriateness of an Outstanding National Waters Designation

Every three years, the Colorado Department of Health's Water Quality Control Commission holds a review of stream standards and classifications (see Tables 2-3 for standards associated with Curecanti NRA waters). In July 1995, the commission requested recommendations from the public regarding changes to standards and classifications. Curecanti NRA participated by suggesting that the Gunnison River below Crystal Reservoir (Segment #1, Lower Gunnison River Basin) be designated as Outstanding Waters based on "The Basic Standards and Methodologies for Surface Waters" section 3.1.8(2)(a). This recommendation does not come without apparent repercussions. In light of the potential for re-operation of the Aspinall Unit due to the upcoming quantification of the Black Canyon of the Gunnison NM water right, and the endangered fish recovery program, this recommendation could impede the quantification process albeit the water quality may still surpass standards required for this designation. Concern with this designation stems from a similar recommendation on the Colorado River below Glen Canyon Dam. Because 40 CFR §131.12(a)(4) states:

> Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

In a letter from the Arizona Department of Environmental Quality, dated October 22, 1993, the department recognized that the results of the Glen Canyon Environmental Assessment could only proceed if no negative impacts would occur to the existing water quality below the dam if such waters were designated as outstanding. Likewise, for Curecanti NRA and Black Canyon of the Gunnison NM, implementation of new flow regimes as a result of reservoir re-operations could supposedly only occur if no negative impacts to existing water quality were demonstrated. However, the Clean Water Act, which guides the development of the state statues, notes that such a designation or classification shall not injure water rights.

The rulemaking hearing for the Gunnison and Lower Dolores River Basins will occur in 1997. An Outstanding Waters designation below Crystal Reservoir would recognize the excellent water quality that currently exists here. However, such a designation prompts the anti-degradation review for all

projects that involve discharges to these waters; both parks should anticipate the consequences resulting from an Outstanding Waters designation for the reservoirs or other segments.

3.1.2 The Aspinall Unit and a Summary of Studies Related to its Re-operation

3.1.2.1 Implications of Re-operation

Curecanti NRA encompasses the Aspinall Unit of the Colorado River Storage Project (CRSP). The Gunnison River, which was dammed beginning in 1965 to create the Aspinall Unit, is tributary to the Colorado River. Crystal, Morrow Point, and Blue Mesa Dams are operated in close association with six other large dams by the Bureau of Reclamation as part of the Colorado River reservoir system. The Secretary of Interior, in consultation with the Colorado River Basin States and the general public, is required to develop an annual operating plan (AOP) for the allocation of water among the eight major storage reservoirs on the Colorado River system.

The AOP is developed in accordance with Section 602 of the Colorado River Basin Project Act and the Operating Criteria developed by the Secretary pursuant to that Act. The plan, which is strongly linked to annual hydrologic forecasts and projections of upper and lower basin water use, also considers flood risk, surplus water deliveries, management of water supply shortages, hydropower generation, recreational needs, and instream environmental interests. The plan determines monthly deliveries of water between reservoir units and monthly changes in reservoir storage. While the AOP does not deal with daily operations, it does need to factor in the daily needs and make water allocations to accommodate special instream flows as required during periods of both high and low flows.

As part of previous NPS participation in the AOP process, Curecanti NRA identified several issues directly related to reservoir operations (official WRD Correspondence dated July 14, 1992). Annual Operating Plan issues at Curecanti NRA include minimum reservoir levels, annual reservoir level fluctuations, and the timing of reservoir level increases and decreases. Blue Mesa Reservoir levels below 7460 feet render two of the park's five boat launch ramps unusable. Lake levels below 7440 render the remaining boat launch ramps unusable (meeting notes, contract negotiation with BoR, 2/28/94). Concerns also extend to the quality of the fishery experience provided to the public, and management of the fishery itself. To date, Curecanti NRA water resource needs have been satisfied by the trial "target level" management plan of the BoR, with gradual filling through spring and early summer to a level at or near full pool in July, and gradual lowering thereafter to prevent ice jam flooding above Blue Mesa and to accommodate runoff the following spring with no or minimal flood damage downstream. The preferred operation of Blue Mesa Reservoir is to reach maximum reservoir levels in June and maintain as high and stable as possible through Labor Day. Re-operation of the reservoir has the potential to change timing of reservoir levels throughout the year. This park along with Black Canyon of the Gunnison NM participated in developing a draft matrix which recognizes potential minimum reservoirs levels and stream flows as they apply to various natural and cultural resources, and visitor use. The draft matrix is exhibited in Appendix B.

Curecanti National Recreation Area hosts over a million visitors each year. In a 1991 Decision, District Water Court Judge Robert Brown determined that the Colorado River Storage Project Act (CRSP) of 1968 expressly makes recreation, fish, and wildlife the primary purposes of the CRSP, such that "the United States could place a refill call for Blue Mesa for the sole purpose of recreation". Presently, this_ case is under appeal.

Extreme changes in reservoir levels in any single year (especially during the boating season) cause problems and additional expense for the National Park Service and concession facilities. Each 2-3 feet of lake level change requires moving floating docks, breakwaters, and concession marina facilities. Extreme annual fluctuations are also believed to intensify problems of wave erosion on shoreline archeological resources in the registered national archeological district (Bruce Jones, NPS, Midwest Archeological Research Center, June 6, 1996). On the contrary, wave erosion may be spread over a large area and not concentrated at one elevation by reservoir level fluctuations. Instead, seepage of bank-stored water may be a contributing process, which can be controlled by determining maximum safe drawdown rates (Brian Cluer, NPS, Water Resources Division, August, 1996).

Additionally, the U.S. Department of Energy, Western Area Power Administration (WAPA) has presented their Salt Lake City Area Integrated Projects Electric Power Marketing Final EIS (U.S. Dept. of Energy, 1996). They describe their commitment-level alternatives and choose the high-capacity, high-energy alternative as their preferred alternative. All the alternatives defined in the Final EIS deal with daily peaking power operations, and are distinct from the Annual Operating Plan which deals with monthly and annual water allocations. Impacts to the Aspinall Unit reservoir system as a result of the preferred alternative and two operational scenarios, either seasonally adjusted high fluctuating flows or seasonally adjusted steady flows, include slight to moderate impacts to flow and stage in Blue Mesa and Morrow Point reservoirs. Regardless, the different operational scenarios are not expected to result in impacts to sedimentation, most aquatic resources and threatened and endangered species, cultural resources, land use, or visual resources. Slight adverse impacts to bald eagles are expected under the seasonally adjusted steady flow scenario , because the reservoir would freeze earlier. Slight adverse impacts to boaters on Morrow Point and Crystal reservoirs could occur at low water under the seasonally adjusted high fluctuation scenario. Both scenarios would result in slight benefits to terrestrial resources at the headwaters of Crystal Reservoir in the form of an increased riparian area. From Curecanti NRA's point of view, re-operation of the reservoir systems resulting from WAPA's commitment-level alternative and operational scenarios will manifest itself especially when coupled with flow requirements for endangered fish species, the Black Canyon NM federal reserve water right, the AB Lateral project (a project involving additional flows through the Gunnison Tunnel to the Uncompaghre River), and possible transmountain diversion. Curecanti NRA anticipates impacts to recreational activities, the fishery, and aquatic and riparian habitat along the reservoir corridor and tributaries. Many of the concerns discussed above are outlined in Tables 13 and 14; these tables summarize impacts from re-operation and some mitigation alternatives.

Contrary to the notion that full is always better for recreational purposes, park staff noted that in 1995 the unusually extended season of full pool for Blue Mesa Reservoir presented some conflicts for the visiting public. Most notably, beach areas were reduced around the entire reservoir, and traditional sites were overcrowded. Visitors of different recreational backgrounds vied for their favorite spots. Such high water conditions are unusual; inflows to the Aspinall Unit in 1995 were 214% of average in

Table 13. Impacts to Aspinall Unit from Re-Operation

Blue Mesa Reservoir

Low Reservoir - 7465' or below	Medium Reservoir - 7465' to full (1 week	High Reservoir - 7490' to full (1 month full)[b]
Boat ramps unusable or difficult to use below 7465'.	Boats ramps usable during peak visitor season (May	Boats ramps usable, launching at other areas may be
Beach sites always available.	Beach sites available before July 4, becoming crowded	Beach sites unavailable to the extent that full pool
Large bathtub ring; aesthetically unpleasant.	Bathtub ring for portion of season; full pool around	No bathtub ring; aesthetically pleasing.
Access to boat-in campsites reduded: steep	Access good around the time of full pool.	Access greatly increased for full summer
Fishery decreases; less area/food to support the	Fishery remains stable with the exception of whirling	Dilution of nutrients; less food source for stocked fish;
Visitor use may decline as a result of poor fishery.	Visitor use remains the same (1 million visitors/yr).	Visitor use may remain the same or change depending
Area for spawning for rainbow (spring spawner) and	No change in spawning area occurs.	Spawning area increases; access to tributaries is
Mudflats exposed for migratory shorebirds; needed for	Some exposure of mudflats for migratory birds.	Little exposure of mudflats for migratory birds.
Cultural resources exposed; potential for exposure to	Cultural resources exposed; potential for exposure to	Erosion to cultural resource from submersion and
The band of exotic vegetation increases around	Exotic vegetation remains same as past; the band of	The band of exotic vegetation decreases permanently
Gunnison R. flood plain exposed for exotic species to	Same as present conditions; timing of cottonwood seed	Higher water table; less riparian area due to
Greater opportunity for riverine fishing experience.	Same as present conditions. Cooper and Neversink	Less opportunity for riverine fishing experience.

[a] full pool occurs for approximately one week around July 4.

[b] full pool occurs for approximately one month or more during June, July, or August

Table 13 (Cont'd.) Impacts to Aspinall Unit from Re-Operation

Morrow Point Reservoir

High Fluctuation/Low Release[s]	High Fluctuation/High Release	Low Fluctuation/High Release	Low Fluctuation/Low Release
If reservoir is high, boaters can get	If reservoir is high, boaters can get off	Boater launching and taking off reservoir	Boater launching and taking off reservoir
Tour boat may be stranded; reservoir	Tour boat may be stranded; reservoir	Tour boat may be stranded; reservoir	Tour boat may be stranded; reservoir needs
Campsites inundated; campers	Campsites inundated; campers	Campsites may be inundated and campers	No problem, except for access to campsite from
Tour boat dock and dam facilities;	Tour boat dock and dam facilities;	Tour boat dock and dam facilities;	Tour boat dock and dam facilities; reservoir
Log jams prevalent.	Log jams prevalent.	Log jams prevalent.	Log jams prevalent.
May impact already utilized spawning	May impact already utilized spawning	May impact already utilized spawning	May impact already utilized spawning areas.

`high fluctuation relates to daily reservoir elevation change up to 4 feet; low fluctuation refers to daily reservoir elevation change up to 2'; high release refers to release through Blue Mesa Dam equal to 100% of power plant capacity(3700 cfs); low release refers to no release or substantially less than 3700 cfs. (Based on information from Salt Lake City Area Integrated Projects Electric Power Marketing Final Environmental Impact Statement. Western Area Power Administration, Salt Lake City, UT, US Dept. of Energy, 1996).

Table 13 (Cont'd.) Impacts to Aspinall Unit from Re-Operation

Crystal Reservoir

High Fluctuation/Low Release[d]	High Fluctuation/High Release	Low Fluctuation/High Release	Low Fluctuation/Low Release
Dock facilities at Crystal Dam are '	Dock facilities at Crystal Dam are	Dock facilities at Crystal Dam are	Dock facilities at Crystal Dam are difficult to
Campsite may inundated and campers	Campsite may be inundated and	No problem, except that access to	No problem, except that access to campsite
If reservoir is high, boaters cannot get	If reservoir is high, boaters cannot get	Boater launching and taking off reservoir	Boater launching and taking off reservoir
May impact already utilized spawning	May impact already utilized spawning	May impact already utilized spawning	May impact already utilized spawning

[d] In wet seasons (Apr-July) high fluctuation relates to a change of 0.5' with 24-hr period if reservoir is less than 6748', a 4' change within a 24-hr period if the reservoir is above 6748', or 6' change within a 48 hr period. In dry seasons, high fluctuation refers to a change of 0.5 ft change within a 24-hr period if the reservoir is less than 6733', a change of 10' within a 24 hr period if the reservoir is higher than 6733', or a 15' change in a 48 hr period. High release refers to release through Morrow Point Dam equal to 100% of power plant capacity(5300 cfs) during dry months and 25-40% of capacity during wet months (Apr-July); low release refers to no release or substantially less than 5300 cfs. (Based on information from Salt Lake City Area Integrated Projects Electric Power Marketing Final Environmental Impact Statement. Western Area Power Administration, Salt Lake City, UT, US Dept. of Energy, 1996).

Table 14. Potential Strategies for Mitigating Impacts from Re-operation of Aspinall Unit

Blue Mesa Reservoir

Low Reservoir - 7465' or below	Medium Reservoir - 7465 to full (1 week full)"	High Reservoir - 7490 to full (1 month full)[b]
Extend boat ramps where possible; problems with extension	Medium conditions imply historical operations with	
Weed eradication and revegetation programs must be		Insure that impacts to sagebrush communities do not
Education of public regarding possible changes in fishery.		Insure that historical beach sites preclude conflict of
Division of Wildlife may have to redefine optimal stocking		
Continued inventorying of shoreline for artifacts.	Continued inventorying of shoreline for artifacts.	Continued inventorying of shoreline for artifacts.

8 full pool occurs for approximately one week around July 4.

" full pool occurs for approximately one month or more during June, July, or August

Table 14 (cont'd.). Potential Strategies for Mitigating Impacts from Re-operation of Aspinall Unit

Morrow Point Reservoir

High Fluctuation/Low Release`	High Fluctuation/High Release	Low Fluctuation/High Release	Low Fluctuation/Low
For all scenarios, warning signs relating dangers of cold water and variable releases must be in place, and visitor education, and ranger contact must			
If a viable trout fishery including cutthroat trout is desirable, then RMP project statement CURE-N-023.150 must be completed. This is research effort based on limnology work			
For each scenario, in order for the tour boat to operate without danger to the boat or visitors, reservoir must remain above 7156'. Communication between BoR, NPS, and			
For each scenario, develop flow/elevation model at Pine Creek dock to assist with decision regarding safety of launching tour boat.			
If possible move campsites above anticipated high water; insure backcountry campers know not to camp below high water mark.			

`high fluctuation relates to daily reservoir elevation change up to 4 feet; low fluctuation refers to daily reservoir elevation change up to 2'; high release refers to release through Blue Mesa Dam equal to 100% of power plant capacity(3700 cfs); low release refers to no release or substantially less than 3700 cfs. (Based on information from Salt Lake City Area Integrated Projects Electric Power Marketing Final Environmental Impact Statement. Western Area Power Administration, Salt Lake City, UT, US Dept. of Energy, 1996).

Crystal Reservoir

High Fluctuation/Low Release[d]	1 High Fluctuation/High Release	Low Fluctuation/High Release	Low Fluctuation/Low
For all scenarios, warning signs relating dangers of cold water and variable releases must be in place, and visitor education, and ranger contact must			
Clear gravel bars to help visitors navigate upstream to take out point - implemented by flushing flows from dam releases or actual excavation; implement RMP Project Statement			
New ladder and floating dock are needed at Crystal Dam; existing setup is dangerous			
If possible move campsites above anticipated high water; insure backcountry campers know not to camp below high water mark.			

[d] In wet seasons (Apr-July) high fluctuation relates to a change of 0.5' with 24-hr period if reservoir is less than 6748', a 4' change within a 24-hr period if the reservoir is above 6748', or 6' change within a 48 hr period. In dry seasons, high fluctuation refers to a change of 0.5 ft change within a 24-hr period if the reservoir is less than 6733', a change of 10' within a 24 hr period if the reservoir is higher than 6733', or a 15' change in a 48 hr period. High release refers to release through Morrow Point Dam equal to 100% of power plant capacity(5300 cfs) during dry months and 25-40% of capacity during wet months (Apr-July); low release refers to no release or substantially less than 5300 cfs. (Based on information from Salt Lake City Area Integrated Projects Electric Power Marketing Final Environmental Impact Statement. Western Area Power Administration, Salt Lake City, UT, US Dept. of Energy, 1996).

June, and the April through July total runoff was over 186 % of average (BoR News Release, August 1, 1995).

To gauge response of visitor experience to changes in reservoir operations a questionnaire was developed. The questionnaire not only tackles the relationship between visitor experience and reservoir levels, but also asks questions regarding need for cutthroat trout re-introduction, and management of the flood plain above Blue Mesa Reservoir. The questionnaire, developed by Dr. Steve Burr of Western Illinois University, is presented in Appendix C. Answers to the question will guide development of recreational opportunities in the General Management Plan for Curecanti NRA and Black Canyon of the Gunnison NM.

3.1.2.2 Research with Regards to Re-operation

Numerous reservoir/river accounting and planning efforts which have been developed regarding the re-operation of the Aspinall Unit. These include the Bureau of Reclamation accounting spreadsheets (BoR, Grand Junction Office), the accounting conducted by the district engineer of Water Division 4 of the State Engineers Office (State of Colorado, Division of Water Resources, Montrose, CO), the Gunnison Basin Planning Model (Hydrosphere, Inc., unpublished, Denver, CO), the State of Colorado's Colorado River Decision Support System Gunnison Basin Model (State of Colorado, unpublished), and models developed for the Arapahoe/Union Park water rights litigation. A spreadsheet and model have been developed by Ralph Clark III (March 21, 1996). This model and the aforementioned efforts typically incorporate estimated inflows to the Aspinall Unit and the requirements downstream of the unit. Some of the efforts include requirements for endangered fish, Black Canyon of the Gunnison National Monument water right, the AB lateral (a project which would divert more water through the Gunnison Tunnel to the Uncompaghre River), hydro-power, and senior water rights among others to predict Blue Mesa Reservoir levels.

Studies which are under way include: 1) a study designed to determine the effects of reservoir operations on zooplankton and fisheries resources (Brett Johnson, Colorado State University; Sherman Hebein, Colorado Division of Wildlife), 2) a study to determine the impacts of varied hydropower operations on the entrainment of fish through the turbines at the Blue Mesa Dam (Gordon Mueller, NBS and Steve Hiebert, BoR), and 3) excavation of a sauropod found at an elevation impacted by reservoir drawdown.

Johnson et.al. (1995) summarized 1994 data by concluding that entrainment of the main food source, *Daphnia pulex,* for the kokanee salmon *(Oncorhyncus nerka)* was minimal during the peak release time for Blue Mesa Reservoir which is May. The study also summarizes estimates of fish and zooplankton populations, and algal biomass, all important in understanding the dynamic of this reservoir.

Johnson et. al. (1996) summarizes findings of their 1995 field season. Kokanee feed almost exclusively on large *Daphnia-pulex.* The kokanne's apparent preference for large Daphnia implies that the pattern of temporal and spatial dynamics for this zooplanktonic species is not affected by kokanee predation. Although discharge from Blue Mesa Reservoir was much higher than average during 1995 (peak discharge was 7000 cfs during July), no detectable entrainment of warmer water from the epilimnion (the top waters where most fish and zooplankton dominate) into the intake structure occurred; the implication being no greater amount of zooplankton, the food source for kokanee, were pulled through the dam structure than in previous years. Bioenergetics models suggest that relatively slight increases in the temperature of the top waters in Blue Mesa Reservoir could reduce the zone in which kokanee could grow to their maximum size. Modelling considers only water temperature, and growth capacity

and consumption predictions could change if food density was also considered. The work of Johnson et. al. (1996) emphasizes the need to continue research on predicting the importance of climate and anthropogenic influences on reservoir dynamics. Blue Mesa Reservoir supports a world class kokanee fishery, but research by Johnson et. al. (1996) note that the fish assemblage exhibits a trend toward increasing lake trout numbers.

Mueller and Hiebert (1995) and Steve Heibert (June 18, 1996,BoR, pers. comm.) relate that fish densities for Blue Mesa Reservoir were 485 fish/hectare and 201 fish/hectare for 1994 and 1995, respectively. Fish tend towards stratification in their vertical distribution as the season progresses, i.e., in June the majority of fish were found within 5 meters of the surface, but later on they are found between depths of 15 to 25 meters. In 1994 a total of 3/4 million fish were found in Blue Mesa Reservoir using their hydroacoustic technique. In 1995 that number decreased to 1/2 million and is corroborated by Brett Johnson's work. These numbers are conservative and reflect only pelagic fish and not those inhabiting less than 1 meter depth waters, the arms or the shores. Presently, the researchers do not offer reasons for the decline.

With regards to the entrainment studies, Mueller and Hiebert (1995) note that kokanee salmon entrainment differed between night and day in 1994. Based on sampling from June 30 to November 29, daytime entrainment levels for kokanee were 0.0015 to 0.0073 fish per acre feet of water passing through the turbines. During the night 0.0293 to 0.0587 fish per acre feet passed through the turbines. In 1995, entrainment studies ran from April through November; an average over the entire season reveals that 0.069 fish per acre-foot were entrained during the day, and 0.029 fish per acre-foot during the night. The 1995 data reveal a reversal in the day versus night time entrainment rates which may correspond to the high release levels occurring in 1995, i.e, more water flowing through, more fish being entrained. Entrainment of other fishes is very low compared to the numbers of kokanee entrained. During high flows in July 1995, entrainment increased three to four times compared to the same time period in 1994. Only during very high flows were detectable numbers of lake trout and rainbow trout entrained. Of the millions of fish stocked, these entrainment levels are comparatively low, but survival rate of stocked fish to the next age class is not well documented (Steve Hiebert, June 18, 1996, BoR, pers. comm.)

Under the guidance of Sherman Hebein, Fishery Biologist, with the State of Colorado Division of Wildlife, creel surveys on Blue Mesa Reservoir have been conducted. These surveys measure species fish, size, and relate the efficacy at which anglers catch fish. These surveys helped to determine that whirling disease existed in Blue Mesa Reservoir.

Research efforts regarding impacts to archeological resources from reservoir fluctuation began at the inception of reservoir construction with an initial inventory. Most recently, projects in 1991 found 2 and in 1992 (Jones, 1996a, 1996b) found 8 previously unrecorded sites exposed by erosion. Revised study sites where the boundaries were extended downslope below the 7520 foot contour total 12 and 4 for the 1991 and 1992 projects, respectively. A site exposed by erosion was identified by Western State College, Colorado archeologists in the spring of 1994 (Jones, 1995). The site is located in a popular swimming area; the greatest concerns for this site are not only erosion by reservoir fluctuation, but also recreational use. Impacts from shoreline erosion and reservoir fluctuation are well known and documented. These impacts are greatest from the Elk Creek Visitor area to the east to the extent that this area has been inventoried to a greater degree than other areas. Less impact occurs on the south side of Blue Mesa Reservoir west of the Elk Creek area, because the sites are typically higher on the slopes. West of the Elk Creek area on the north side of the reservoir, less inventorying

of archeological sites has taken place, thus degree of impact is unknown in this area. (Bruce Jones, NPS, Midwest Archeological Center, pers. coin., June 6, 1996).

Generally, the impacts to archeological resources include loss of artifacts from wave action and reservoir fluctuation, loss of site context, and illicit collection of artifacts after exposure. Also vehicle use below high water can result in loss of artifacts. These concerns are addressed in Tables 13 and 14. Inventorying needs still exist, and most successful mitigation of impacts from re-operation of the reservoir include education, signage, and stabilization of the most important sites (Bruce Jones, NPS, Midwest Archeological Center, pers. corn., June 6, 1996).

Lastly, in 1995, three articulated vertebrae from the pelvis of what is believed to be an apadasaur were excavated from a site on Blue Mesa Reservoir. An archosaur (ancestral crocodile) was also discovered well below full pool of the reservoir. The other bones were located at the full pool level; they were excavated before either slope debris covered and/or the waves at reservoir level washed away the material.

This resource continues to be threatened because each time the reservoir rises, more bone material is removed from the burial horizon and weathered onto the slope beneath and/or into the reservoir. The extent to which resources such as this have been damaged by reservoir fluctuations will continued to be studied as more of the dinosaur is recovered and excavated.

3.1.3 Fishery and Recreation Issues

Because one of Curecanti's prime recreational activities is fishing, much of the park infrastructure and park staff operations revolves around the fishery in the reservoir systems and tributaries. The reservoirs receive the greatest amount of angling use, and the use and degree of success depends on the population and health of the stocked fishery. The scoping report noted several concerns ranging from low reservoir levels, to whirling disease, to the basic aging process of reservoirs.

The issues of greatest concern related to fisheries and recreation are that: 1) the productivity of the reservoirs meet the needs of the native and stocked fish, 2) the whirling disease, an exotic parasitic disease, where avoidable, is not introduced to more of the park's waters, 3) introduction of native cutthroat trout *(Oncorhyncus clarki* pleuriticus) to tributaries is explored, 4) contaminant levels in fish are examined periodically, and 5) a need for a fishery management plan be addressed. Items 1, 3, 4 and 5 are explored in problem statements and a discussion of the whirling issue ensues.

3.1.3.1 Whirling Disease

Whirling disease is a parasitic infection caused by the microscopic amoeba, *Myxobulus cerebralis,* that requires two different host species to complete its life cycle. Fish are infected by the disease by taking in a specific spore stage of the parasite. The spores develop into the actual parasite and feast on the head and spine cartilagenous tissue of developing fish less than 4-inches long. Injury and loss of this tissue result in disorientation, thus the term "whirling". After 86-96 days from the day of the initial infection, *Myobulus cerebralis,* produces spores. These are released to water and taken up by an aquatic annelid, *Tubifex.* This species inhabits stream bottoms primarily covered by fine sediment, the Colorado River, being a good example. Further transformation within the *Tubifex* organisms causes development of spores which can again be taken up by fish. Adult fish are immune to the disease as their head and spine have developed into bony material which cannot be destroyed by the parasite. Interruption of the life cycle of this parasite is difficult if not impossible. Either all infected fish in the stream reach of interest must be eradicated, or the stream sediments must be removed or rid of the

aquatic annelid. Reinfection occurs with the former method, because the ever present worm continues to inhabit the stream bottom. The latter method is not feasible until studies regarding flushing flows in suitable areas are explored.

This parasite is not native to North America, is endemic to Europe, and was introduced to North America via frozen fish imported from Denmark. *Myxobolus cerebralis* first reached Colorado in 1987 via a private hatchery. Currently, eight Colorado Division of Wildlife hatcheries have tested positive for the disease. Many of Colorado's streams and rivers were stocked with infected fish prior to any knowledge of the existence of the disease in hatchery fish.

Rainbow trout *(Oncorhyncus mykiss)* are most susceptible. Brook trout *(Salvelinus fontinalis),* cutthroat trout *(Oncorhyncus* clarki) and kokanee salmon *(Oncorhynchus nerka)* are also susceptible. Other species, including brown trout *(Salmo trutta),* are less susceptible, but can carry the spore. Lake trout *(Salvelinus namaycush)* are not affected by this parasite.

The reservoir system and the Gunnison River above the Aspinall Unit and below Crystal Dam have tested positive for whirling disease. According to Draft Policy No.D-9 (State of Colorado, Wildlife Commission, May 1, 1996)

> fish tested positive for, or exposed to the whirling disease parasite on positive salmonid fish culture facilities may be used to provide recreational fishing opportunity in positive standing waters or low-risk aquatic habitats that are deemed by the Director of the Division of wildlife not to present a further threat to the expansion of the parasite to other waters. There will be no stocking of fish exposed to the whirling disease parasite in waters designated by the Director of the Division of Wildlife as "Protected Habitat" to insure the continued protection of Colorado's coldwater aquatic resources. " Protected Habitats" include all native cutthroat trout recovery and special management waters; waters in wilderness areas, wilderness study areas, national parks, and designated primitive areas; waters set aside now or in the future as salmonid spawning habitats; and all coldwater streams with few exceptions.

Consideration has been given to closing the Roaring Judy Fish Hatchery, located on the East River tributary to the Gunnison River, which in the past has provided some of the rainbow trout and all of the kokanee to the park. The hatchery has tested positive for the disease. Presently, kokanee will continue to be raised at the hatchery; however, production of catchable rainbow trout at the hatchery will cease. A draft document (CDOW, 1996) suggests allowing Roaring Judy Fish Hatchery to annually stock 700,000 whirling disease positive subcatchable trout into Blue Mesa Reservoir to divert the same number of disease free fish from the Hotchkiss Fish Hatchery to whirling disease negative streams on the west slope of Colorado.

Policies and regulations regarding stocking of positive fish may change as well as the management of the Roaring Judy Fish Hatchery. Curecanti NRA management must keep apprised of the situation as a large portion of the recreational activities in the park unit center on the fishery.

3.1.4 Inventory of Water Resources

Curecanti NRA is responsible for knowing the nature and condition of its resources, develops and has the means to detect and document changes in those resources, and understand the forces driving the changes (NPS-77, 1991). The NPS Management Policies (1988) state that:

> The National Park Service will assemble baseline inventory data describing the natural resources under its stewardship and will monitor those resources at regular intervals to detect

> or predict changes...that may require intervention, and to provide reference points for comparison with other, more [human]altered environments.

To this end and specifically for water resources, Curecanti NRA has or has developed:

♦ A hydrography layer in the park GIS covering all three reservoirs, all streams, springs, and monitoring sites that are within Curecanti NRA boundaries.
♦ A cyclical water quality monitoring program which is based on threats.

♦ A water quality monitoring protocol maintained in the long term monitoring handbook (NPS, 1994).

♦ An extensive water quality and macroinvertebrate database that is updated and complete insofar as each year's data is collected. This database is checked for accuracy based on a QA/QC program outlined in the water quality monitoring protocol.

♦ A listing of the water quality use classifications in this document. These do change, and must be updated on schedule with the Colorado Department of Health.

♦ Formal analysis and summaries of the water quality data in the form of several published reports. See NPS, 1986; Hickman, 1987; Cudlip et.al. 1987; NPS, 1995d.

♦ A geo-referenced watershed assessment that includes information on stream stability, channel type, wetland status, and plant association assessment. This is discussed as a project statement.

♦ A program to monitor aquatic invertebrates in the streams using the rapid bioassessment technique (U.S.EPA, 1989).

♦ A contingent of researchers and other agencies which investigate or oversee other aspects of reservoir operations.

♦ Coordination with other local and federal agencies including the U.S. Geological Survey's National Water Quality Assessment program to sample sites in the Gunnison Basin.

♦ Cottonwood regeneration and establishment study at Cooper Ranch. This program documents establishment of cottonwoods in the area where the Gunnison River avulsed and is close to the present heron rookery.

♦ A long-term monitoring program in the wet meadow complex of Cooper Ranch. Vegetation, birds, and small mammals are monitored here.

♦ A means of monitoring consequences of unusual events such as hazardous spills from highway accidents.

The above list meets the requirements of the NPS-77, Natural Resources Management Guideline and suggestions of NPS-75, Natural Resources Inventory and Monitoring Guideline, with the exception

that Curecanti NRA needs to expand its long-term monitoring program to include a site within a narrowleaf cottonwood community. A site could be established on Neversink Island. No new personnel or equipment would be required to monitor this area.

Curecanti NRA could develop an annual report of its water resource-based long-term monitoring effort for internal use and distribution to appropriate state and federal agencies. However, the formal publications mentioned above already serve as professional summaries that can be used by other divisions and local and federal agencies.

3.1.5 Flood Plain, Wetlands and Watershed Management

3.1.5.1 Management Alternatives of Gunnison River Flood Plain

3.1.5.1.1 Affected Environment: General Description

Curecanti NRA encompasses an extensive riparian and wetland site in the eastern portion of the park upstream of the canyon leading to Blue Mesa Reservoir. Here the Gunnison River is a free flowing stream bordered by a healthy riparian community and an outlying wet meadow community sub-irrigated by surrounding private property. Two developed areas, Neversink and Cooper Ranch Picnic Areas, border the Gunnison River on the north side. The general area is referred to as Cooper Ranch. This area, not including the picnic grounds, is managed by Curecanti NRA as a natural zone. Curecanti NRA conducts long term monitoring in this area on the vegetation and birds. There are few areas along the Gunnison, or other large stream systems in the vicinity, which support functioning wet meadow and narrowleaf cottonwood habitats. The area encompasses an alluvial flood plain, therefore, the landscape is very dynamic and experiences channel avulsions with the most recent one occurring in 1993, a high flow year. Curecanti NRA, guided by NPS Management Policies (1988) is interested in allowing natural ecological functions to occur on this stretch of the river; upstream to a large degree, the Gunnison River is constrained naturally by canyon walls or by human activities such as haying and grazing operations, channelizations, or housing developments.

3.1.5.1.2 Vegetation

Narrowleaf cottonwoods form the vegetative community to the north channel of the Gunnison River. Several grass species including smooth brome, Kentucky bluegrass, and several wheatgrasses, form the understory along with many forb species. Canada thistle dominates in patches along the entire portion of the Gunnison River.

The south channel, carrying the bulk of the river, flows through wet meadow. This area had been grazed and hayed from the late 1800's until 1986. Cattle only infrequently graze this area as a result of getting through fences which demarcate private property to the south. The vegetation consists of wheatgrasses, bentgrasses, tufted hairgrass, timothy, bluegrasses, and several forb species. Several ditches run through this section, and in places, willows stabilize the banks of these ditches.

3.1.5.1.3 History of Channel Management

A report discussing "Winter Ice Jams on the Gunnison River" (Burghi, 1979) notes that snagging, channelization and clearing operations have occurred on the Gunnison River just upstream of Blue Mesa Reservoir since 1965. Citizens of the county report that work also occurred in the channel in the 1950s (Letter from Billie Mick, 1993). In 1968 and 1969, the U.S. Army Corps of Engineers placed dikes along the river channel extending from Blue Mesa Reservoir upstream past the Moncrief property; these dikes were removed in 1971 when further clearing and snagging occurred.

Another report entitled the "Gunnison River Icing Study" (Morrison-Knudsen Engineers, Inc., 1985) details the process of ice jam formation on the Gunnison River in the Dos Rios area and west towards Blue Mesa Reservoir. Ice jams are created as a result of frazil ice accumulation. Production of frazil ice and the concomitant ice jam depend on temperature conditions. As the winter season progresses, the rate of frazil ice production decreases at a particular temperature, i.e., a lower temperature is required to create a greater amount of frazil ice until a point when the river is entirely iced over. At this time no more frazil ice is produced and ice jam movement upstream is halted. Interest in ice jam production rests with various means of halting ice jam formation as it can cause flooding on private property during the winter. The report notes that river clearing, snagging, or alignment straightening have a minor effect on the overall icing problem. Localized levees and dikes can protect individual homeowners, but may cause problems with neighbors. Apparently these modes of stream channel maintenance do little to alleviate the ice jam problem. To remedy the ice jam problem, the reservoir is lowered to 7490 feet by December 30 of each year.

3.1.5.1.4 Hydrology

Three studies address the dynamics of the Gunnison River avulsion. Smillie and Long (1993) investigated the Gunnison River channel avulsion, and noted that rivers in alluvial floodplains such as the Gunnison River change course and are naturally dynamic. The request for technical assistance from the Water Resources Division arose from community pressure to move the river back to the north channel after the avulsion occurred. Subsequently, Martin (1993) collected survey data to assess the stability of the new channel and develop information relevant to returning flow to the north channel. Results showed that the south (new) channel is 0.5 meters lower in elevation than the north channel indicating that the Gunnison River at the avulsion site is more stable than prior to the channel change in 1993.

Lastly, Wohl and Hammack (1995) addressed the following questions: 1) What is the historic frequency of channel avulsions on the Gunnison River in the vicinity of Curecanti National Recreation Area? and 2) What do present channel characteristics indicate in terms of channel stability over the next 50 years? They determined that the Gunnison River exhibits characteristics resembling braided and meandering channels. They predicted that the Gunnison River will move laterally in the study area over time intervals of years to decades. The point of these studies was directed towards understanding the hydrology of the Gunnison River on this stretch, and how difficult it is to control such a stretch over the long term.

Park staff established four ground water wells south of the southern channel in the latter half of 1995. Depth to ground water at the four sites measured greater than one foot from August to late September 1995. Ground water measurements at these wells will continue in the following years with the objective of characterizing wetland hydrology, influences from runoff, and re-operation of Blue Mesa Reservoir.

3.1.5.1.5 Wildlife

In the semi-arid region of the United States, riparian areas can harbor over 80 % of the organisms within the locale. Bald eagles utilize the open waters of the Gunnison River from November through January. Mink, beaver, and weasels are also present. Other small mammals include various shrews, voles, and mice species. Deer, elk, an occasional moose, foxes, and coyotes also inhabit the area. Birds are numerous and range from the savannah sparrow found in wet meadow areas to dusky flycatchers found in wooded areas to Canada geese which nest on Neversink Island. Great blue herons have only recently moved their colony from private land to park service land on the south side of the

Gunnison River upstream of the channel avulsion. No southwest willow flycatchers have been found in the area, but no concerted effort to find them has occurred. Bats also abound along the Gunnison River, but again no concerted effort to inventory them has occurred.

3.1.5.1.6 Socio-economic

Community members have expressed their interest in seeing the flow remain the same in the existing Gunnison River channels. Examples of this desire are reflected in the efforts by the Gunnison County Commissioners and the City of Gunnison to have Curecanti NRA move the river back to the north channel. In previous years particularly the flood year of 1984, Gunnison County was instrumental in pursuing permits and funding to repair damage to Gunnison streambanks above Curecanti NRA. During that year, damage resulting from flooding accrued to over two million dollars. Reference to permit requests to place dredge or fill material in the Gunnison River and to snag and clear channels are documented in the files of the Gunnison County Emergency Officer. Discussions with individuals actually involved with the clearing and fill work in the Gunnison River verify the time, difficulties and cost associated with maintaining a river channel in a strictly defined area.

The direction of flow in the Gunnison River has been changed by human intervention several times to insure adequate flows to the north channel and to diminish the ice jam problem (1971 BoR photographs, Curecanti NRA Museum collection). Each time, however, the river seeks some equilibrium which results in movement of the main stream channel. It is the policy of the National Park Service to allow natural processes to take place; to allow the majority of the flow to remain in the south channel would abide by this policy. Reworking the channel hydraulics, although an inherent part of humans' dealings with meandering rivers in the past, would require that Curecanti NRA proceed through a 404 permitting process.

Data collected and maintained by Curecanti NRA Visitor Protection Division reveal that between 1990 and 1995 visits to the Neversink Picnic Area decreased from 11,556 in 1991 to 6723 in 1995 (NPS, Unpublished Visitor Data, Visitor Protection Division, Curecanti NRA). In some months of some years, the counter was not used resulting in calculation errors. If the data reflect true events, use at this picnic area has declined over the recent period of record. However, after three years of decline from 1991 and 1992 to 1993, the year after the avulsion (1994) realized an increase in visitor numbers (Table 15). The noticeable decline in 1995 may be attributed to very poor weather conditions in early summer, and high and turbid flows late into summer. Overall declines may be attributed to several causes including change in the river channel and poor weather.

3.1.5.1.7 Hunting

Hunting has historically been allowed in the Cooper Ranch area. Presently, shotguns are allowed as well as bow and arrow. Hunting must occur at least 50 feet away from developed areas; this includes trails. Hunting pressure and number of waterfowl taken varies from year to year based on prevailing weather conditions. Few deer and elk are taken in this area.

3.1.5.1.8 Grazing

The history of grazing in the Cooper Ranch area begins with settlement in the Gunnison Basin in the 1870's. From approximately that time until the 1986, a grazing and haying operation dominated the landscape. Irrigation canals using old meander channels and newly constructed canals are still visible

Table 15. Numbers of Visitors to the Neversink Picnic Area and Curecanti National Recreation Area.

Year	Total# of Visitors to Park	# of Visitors to Neversink
1990	1,102,283	11,556
1992	1,098,183	10,683
1993	1,103,542	8,389
1994	1,059,751	9,469
1995	996,522	6,168

within park boundaries. Cattle, which graze on the private property regularly, move on to NPS ground as a result of downed fences. Maintaining fences in this area is difficult due to the recent overbank flows which lodge debris on the upstream side of the fences.

As no grazing is allowed in the area, litter accumulates, but does not appear to reduce production based on 4 years of biomass data. For four years, Curecanti NRA staff have conducted biomass studies and note an ever increasing amount of biomass. The park staff recognizes that four years of data does little to support trend analysis, and most likely the data will be analyzed fully in ten years.

3.1.5.1.9 Education and Visitor Accessibility

Once inaccessible, the Cooper Ranch area is now available to the public for a multitude of recreational experiences. The Interpretation Division provides outdoor instruction in river dynamics, invertebrate study, and plant ecology. Students learn what rivers do in alluvial flood plains. Visitors and students must cross the north channel to access the Neversink Island and its environs, but at low flow this is not an impossible task. During spring runoff a bridge is required.

One area of concern at Cooper Ranch includes increased use of the island south of the north channel. This area harbors abundant wildlife including nesting geese. With increased use of the area, Curecanti NRA wishes to insure that the wildlife and habitat are not disturbed.

3.1.5.1.10 Research

Curecanti NRA continues with its long-term monitoring of the wet meadow area. The staff collects or has collected data on vegetation cover, frequency, biomass, bird and mammal densities. Data are analyzed yearly. The staff will assess long-term trends within six years. Additional research consists of monitoring ground water levels in the wet meadow to determine influences from sub-irrigation, spring runoff, and operation of Blue Mesa Reservoir.

In 1993 the Gunnison River near the Neversink Picnic Area avulsed, i.e., changed its course. This type of fluvial process in an alluvial flood plain is not unusual, and in fact is the driving geomorphological process which fashions flood plains. The consequence regarding plant communities is the establishment of cottonwoods in an area shaped by an avulsion. This combination of establishment and avulsed areas has not been studied before (Mike Scott, pers. comm. 1994).
Curecanti staff, in 1993, 1994, and 1995, established a series of plots which allow the park to track the

establishment of cottonwoods in an area subjected to seasonal flooding, severe ice scouring, and visitor use.

Photographs from time-lapsed camera which took a picture per day for one year (May 1994 - June 1995) of the Gunnison River above Blue Mesa is in video form for research and interpretive use. Photographs were taken in 1994 and 1995 during one of the highest flow years witnessed on the Gunnison River.

Another concern in the Cooper Ranch area includes a portion of the south channel which may eventually cut through private property as it meanders back to the north channel. The private property owner is aware of the situation and not adverse to the river moving onto his property. The park continues to monitor the movement of the channel from a fixed photo point and measurement of bank erosion from the private property owner's corner.

3.1.5.2 Management Alternatives for the Gunnison River Flood Plain
Management alternatives abound for the Cooper Ranch area due to the proximity to water, the existing picnic area and trails system, the dynamic nature of this area, the important riparian habitat afforded the wildlife, and the educational opportunities. Table 16 provides three management alternatives for this area.

3.1.5.3 Impacts from Management Alternatives for the Gunnison River Flood Plain
Table 17 reveals impacts associated with alternatives to management of the Cooper Ranch Area as outlined in Table 16.

3.1.5.4 Preferred Alternative
Curecanti NRA determines that Alternative B allows for natural ecological functions to resume and exist at the Cooper Ranch area, and provides for the greatest opportunities for the visitors. Visitors will be able to access park land south of the north channel of the Gunnison River via bridge and continue to the south channel of the Gunnison River where the bulk of the river flows.

3.1.5.5 Wetlands and Watershed Assessment

3.1.5.5.1 Watershed Assessment
Through an extensive inventory of Curecanti NRA's watershed, the park, using GIS tools, can collate data layers of soils, geology, vegetation, stability, channel type, and land use as a means of assessing impacts to reservoir water resources.

In 1994, field personnel visited every drainage that entered the three reservoirs. At each drainage and within the boundaries of Curecanti NRA, staff recorded dominant vegetation using methods developed by Rowlands (1994), drainage stability using a rating developed by US Forest Service (1990), soils identification based on texture and color, and channel type based on Rosgen (1994). Because the smaller drainages extend for a very short length within Curecanti NRA boundaries, only one representative site was sampled at each drainage. Longer drainages were assessed by a stratification based on channel type and overall vegetative formation. Associated wetland areas were also identified and compared to the National Wetland Inventory (NWI) draft maps.

Table 16. Man a[g]ement Alternatives for Cooper Ranch Area

Alternative A	**Alternative B**	**Alternative** C
Managed as a natural zone according to NPS, Management Policies, 1988, Chapter 4. Allows for natural ecological functions to occur and continue.	Managed as a natural zone according to NPS, Management Policies, 1988, Chapter 4. Allows for natural ecological functions to occur and continue.	Move bulk of flow to north channel which is contrary to NPS, Management Policies, 1988, Chapter 4. Natural ecological functions would continue to be impeded.
Access to entire area assured except during very high flow.	Bridge constructed over north channel to allow access even during very high flow.	Access restricted to area south of the north channel except during lowest of flows.
Managed for educational opportunities. Outdoor programs developed to cover river dynamics, invertebrate study, and plant ecology.	Managed for educational opportunities. Outdoor programs developed to cover river dynamics, invertebrate study, and plant ecology.	Managed for educational opportunities. Outdoor programs and nature walks restricted to Neversink Trail.
Hunting allowed with shotguns or bow and arrow 50' away from developed areas.	Hunting allowed with shotguns or bow and arrow 50' away from developed areas.	Hunting allowed with shotguns or bow and arrow 50' away from developed areas.
No grazing is allowed, and has not occurred since 1986.	No grazing is allowed, and has not occurred since 1986.	No grazing is allowed, and has not occurred since 1986.
Emphasis on scientific research to include long term monitoring and study of cottonwood establishment in an avulsion site.	Emphasis on scientific research to include long term monitoring and study of cottonwood establishment in an avulsion site.	Emphasis on scientific research to include long term monitoring of birds and vegetation.

Table 17. Im[p]acts from Mana[g]ement Alternatives for Coo[p]er Ranch Area

Alternative A	**Alternative B**	**Alternative** C
Follows NPS policies; allows natural ecological functions to occur and persist.	Follows NPS policies; allows natural ecological functions to occur and persist.	Does not follow NPS policies; disrupts progression of natural ecological functions. Potential for increased exotic plant invasion in south channel which will be mostly abandoned.
No construction of bridge; impacts to north channel from visitor crossing expected to be minimal.	Construction of bridge over north channel will disturb streambank and destroy a small wetland area. 404 permit will be required.	No construction of bridge; impacts to north channel from visitor crossing expected to be minimal. Crossing will occur only during the lowest of flows in the north channel.
Allows for more visitor impact to riparian habitat during periods of relatively low flow. Impacts perceived to be minimal if visitor use directed to established trails.	Allows for more visitor impact to riparian habitat even during high flow periods. Impacts perceived to be minimal if visitor use directed to established trails.	Reduces impacts to riparian habitat from visitor use.
Educational opportunities increase with attendant impacts to riparian areas. Outdoor instruction limited to restricted areas during nesting season.	Educational opportunities increase with attendant impacts to riparian areas. Outdoor instruction limited to restricted areas during nesting season.	Educational opportunities limited to Neversink Trail. Limited opportunity to see avulsion site and learn about river dynamics.
Hunting allowed. No change to perceived impacts that already occur.	Hunting allowed. No change to perceived impacts that already occur.	Hunting allowed. No change to perceived impacts that already occur.
No grazing allowed. No change to perceived impacts that already occur.	No grazing allowed. No change to perceived impacts that already occur.	No grazing allowed. No change to perceived impacts that already occur.
Scientific research continues to be non-destructive. -	Scientific research continues to be non-destructive.	Scientific research limited to Neversink Trail. No research conducted at avulsion .

This process of watershed assessment incorporated techniques used by other federal agencies. Rosgen channel typing and assessment of stability are used by the BLM in the Gunnison Resource Area, and the stream stability assessment is a US Forest Service generated procedure. The measurement of vegetation dominance was developed for the Colorado Plateau Cluster.

This document outlines how a GIS database can assist analysis of the information gathered in 1995 and help identify drainages that may contribute to water resource problems within the park (Section 4). By doing so, park staff can perhaps change its own practices or bring to the attention of private landowners and federal agencies stream systems which may be improved.

The stream system which immediately presents problems is Cimarron Creek. As noted in the Curecanti NRA Water Resource Scoping Report (NPS, 1995b), Cimarron Creek exhibits high turbidity levels during spring runoff. This creek drains land which is timbered, grazed, hayed, and irrigated. These cumulative impacts, coupled with the nature of the surrounding soils and geology can contribute to high sediment loads. This document discusses the development of a "project implementation plan" to stem nonpoint source pollution to the Cimarron Creek system (Section 4).

These implementation plans stem from Colorado's voluntary Nonpoint Source Management Program (Water Quality Control Division, 1990) which fulfills Section 319 of the Clean Water Act of 1987. Specifically, poor agricultural and silvicultural practices can contribute nonpoint source pollution to streams. Implementation plans utilize tested and accepted best management practices and local participation to stem nonpoint source pollution caused by agriculture or silviculture. The applicability of developing a implementation plan is discussed in the above mentioned problem statement.

3.1.5.5.2 Wetlands

Through the watershed assessment project conducted in 1995, wetland areas within park boundaries were identified. These wetlands are mapped on 7.5 minute quads and will be digitized into the GIS database. In addition, this initial effort has been compared to the National Wetland Inventory (NWI) draft maps and changes or additions sent to the US Fish and Wildlife Service for inclusion into the NWI maps. These maps reveal excellent coverage of the Gunnison River upstream of Blue Mesa Reservoir, but small wetland areas within Curecanti NRA especially those associated with very steep side drainages are not identified on the NWI maps

This initial effort at mapping Curecanti NRA wetlands guides the construction of new visitor facilities that may impact wetlands. The wetland inventory by the park and the NWI maps serve as an advanced identification only; if discharging to or draining of wetlands is anticipated, Curecanti NRA must be in compliance with Section 404 of the Clean Water Act of 1972 and Section 401 of the state regulations.

3.1.5.5.3 Flood Plain Assessments

Curecanti NRA conducted flood plain assessments of only the Neversink and Cooper Ranch picnic areas. The maps and associated documentation were last seen in the park in 1994. These maps are missing. Curecanti needs to locate these maps and develop a filing system for floodplain assessments completed in the park and get such products into the GIS system.

Black Canyon of the Gunnison NM and Curecanti NRA are proceeding with their General Management Plan. If new development sites are located within suspected floodplains, the Water Resources Division will be contacted regarding technical assistance with flood plain assessments under guidance of the Flood Plain Management Guidelines (NPS, 1993). Steve Riley, Facility Manager,

(per. comm., 1995) noted that at the present time, no new facilities were planned within flood plain areas.

3.1.6 Water Rights

Water rights issues at Curecanti NRA fall into the following categories: (1) groundwater resources; (2) tributary inflows to Blue Mesa, Morrow Point, and Crystal reservoirs; (3) consumptive water use from Blue Mesa Reservoir by NPS staff and/or visitors; and (4) coordinated management (through contract discussions with the Bureau of Reclamation) of reservoir water levels to maintain park resources.

3.1.6.1 Ground Water Resources

Table 18 inventories some of the ground water wells within Curecanti NRA. None have been adjudicated. The Neversink, Beaver Creek, Cooper Ranch, East Cimarron and Riverway are now inactive, the handpumps pulled, and the wells plugged. Information for the Red Creek, Iola, Dry Gulch, and East Portal wells is unavailable, however, these wells are active and do have drinking water permits (Table 20.), and are tested for potability during the summer season. Information in Table 18 should be verified with the Colorado State Engineer's Office; missing or inaccurate information should be appended or corrected.

Curecanti NRA staff must assess the current and anticipated use associated with each well listed and determine the need for adjudication. The NPS Water Resource Division will then assist Curecanti NRA in the process of adjudicating those existing well permits that are not currently decreed.

3.1.6.2 Tributary and Side Flows to Curecanti NRA Reservoirs

Curecanti NRA has at least one known water right on tributary inflow to the Aspinall Unit. The State of Colorado, Gunnison County water files indicate a 1.85 cfs right on East Elk Creek, a tributary to Blue Mesa Reservoir. This right, deeded to the BoR prior to the construction of Blue Mesa Dam, is comprised of the Henry F. Ditch and the Elk Creek Ditch. These two ditches deliver water to the irrigation system at the present day Elk Creek Visitor Center and Campground, and are believed to have been constructed in the late nineteenth century. Prior to the Bureau of Reclamation's acquisition of the water right, the Colorado Division of Wildlife maintained the canals from East Elk Creek to the present day Elk Creek Visitor Center and Campground. Administration of this water right is believed to have been transferred to the National Park Service in 1965 when Curecanti NRA was organized to administer recreational activities at the Aspinall Unit.

In 1969, Curecanti NRA upgraded the Elk Creek irrigation system. This consisted of a concrete diversion dam, excavation of approximately 22,005 feet of earth lined ditch, four long span pipe structures, lateral turnout boxes, concrete siphon boxes and metal pipe sections. Proper operation of the project required a full-time irrigator position during the spring, and for several hours almost daily through the summer. By 1978 the necessary man-hour commitment to tend the system was discontinued, which resulted in extreme flooding in the Elk Creek Campground. Since 1993, however, the irrigation system has been used to control prairie dog populations and to revegetate denuded areas around the visitor area and the campground.

Curecanti NRA wishes to continue to develop and use East Elk Creek water via the Henry F. Ditch and the Elk Creek Ditch for irrigation purposes near and in the Elk Creek Visitor Center and Campground. Curecanti NRA must determine the current status of the East Elk Creek water right,

Table 18. Well Locations and Permit Numbers.

Well Name	Permit #	Date of Priority	Quantity of Water*
Elk Ck Well	68522**	06/28/93	40-50 gpm: 200,000 gal storage
Elk Ck Well #1	33692-F	01/11/90	11 gpm: 24ac-ft per yr
Elk Ck Well #2	32263-F	12/15/89	50 gpm: 40ac-ft per yr
Stevens Ck Well	119675	10/07/80	15gpm: 1.6ac-ft per yr
Cimarron Town Well	119613	09/29/80	l lgpm: 6.5ac-ft per yr
East Elk Ck Well	119671	10/30/80	5gpm: 0.8ac-ft per yr
Lake Fork Well	31666-F**	05/20/89	30gpm: 10ac-ft per yr
Gateview Well	139681	05/23/85	1pgm: 0.3ac-ft per yr
Ponderosa Camp Well	28618-F	6/21/85	25gpm: 10ac-ft per yr
Beaver Ck Well	119676	10/07/80	5 gpm: 0.8 ac-ft per year
Neversink Well	119673	10/10/80	5 gpm: 0.8 ac-ft per year
Riverway Well	119674	10/16/80	5 gpm: 0.8 ac-ft per year
Cooper Ranch Well	119677	10/15/80	5 gpm: 0.8 ac-ft per year
East Cimarron Well	119672	09/30/80	3.7 gpm: 0.8 ac-ft per year
Iola Ck Well	no data		
Dry Gulch Well	no data		
Red Ck Well	no data		
East Portal Well	no data		

* Proposed maximum pumping rates (in gallons per minute - gpm), and average annual amount of ground water appropriation (in acre-feet).
** Permit numbers taken from Well Completion and Pump Installation Report

assess current water use and anticipated needs at all reservoir tributaries, and initiate water right application procedures as appropriate and necessary.

3.1.6.3 Consumptive Use_from Blue Mesa Reservoir

Under Colorado state law, the BoR's Aspinall water rights are currently sanctioned as direct flow rights and storage rights; the rights entitle the United States to consumptively use water for the purposes decreed. To date, Curecanti NRA staff have been operating under the assumption that an existing contract between the BoR and the NPS authorized Curecanti NRA to use 500 acre-feet of water from Blue Mesa Reservoir for culinary purposes. However, recent discussions with the BoR (Steve McCall, BoR, pers. comm.), have revealed that no such contract exists. The BoR, however, has suggested that the NPS pursue contract discussions with them if the NPS wishes to continue this use of Aspinall water. Curecanti NRA staff should determine the magnitude of consumptive use water

required to meet anticipated culinary needs as Curecanti NRA, and, based on that determination, make a recommendation to the NPS Water Resources Division to pursue a contract with the BoR for the appropriate amount of Aspinall Unit water.

3.1.6.4 Instream Flow Rights

The Colorado Water Conservation Board is responsible for filing for instream flow rights on Colorado streams. Recommendations for amounts of flow in cubic feet per second (cfs) are made by the Colorado Division of Wildlife to the Board. The public can comment on the amounts that the Board wishes to apply to various streams. An instream flow right for 1.5 cfs does exist on East Elk Creek for 10.9 miles upstream of the reservoir; the date on this right is 1984.

Presently, Instream Flow Recommendations are being made for South Beaver Creek, West Elk Creek, West Beaver Creek, West Antelope Creek, and Beaver Creek which all flow into the Aspinall Unit. Curecanti NRA staff needs to apprise themselves of these recommendations, participate in the comment period, and recognize how these instream flow rights if adjudicated affect the park's water resources.

3.1.7 Upstream Impacts

The scoping report identified how land use activities such as urbanization, logging, mining, grazing, irrigation, roads and road development, and oil and gas development may impact water resources. Partnering with the BLM, US Forest Service, State of Colorado, and land owners in order to obtain the information is an obvious step and has already taken place, e.g., a MOU exists which allows sharing of digital databases between the BLM and NPS. The logical extension is a program which deals with poor water quality as is the case with Cimarron Creek. Discussion of this is presented in Section 3.1.5.4.1. The GIS staff must document changes in land ownership around Curecanti NRA, and update the database; this presently occurs. Lastly, the park must continue with its water quality monitoring effort in order to detect changes resulting from upstream impacts.

3.1.8 Curecanti NRA Impacts

The scoping report at length discussed Curecanti NRA infrastructure that may impact resources at the park. The scoping report lists seven items of concern that will be discussed in this document or that are already being dealt with by divisions other than Resources Management. In order of priority impacts from Curecanti NRA's own operations are:

- The effects of parking lot runoff from the maintenance parking lot at Elk Creek.

- Background levels of hydrocarbons in the reservoirs and the effects of hydrocarbons on the water quality at the developed marinas and at the most used boat ramps.

- The effects of the Cimarron and East Portal septic systems on the Cimarron and Gunnison River, respectively.

- The extent of dumping of sewage from boats directly into the water, and the effects and efficacy of pumping sewage into the floating collectors at Elk Creek Marina and Lake Fork Marina.

- Replacement of the Elk Creek water treatment plant and reservoir. This project is addressed in a Development/Study Proposal (10-238) submitted by Curecanti on August 13, 1992.

- Elk Creek sewage treatment system's future capacity needs, location of a future site, and the need for primary treatment and-groundwater injection.

- Redesign and construction of the septic tank and leach field at the Lake Fork Campground.

The first item is addressed in this section. The next two items are addressed through the development of a cyclical monitoring program (see section 3.1.1). The fourth item is being addressed by the visitor protection division, and the latter three items will be addressed by the maintenance division. In particular, the redesign and construction of the septic tank and leach field at the Lake Fork Campground is completed.

3.1.8.1 Assessment of Maintenance Parking Lot Runoff

The park has identified that runoff occurs from the maintenance parking lot on a bluff above the road to Elk Creek Marina. This does not reach Blue Mesa Reservoir, but instead flows down the hill side filtering into the soil. Most of the maintenance vehicles are stored at this parking lot. Vehicles, including the pumper truck and garbage truck are washed also at this site. Curecanti NRA has characterized the runoff from the parking lot by sampling five separate events associated with either washing of vehicles or storm water runoff. ROF1 represents a sample from a storm event, and the remaining samples were taken when vehicles were being washed in the parking lot.

Samples were collected, preserved, and sent to Accu-Labs in Golden, CO for analysis. Results from the study reveal that little metals, oil&grease, and total hydrocarbons were introduced to the area in question, until a new layer of asphalt was applied to the parking lot. Also noted, runoff from storm water events does not appear to differ from runoff associated with washing of vehicles with the exception of the last collection where newly laid asphalt contributed to high oil&grease and total petroleum hydrocarbons. Table 19 shows results from the study.

The area impacted by this runoff extends approximately 45 meters downslope from the parking lot. The width of the impacted area is approximately 7 meters. Immediate impact from the runoff would comprise an area approximately 28 square meters. However, if an extended event were to occur the entire 45 by 7 meter area could be impacted as evidenced by a small channel that downcuts through the soil. The impacted area does not even reach the road below the maintenance parking lot. This runoff is not likely to reach Blue Mesa Reservoir nor even reach groundwater, before evaporation. The groundwater in this area is present at the interface between the sandstone and Precambrian rock surface, which in places, is less than 100 feet below ground surface. This implies that metals could be absorbed by plants, or could be adsorbed to soil particles. The hydrocarbons may volatilize or form a residue on the soil and associated plant material. Plant die- backs have not occurred, in fact the grama grass is more robust in the impacted area.

Vegetation in the area consists of sagebrush, wheatgrasses, grama grass and smooth brome. If runoff had been extensive since the establishment of this drainage area in 1992, the plant community would begin to support baltic rush. However, no rushes are present and a patch of Canada thistle is present immediately below the concrete area adjacent to the parking lot.

Table 19. Results of maintenance parking lot runoff study.

Parameter	Sites, Date and Time				
	ROF1 6/1/95 14:00	ROF2 7/3/95 9:00	ERSI[a] 7/13/95 16:10	ROMA3 **9/28/95** 14:44	ROMA4 10/13/95 13:18
Ammonia - N (mg/L)	-9.9[e]	0.1	1.8	4.7	0.5
Nitrate - N (mgL)	-9.9	-9.9	3.7	1.2	4.1
OrthoP - P (mg/L)	-9.9	0.01	0.14	0.2	0.4
T. Phosphorus - P (mg/L)[b]	-9.9	0.2	0.4	0.5	0.4
TKN` (mg/L)	-9.9	1.0	5.0	2.0	2.0
Oil&Grease (mg/L)	-9.9	5	4	4	170
TotPetHydro (mg/L)[d]	-9.9	0.5	6	6	340
Cadmium (mg/L)	<0.005	<0.005	<0.005	<0.005	0.016
Copper (mg/L)	0.015	0.008	0.022	0.027	0.061
Iron (mg/L)	2.0	0.73	0.01	2.7	14
Lead (mg/L)	0.006	<0.005	<0.005	0.008	0.052
Manganese (mg/L)	0.12	0.12	0.14	0.37	1.1
Mercury (mg/L)	<0.00010	<0.00010	<0.0001	<0.00010	<0.00010
Selenium (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005
Silver (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (mg/L)	0.080	0.050	0.026	0.19	1.0

[a] Metals were measured in their dissolved form for this collection. All other samples were not filtered.

[b] T. Phosphorus indicates total phosphorus
TKN indicates total Kjeldahl nitrogen
[a] TotPetHydro indicates total petroleum hydrocarbons

[e] -9.9 denotes no data taken

Runoff discharge is estimated at 0.0006 cubic feet per second or 0.25 gallons per minute for each runoff event sampled. If a large storm event were to occur runoff could be much higher and actually calculated based on size of parking lot and amount of rainfall per hour. Here in the semi-arid west, typical rainfall events are of short duration, intense and do not exceed tenths of inches. In contrast, accumulated snow is plowed off the parking lot and left to melt in the surrounding area. Thus, runoff from snowmelt does not always occur in the area under question, but instead melts on surrounding vegetation.

Presently, the velocity of the flow running off the parking lot is dissipated by a small area of concrete which is seamed with rocks. The runoff moves through several small channels and then onto the vegetation. If_ metals were high for every sample, then another approach may be required to alleviate contamination of the hillslope. Such a design includes an underground stormwater runoff detention

system or containment pond. These alternatives are limited in that runoff would have to be taken from the systems and processed some other place.

Again, the park recognizes that stormwater runoff quality is the worst after the parking lot is re-surfaced. This occurs every seven to eight years. With this frequency and with the small amount of runoff occurring, the best approach is perhaps to limit the amount of vehicle washings up to two months after resurfacing.

3.1.9 Drinking Water and Wastewater Treatment at Curecanti NRA

3.1.9.1 Drinking Water

Curecanti NRA has eleven water systems of which the Elk Creek system serves the greatest number of visitors and staff, and is operated throughout the year. These systems include those served by the wells listed in Table 18 as well as the East Portal and Iola systems, and the Gateview, Dry Gulch, and Red Creek systems. Table 20 identifies each well, notes the Colorado State Health Department's drinking water permit number, and actual pumping rates. East Elk Creek, Dry Gulch, Red Creek, and Gateview Campgrounds are served by solar pumps and treated by chlorination.

Table 20. Drinking Water Well Location, PWSID #, and Pumping Rates.

Well Location	Pumping Rate (gpm)	**PWSID** #
Iola	11.5	32601
Stevens Creek	15	326002
Elk Creek	20.5	326003
East Elk Creek	1	326004
Dry Gulch	1	326005
Red Creek	1	326006
Gateview	1	326007
Lake Fork	30	326007
Ponderosa	25	326009
Cimarron	5.5	326010
East Portal	11.5	32011

The primary source of culinary water for the Elk Creek area comes from two groundwater wells located in the Elk Creek Campground. These wells are approximately 400 feet deep. Westwater Associates (1991) discussed location of new wells for drinking water including exploration of Haystack Gulch, Dry Creek area and East Elk Creek north of Highway 50. A recommendation was made to proceed with a test well at the East Elk Creek site, though this option was not taken and wells were revitalized at the Elk Creek Campgrounds.

As a back up to the existing system, Curecanti NRA can pump water from Blue Mesa Reservoir through a 2.5" diameter 340' long pipe. This water is treated by 2 pressure-rapid sand filters, bag filters, and chlorinated. A 200,000 gallon reservoir stores water for the approximate maximum demand

of 70-80,000 gpd. A 550' deep well drilled in 1973, now abandoned due to geologic activity that sheared the casing, is used for injection of the backwash from the lake water filtration plant under a US Environmental Protection Agency (EPA) permit (File # CO5000-03914). Another EPA permit (CO-0034657) for surface discharge of this backwash is maintained, but not used due to the inability of the effluent to meet the current standards without treatment. The Elk Creek water supply needs to be upgraded. A Development/Study Proposal (10-238) to replace the water treatment plant and reservoir was submitted in August of 1992 (Steve Riley, Facilities Manager, Curecanti NRA, pers. comm., 1994).

Private septic systems exist upstream of the Iola Picnic Area and the park is concerned that this may affect water supply at the park's well. The park needs to document such an effect, if in fact, it is a problem. Lastly, the Lake Fork well is very close to the highway, and impacts from potential spills on the highway may be potentially realized in this drinking water system.

All water supply systems at Curecanti NRA with the exception of the Elk Creek wells are shallow wells near streambeds or reservoirs. All wells have been tested for surface water influence, and at this time show no evidence of such influence (Greg Walker, Maintenance Division, Curecanti NRA, pers. comm., 1994). All wells have state permits. Water at the Cimarron Visitor Center is potable, but of poor quality with the existing treatment. Presently, there are no plans to improve this drinking water source. In the fall of 1994, the park capped and removed the pumping equipment from four unused wells - these wells, Neversink, Beaver Creek, Cooper Ranch, and East Cimarron, are now inactive.

To meet Federal Safe Drinking Water Act (40 CFR § 141-144) requirements and NPS-83 (NPS, 1993), Curecanti NRA samples for total coliform bacteria at each of the operational wells on a bimonthly basis. The park, however, is required by the state to sample only on a quarterly basis at the handpump sites. Samples are analyzed at the City of Gunnison Water Laboratory using the most probable number (MPN) methodology. Only the Elk Creek system remains functioning during the winter; the other well systems operate from approximately May through September. Beginning in 1993, Curecanti NRA was required to sample for radionuclides, inorganics in 1994, and organics in 1995. This sequence will begin again in 1996. However, through the Chaffey Amendment, Curecanti NRA was able to waive the organic testing requirement (Greg Walker, Maintenance Division, Curecanti NRA, pers. comm., 1994). Also Curecanti NRA is required to test for nitrates on a quarterly basis at each of the operating wells. Nitrite testing was waived as a result of chlorination used as a disinfection technique (Greg Walker, Utility Worker, Curecanti NRA, pers. comm.).

3.1.9.2 Waste Water Treatment

Waste water at Elk Creek is treated in an open air lagoon system consisting of two primary and two secondary lagoons. No aeration is provided. However, funding has been requested to install the necessary equipment to handle the high biological oxygen demand caused by the fish cleaning station (Steve Riley, Facilities Manager, Curecanti NRA, pers. comm., 1994). The lagoons were originally lined with bentonite clay, but loss of sealing led to lining them with polyethylene in 1989. Low flush toilets were installed in 1990 when it became apparent that total lagoon capacity was insufficient to handle existing flows. Staff gauges installed as part of the lining contract have caused leaks in the toe of the lagoons, allowing effluent to reach organic matter under the liners. The resulting bubbles of trapped gases further diminished lagoon capacity. One primary lagoon was removed from service in 1994 to install perforated pipe and gravel under the liner to vent gases. The parks needs to assess the potential for future growth in the area in order to determine the relative increases in loading to the lagoon system. Depending upon the assessment, the park may expand the existing facilities or change to different waste water treatment facility.

The Lake Fork waste water system consists of a series of septic tanks and a gravity fed leach field. In 1994, the leach field was nonfunctional due to sedimentation in the feed and leach lines from the septic tank. A temporary line was placed in the existing. The fish cleaning station was closed through the end of the summer. Regional maintenance and US Public Health Service staff have visited the site to assist in properly sizing and engineering a system to handle future waste water loading at Lake Fork. A new and functioning system is in place.

At the Iola Picnic Area, a septic tank and a leach field, which serves a fish cleaning station and a flush toilet comfort station, appears to function properly.

Curecanti NRA has identified a need for a fish cleaning station at the Stevens Creek campground. Park maintenance staff is reviewing the feasibility and capacity of a composting fish cleaning station, with the potential of using them at Steven's Creek and to replace existing ones on Elk Creek, Iola and Lake Fork.

At Cimarron, the park has a septic system that receives a heavy inflow, and presents a potential problem. One of the park's water quality monitoring sites, located on Cimarron Creek, is below the septic system. From Curecanti NRA's 1988-1992 water quality monitoring program, the park has data which documents fecal coliform counts of nearly the same level or variability above and below the leach field. Most likely the inflows from Squaw Creek, a polluted water source, outweigh the effects of potential problems associated with the leach field.

At East Portal, the park has a septic system which was placed into service 1971 prior to state regulations regarding individual sewage disposal systems (Steve Riley, Facility Manager, Curecanti NRA, pers. comm., 1994). Replacement would not be possible at the existing location. Very low loading occurs at this facility now. The park has a water quality monitoring site on the Gunnison River immediately downstream of the septic system, and in 1993 completed special monitoring on the Gunnison River above and below estimated inputs from the septic system. At that time, no problem was identified.

Curecanti NRA has vault toilets located at 25 sites which are associated with either campgrounds or picnic areas. In most cases these vault toilets are located near streambeds. Several times a year, these toilets are pumped, and the waste taken to the lagoon system at Elk Creek. One of the park's water quality monitoring sites is located downstream of the Pine Creek vault toilet. To date, the fecal coliform counts at this site have been low (maximum = 29 CFU/100ml).

4. Project Statements

Curecanti NRA presents eight project statements which if funded would either 1)complement the existing water quality program, 2) provide much needed baseline information, 3) increase interagency coordination, 4) clarify the park unit's water rights, or 5) keep at bay the listing of yet another fish species on the endangered species list.

Curecanti NRA already has established a thorough water quality monitoring program, but questions remain regarding the biota that inhabit the aquatic system, and the dynamics of the lower two reservoirs. These projects statements attempt to focus and round out a water resources program that has been ongoing since 1983.

The project statements with budgets and literature cited are provided. The funding includes FTE costs with specific grade levels defined, but not the FTE requirements. Also included are equipment, vehicle, and supply costs. In order of priority, Curecanti NRA lists the following project statement titles with the entire statements to follow:

CURE-N-23.130	Monitor Hydrological and Ecological Conditions in a Shallow Wetland Flood Plain of Curecanti National Recreation Area
CURE-N-045.000	Clarification and Establishment of Water Rights
CURE-N-041.000	Assessment of Metals Contamination in Fish
CURE-N-044.000	Establishment of Cutthroat Trout
CURE-N-042.000	Productivity of Morrow Point and Crystal Reservoirs
CURE-N-043.000	Control of Nonpoint Source Pollution to Cimarron Creek
CURE-N-040.000	GIS-Based Watershed Assessment
CURE-N-006.000	Develop Fisheries Management Program

Project Statement CURE-N-023.130
Last Update: 06/14/96
Initial Proposal: 1996
Title: MONITOR HYDROLOGICAL AND ECOLOGICIAL CONDITIONS IN A SHALLOW WETLAND FLOODPLAIN OF CURECANTI NATIONAL RECREATION AREA Funding Status: Funded: 0.00 Unfunded: 50.00
Service Wide Issues: N20 (BASELINE DATA)

Problem Statement: Curecanti National Recreation Area encompasses three impoundments on the Gunnison River. These reservoirs form the main recreational feature of the park unit. The eastern most portion of Curecanti NRA, however, is comprised of a riverine system, essentially unaltered since the construction of the reservoirs. This diverse riparian area harbors a mature cottonwood *(Populus angustifolia)* overstory with an herbaceous understory. Numerous ephemeral pools and wetland areas adjoin the river. Two developed picnic areas also provide fishing access, hiking, birdwatching, and other recreational activities. As the result of floods in 1984 and 1993, the river has changed channels from a human maintained course to one of its natural channels. This current channel lies further from a state highway than the previous channel thus potentially diminishing the immediate recreational opportunities offered at the picnic areas. This channel change, however, has provided excellent regeneration sites for cottonwoods via scouring of stream bed and bank areas and an opportunity to interpret the significance of natural, meandering river systems to visitors. In addition, to the south of the current channel, a wet meadow receives sub-irrigation waters and is included as a long-term ecological monitoring site. Currently, there is pressure from the local community to force the river back to a previous channel.

A recent scoping report (National Park Service, 1995) of water resource issues concerning Curecanti NRA suggests that floodplain dynamics, cottonwood regeneration, wetland and riparian areas of the Gunnison River above Blue Mesa Reservoir be assessed and preserved.

The opportunity arises to monitor the hydrological regime which underlies the upper Gunnison river area (T49N,R1W,Secl8) and determine it's affects on the physicochemical and biological conditions of the hyporheic and adjacent riparian systems. There is no current understanding of the hydrological regime from the proposed area to the beginning of the Blue Mesa impoundment. Knowledge of the influence of changing reservoir elevations on the hydrological regime of this meandering river system would allow Curecanti NRA to:

- Provide base-line hydrologic, chemical, and biotic data before proposed re-operation of Blue Mesa reservoir for in-stream flow needs of endangered fish within and below Black Canyon of the Gunnison National Monument and it's yet unquantified reserve water right.
- Interpret the importance of natural, dynamic systems to visitors.

*Model potential impacts to sensitive wetland and hyporheic systems, and provide indisputable hydrologic data which can be presented to current community pressure to move the channel.

*Provide the scientific community and other park units with data regarding chemical and biotic components of reservoir/groundwater interactions.

'Describe possible trophic interactions among and between wetland and hyporheic invertebrates, and terrestrial and aquatic vertebrates.

Alternate Actions and Their Probable Impacts: No action would result in lack of any groundwater information for one of the main riparian areas within the Curecanti boundary. This area includes long term monitoring sites, cottonwood regeneration sites, and a newly established great blue heron *(Ardea herodias)* rookery. In addition, county government perceives that a change in flow of the Gunnison River has diminished the recreational experience. Without our ability to monitor depth to water table, Curecanti NRA will not be able to provide basic information to the long term monitoring program nor supplement efforts to understand the dynamics of the Gunnison River ecosystem.

Description of Recommended Project or Activity:

Establish a series of monitoring wells

Recent investigations have demonstrated distinct physicochemical subsystems associated with ephemeral aquatic environments (Stanley & Boulton, 1995; Boulton & Stanley, 1995; Williams, 1993). In addition to adjacent wetland areas and groundwater zones, the shallow hyporheic zone extends to approximately 50 cm sediment depth beneath the river channel; the phreatic zone between 50 cm and bedrock; the parafluvial zone includes saturated sediments lateral to the wetted channel; and the dry channel hyporheic, is composed of former shallow hyporheic and phreatic areas that remain saturated after the loss of surface flow (Stanley & Boulton, 1995).

The Upper Gunnison River is similar to these systems in that seasonal reservoir levels affect ground and surface water levels. Many models assume a static hydrologic system, although conditions of the proposed study site would predict a more elastic system which changes with such anthropogenic disturbances as fluctuating reservoir levels. Therefore, the size and chemical interface between surface water, groundwater and hyporheic zone should show spatial and temporal variation (Gibert et al., 1990).

This effort would allow mapping of the hydrological regime at our long term monitoring site and near the river where in-channel flow has changed. A series of 10 monitoring wells in approximately 5 transects would be established in the area. These wells will be dug to various depths to intersect the hyporheic, phreatic, and parafluvial zones associated with the Gunnison river. The wells would be associated with the long term monitoring site, newly established cottonwood regeneration monitoring sites, and the new and abandoned river channels. Depth to water table would be measured continuously in critical wells using several pressure transducer/datalogger systems. Other wells would be monitored continuously and weekly for depth to water table in addition to in situ pH, conductivity, and dissolved oxygen. In addition, wells would be bailed and analyzed for total nitrogen, nitrate, ammonia, and total phosphorus to delineate true hyporheic, phreatic, and parafluvial zones (sensu Stanley & Boulton, 1995). Standing water depth of adjoining wetland areas and in-stream velocity would also be recorded. Data would be analyzed and mapped in light of the long term monitoring program and changes in flow regimes of the Gunnison River.

Sample wetland and hyporheic invertebrates

Boulton and Stanley (1995) maintain that most investigations concerning anthropogenic impacts to natural systems are based on acute "pulse" disturbances, but protracted "press" events such has the effects of lowering Blue Mesa reservoir should also be examined. These events essentially shrink or swell the amount and size of the groundwater/hyporheic interface and potentially diminish the amount of habitat useable by lotic and hyporheic invertebrates. Changes in nutrients and dissolved oxygen

concentration of hyporheic and wetland areas due to falling water table, may force invertebrates from normal refugia, thus decreasing survivability of entire invertebrate populations (Boulton & Stanley, 1995). Also, current knowledge of aquatic insect ecology and taxonomy within wetland areas is finite.

In addition to physicochemical mapping of the upper Gunnison river, both wetland and hyporheic invertebrates will be sampled to determine vertical and horizontal subsystem boundaries. Distinct variations in invertebrate fauna occur between these zones. Groundwater wells will be sampled quarterly with a manual bilge pump (sensu Boulton & Stanley, 1995) for subsystem invertebrates. In addition, wetland areas will be sampled quarterly using sampling techniques of MacKay (1993). Invertebrate data will then will correlated with physicochemical data to determine impacts of reservoir elevation on flow regimes and invertebrate and ecosystem viability.

Anticipated Products
This project is long term with a minimum sampling scheme of two years and will provide baseline data, as well as additional information for the already established long term monitoring program. This investigation will also meet the recommendations outlined in the recent Curecanti scoping report (National Park Service, 1995).

These data will also help to characterize how changes in flow regime occur as a result of abandonment of channels in the Gunnison River, presently a critical issue at Curecanti NRA. These conclusions can then be utilized by other park units and the scientific community as a template for reservoir/groundwater investigations. This investigation will allow interpretive staff to discuss dynamic systems and their relation to the ecosystem, with park visitors. Invertebrate ecology and taxonomy, and the regeneration of cottonwood stands can also be discussed as critical components of this riverine ecosystem.

Personnel: This project requires a biological science technician (GS-5) for 3 months for two years in order to install the equipment and begin monitoring. Once the monitoring network is established, the program can be carried out with base funding.

Compliance: CATEGORICAL EXCLUSION based on 516 DM2 APP. 2, 1.6

Relationships: This project is not related to other projects. Funding:

CURE-N-0023.130	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personnel	4,500	5,000		
Other	36,750	3,750		
TOTAL	41,250	8,750		
Funds Available in Park	4,500	5,000		
Additional Funds Needed	36,750	3,750		

Explanation
BUDGET AND FTEs
Year 1 Equipment:
Dataloggers and Associated Hardware $10,000

	Pressure Transducers and Associated Hardware	$10,000
	Multiparameter Water Quality/Datalogging Units	$10,000
	Compound Microscope.	$ 1,500
	Dissecting Microscope	$ 1,500
	Miscellaneous Equipment Expense	$ 1,000
	Vehicle:	$ 1,250
	Chemical Analysis:	$ 1,500
	FTEs: 3 months GS-05	$ 4,500 (field technician)
Year 2	Miscellaneous Equipment Expense	$ 1,000
	Vehicle:	$ 1,250
	Chemical Analysis:	$ 1,500
	FTEs: 3 months GS-05	$ 5,000 (field technician)
	Total 2 year budget:	$50,000

Annual Project Status and Accomplishments: This report will be initiated once work begins on this project.

Boulton, A.J. and Stanley, E.H. 1995. Hyporheic processes during flooding and drying in a Sonoran Desert stream 2. Faunal dynamics. Arch Hydrobiol 134(1): 27-52.

Gibert, J., Dole-Oliver, M.J., Marmaonier, P. & Vervier, P. 1990. Surface water-groundwater ecotones. - In: Naiman, R.J. & Decamps, H. (eds.): The Ecology and Management of Aquatic-Terrestrial Ecotones. Man and the Biosphere Series. -UNESCO, Paris & Parthenon Publishing, Camforth, pp. 199-225.

Mackay, J., E. Mackay, and H. Ned. 1993. A sampler for quantifying the vertical distribution of macroinvertebrates in shallow wetlands. California Fish and Game 79(3): 126-130.

National Park Service. 1995b. Curecanti National Recreation Area Water Resource Scoping Report. Technical Report NPS/NRWRS/NRTR-95/54. Water Resources Division, Fort Collins.

Stanley, E. H. and Boulton, A. J. 1995. Hyporheic processes during flooding and drying in a Sonoran Desert stream 1. Hydrologic and chemical dynamics. Arch Hydrobiol 134(1): 1-26.

Williams, D. D. 1993. Nutrient and flow vector dynamics at the hyporheic/groundwater interface and their effects on-the interstitial fauna. Hydrobiologia 251: 185-198.

Project Statement CURE-N-045.000
Last Update: 07/16/96
Initial Proposal:1996
Title: CLARIFICATION AND ESTABLISHMENT OF WATER RIGHTS
Funding Status: Funded:0.00 Unfunded: 15.00

Problem Statement: Water rights issues at Curecanti NRA fall into the following categories: (1) groundwater resources; (2) tributary inflows to Blue Mesa, Morrow Point, and Crystal reservoirs; (3) consumptive water use from Blue Mesa Reservoir by NPS staff and/or visitors; and (4) coordinated management (through contract discussions with the Bureau of Reclamation) of reservoir water levels to maintain park resources.

Ground Water Wells

Curecanti NRA recognizes and manages 14 ground water wells within park boundaries (Table 1). None have been adjudicated. These wells serve as culinary sources used by visitors and staff members. Of the fourteen recognized wells, eleven have drinking water permits. Of those eleven, the Neversink, Beaver Creek, Cooper Ranch, East Cimarron and Riverway are now inactive, the handpumps pulled, and the wells plugged. Information regarding well permits for the Red Creek, Iola, Dry Gulch, and East Portal wells is unavailable, however, these wells are active, do have drinking water permits, and are tested for potability during the summer season.

Tributary and Side Flows to Curecanti NRA Reservoirs

Curecanti NRA has at least one known water right on tributary inflow to the Aspinall Unit. The State of Colorado, Gunnison County water files indicate a 1.85 cfs right on East Elk Creek, a tributary to Blue Mesa Reservoir. This right, deeded to the BoR prior to the construction of Blue Mesa Dam, is comprised of the Henry F. Ditch and the Elk Creek Ditch. These two ditches deliver water to the irrigation system at the present day Elk Creek Visitor Center and Campground, and are believed to have been constructed in the late nineteenth century.

Prior to the Bureau of Reclamation's acquisition of the water right, the Colorado Division of Wildlife maintained the canals from East Elk Creek to the present day Elk Creek Visitor Center and Campground. Administration of this water right is believed to have been transferred to the National Park Service in 1965 when Curecanti NRA was organized to administer recreational activities at the Aspinall Unit.

In 1969, Curecanti NRA upgraded the Elk Creek irrigation system. This consisted of a concrete diversion clam, excavation of approximately 22,005 feet of earth lined ditch, four long span pipe structures, lateral turnout boxes, concrete siphon boxes and metal pipe sections. Proper operation of the project required a full-time irrigator position during the spring, and for several hours almost daily through the summer By 1978 the necessary man-hour commitment to tend the system was discontinued, which resulted in extreme flooding in the Elk Creek Campground. Since 1993, however, the irrigation system has been used to control prairie dog populations and to revegetate denuded areas around the visitor area and the campground.

Curecanti NRA wishes to continue to develop and use East Elk Creek water via the Henry F. Ditch and the Elk Creek Ditch for irrigation purposes near and in the Elk Creek Visitor Center and Campground.

Table 1. Well Locations and Permit Numbers.

Well Name	Permit #	Date of Priority	Quantity of Water*
Elk Ck Well	68522**	06/28/93	40-5- gpm: 200,000 gal storage
Elk Ck Well #1	33692-F	01/11/90	11 gpm: 24ac-ft per yr
Elk Ck Well #2	32263-F	12/15/89	50 gpm: 40ac-ft per yr
Stevens Ck Well	119675	10/07/80	15gpm: 1.6ac-ft per yr
Cimarron Town Well	119613	09/29/80	l lgpm: 6.5ac-ft per yr
East Elk Ck Well	119671	10/30/80	5gpm: 0.8ac-ft per yr
Lake Fork Well	31666-F**	05/20/89	30gpm: 10ac-ft per yr
Gateview Well	139681	05/23/85	1pgm: 0.3ac-ft per yr
Ponderosa Camp Well	28618-F	6/21/85	25gpm: 10ac-ft per yr
Beaver Ck Well	119676	10/07/80	5 gpm: 0.8 ac-ft per year
Neversink Well	119673	10/10/80	5 gpm: 0.8 ac-ft per year
Riverway Well	119674	10/16/80	5 gpm: 0.8 ac-ft per year
Cooper Ranch Well	119677	10/15/80	5 gpm: 0.8 ac-ft per year
East Cimarron Well	119672	09/30/80	3.7 gpm: 0.8 ac-ft per year
Iola Ck Well	no data		
Dry Gulch Well	no data		
Red Ck Well	no data		
East Portal Well	no data		

* Proposed maximum pumping rates (in gallons per minute - gpm), and average annual amount of ground water appropriation (in acre-feet).

** Permit numbers taken from Well Completion and Pump Installation Report

Consumptive Use from Blue Mesa Reservoir

Under Colorado state law, the BoR's Aspinall water rights are currently sanctioned as direct flow rights and storage rights; the rights entitle the United States to consumptively use water for the purposes decreed. To date, Curecanti NRA staff have been operating under the assumption that an existing contract between the BoR and the NPS authorized Curecanti NRA to use 500 acre-feet of water from Blue Mesa Reservoir for culinary purposes. However, recent discussions with the BoR (Steve McCall, BoR, pers. comm.), have revealed that no such contract exists. The BoR, however, has suggested that the NPS pursue contract discussions with them if the NPS wishes to continue this use of Aspinall water

Alternative Actions and Their Probable Impacts: No Action. This alternative would preclude the park unit from establishing its water rights. Uses for culinary purposes and irrigation be nullified.

Description of Recommended Project or Activity: Curecanti NRA would request technical assistance from the NPS Water Resources Division to verify information in Table 1 with the Colorado State Engineer's Office; missing or inaccurate information should be appended or corrected. Curecanti NRA staff must assess their current and anticipated use associated with each well listed and determine the need for adjudication. The NPS Water Resource Division (WRD) will then assist Curecanti NRA in the process of adjudicating those existing well permits that are not currently decreed.

Curecanti NRA staff will determine the current status of the East Elk Creek water right, assess current water use and anticipated needs at all reservoir tributaries, and with assistance from WRD, initiate water right application procedures as appropriate and necessary.

Curecanti NRA staff should determine the magnitude of consumptive use water required to meet anticipated culinary needs as Curecanti NRA and, based on that determination, make a recommendation to the NPS Water Resources Division to pursue a contract with the BoR for the appropriate amount of Aspinall Unit water.

Curecanti NRA would request that the Water Resources Division assist the park unit in the adjudication process of the requested water rights for wells and diversions and to help in developing a contract between the NPS and the BoR for consumptive use of water in Blue Mesa Reservoir.

Personnel: This project requires the assistance of the Water Resources Division with the Chief, of Resources Management and the Superintendent fostering the project.

Compliance: CATEGORICAL EXCLUSION Relationships:

This project is not related to other projects. Funding:

CURE-N-041.000	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	7,500	7,500		
Other	0	0		
Total	7,500	7,500		
Funds Available in Park Base	0	0		
Additional Funds Needed	7,500	7,500		

Annual Project Status and Accomplishments: This report will be initiated once work begins on this project.

Project Statement CURE-N-041.000
Last Update: 05/08/96
Initial Proposal: 1996
Title: ASSESSMENT OF METALS CONTAMINATION IN FISH
Funding Status: Funded: 0.00 Unfunded: 3.50
Servicewide Issues : N00 (FISHERIES)
N-RMAP Program codes : Q00 (Water Resources Management)
QOl (Water Resources Management)

Problem Statement: Over one million visitors come to Curecanti NRA; of those greater than 50% fish the waters of the three reservoirs that comprise the park unit. For those that fish the flatwaters of the reservoirs, many keep their catch for food. One of the objectives of the park is to insure a safe and palatable fishery for visitors consumption.

In 1983 and again in 1987, fish samples were taken from Blue Mesa Reservoir to determine metals contamination in the flesh of these organisms. The 1983 effort culminated in a document (Kunkle et.al., 1983) that found metals at levels not harmful to humans. Although average intake of aluminum, based on consumption of one pound of brown trout from Blue Mesa Reservoir exceeds the average daily consumption, there is little research which contends that aluminum coming from water supplies, cooking utensils, or baking powder is harmful to humans (Kunkle et.al., 1983). The study concludes that chemicals found in tissue of fish from Blue Mesa Reservoir are at levels comparable to those found in other studies. From the perspective of toxicity to humans, the amount of cadmium, mercury, or other metals consumed in fish taken from the reservoir would be minimal. If, however, large scale mining, urbanization, or industrial development were to take place, then a more intense program of sampling should commence. In the meantime, the report suggested sampling for contaminants in fish tissue every five years.

In 1987, another effort was made to sample for metals in fish tissue from Blue Mesa Reservoir USFWS, 1987 unpublished data). The US Fish and Wildlife Service assisted the Division of Wildlife and park staff with sampling at four sites on the reservoir.

Findings from this study corroborate earlier findings with the exception of what appear to be elevated zinc and selenium levels. Elevated selenium levels in brown trout livers appear anomalous, but nonetheless, important in determining if fish are healthy and not harmful to humans. The data are available from this effort, but their was no attempt to analyze the information.

Alternative Actions and their Probable Impacts: No Action. This alternative would further our lack of understanding regarding the status fish palatability. Discussions regarding whirling disease prevail in the park; these discussions and questions typically lead to "Are the fish safe to eat?" Based on data from ten years. ago, the fish are safe to eat, but the park should be able to answer positively based on more current information.

Description of the Recommended Project or Activity: Initiate another round of fish tissue analysis from Blue Mesa Reservoir and include Morrow Point Reservoir and Crystal Reservoirs.

By coordinating with the US Fish and Wildlife Service and the Division of Wildlife, Curecanti NRA could initiate another round of fish tissue sampling. Discussion with US Fish and Wildlife

regarding zinc and selenium levels (R. Krueger, 1995, pers. comm.) reveal that high levels of selenium and zinc in brown trout livers are documented in other studies; they do not understand the mechanism which facilitates the preferential uptake and storage. Since livers are rarely eaten, their concern is minimal.

The sampling effort would mimic the two previous efforts in that fish flesh and organs would be collected for analysis. Gill nets would be placed at the four sites similar to those sampled in 1987 in Blue Mesa Reservoir. One gill net suspended from shore to shore would be placed in each of the lower reservoirs. A total of fifteen organisms would be randomly collected but representative of the species that were caught. All organisms differ in their ability to accumulate metals and other compounds. This effort would recognize that many metals accumulate in the liver and kidney, but mercury tends to accumulate throughout the body. Samples from flesh and organs would be taken.

In concert with the National Water Quality Assessment (NAWQA) program which takes fish tissue and sediment samples above and below the Aspinall Unit, Curecanti NRA could review results from the NAWQA program and from the past and present studies on fish tissue. In this way, Curecanti NRA might be able to isolate and attribute any contaminant problems to upstream or in park-sources.

Personnel: This project would be completed by US Fish and Wildlife personnel with the assistance of park personnel if required.

Compliance: CATEGORICAL EXCLUSION based on 516 DM6 APP. 7.4 D

Relationships: This project is not directly related to projects listed in this plan.

Funding:

CURE-N-041.000	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	500			
Metals Analysis	4,000			
Total	4,500			
Funds Available in Park Base	0			
Additional Funds Needed	4,500			

Annual Project Status and Accomplishments: This report will be initiated once work begins on this project.

Project Statement CURE-N-044.000
Last Update: 05/21/96
Initial Proposal: 1996
Title: ESTABLISHMENT OF CUTTHROAT TROUT
Funding Status: Funded: 0.00 Unfunded: 18.00
Servicewide Issues : N00 (FISHERIES) N17 (BIODIVERSITY)

Problem Statement: The Gunnison River, Colorado, a fishery so well known to the public since the early 1900's, has been a stocked fishery since the late 1880's. Prior to introduction of non-native trout species, cutthroat trout *(Oncorhyncus clarla),* bluehead and flannel mouth suckers *(Catostomus discolubus, C. latipinnis),* and speckled dace *(Rhinichthys osculus)* flourished in the upper Gunnison River; this lack of biodiversity reveals that a changing environment and introduction of non-native fish species could expose the community to replacement (which is the case) and possible extinction (which has locally occurred in the upper Gunnison River) (Behnke, 1993). Without management, in the worst case, Colorado River cutthroat trout native to this basin could become extinct; in the best case, the cutthroat trout population would remain small but stable in the basin. The Colorado River cutthroat subspecies is not listed as threatened or endangered under the Endangered

Species Act, but is classified currently as Category 2 by the US Fish and Wildlife Service, a sensitive species by Regions 2 and 4 of the US Forest Service, and has special status in Colorado, Utah, and Wyoming (Young, 1995).

Through inter-agency cooperation, the US Forest Service, the BLM, the Colorado Division of Wildlife, and the NPS, native cutthroat trout have been introduced to North Beaver Creek on Forest Service land. Curecanti NRA desires to continue with re-introduction of the Colorado River subspecies in East Elk Creek, West Elk Creek, and Curecanti Creek. Based on a recommendation from the Curecanti National Recreation Water Resources Scoping Report (1995b) investigators from Colorado State University were contracted to determine the feasibility of establishing populations of Colorado River cutthroat trout in streams draining into Curecanti National Recreation Area. To that end, Gowan and Fausch (1996) discuss their findings and recommendations. The investigators with assistance from Colorado State University students walked the three drainages mentioned above to locate permanent migration barriers capable of preventing movement of non-native trout into candidate reaches, and to evaluate trout habitat quality. They also discuss concerns regarding whirling disease which is present in many of the streams and reservoirs of Colorado including the Gunnison River and Blue Mesa Reservoir. Lastly, they discuss potential sources of brood stock for use in re-introductions.

Gowan and Fausch (1996) found that in West Elk Creek, a migration barrier exists at 11.5 miles upstream from the mouth of the creek. From this point upstream they estimate that 1.5 miles of suitable habitat may exist, but temperature may prove too low to support a fishery. In Curecanti Creek, they found a migration barrier near the mouth of the 14.5 mile stretch that they surveyed. They determined that introductions of cutthroats to this creek may be more difficult due to the extent of private property and three active water rights on the creek. In East Elk Creek, no migration barriers were found along the eleven miles that were surveyed. Removal of non-native fishes would prove extremely difficult due to the number of beaver ponds on reaches in the Sapinero Wildlife Area. A migration barrier would have to be constructed.

Gowan and Fausch (1996) note three candidate sources for Colorado River cutthroat trout in the Gunnison Basin; these include Road Beaver Creek, Deer Beaver Creek, and Second Creek. However, some question remains regarding the purity of the cutthroat trout in these streams. Nanita Lake in

Rocky Mountain National Park contains possible brood stock, but these fish are only partially derived from the Gunnison River basin stocks. The importance of using Colorado River cutthroat trout as the brood stock stems from the fact that this subspecies is endemic to the Colorado River Basin and inhabits about 1% of its former range that included parts of Utah, Wyoming, Colorado, Arizona, and New Mexico (Behnke, 1992).

Gowan and Fausch (1996) note that all potential brood stock must test negative for whirling disease before introduction. In addition, the receiving creeks should also test negative for whirling disease; if they test positive, no cutthroat trout should be introduced, because Colorado River cutthroat trout are known to be susceptible to the disease.

Alternative Actions and Their Probable Impacts: No Action. This alternative would preclude the possibility developing a naturally reproducing population of Colorado River cutthroat trout in additional drainages to the north side of Blue Mesa Reservoir.

Description of Recommended Project or Activity: Prior to initiation of any Curecanti NRA-based project regarding cutthroat trout, the report completed by Gowan and Fausch (1996) should be read. They recommend that any introduction program be based on a coordinated basin-wide review of suitable habitat and, once decided upon, the introduction proceed in three steps. First, non-native fish are removed from the reach by using toxicants such as rotenone. Second, cutthroat trout are introduced over several years, and, third, monitoring of success is conducted. They emphasize that introduction requires a coordinated effort between the NPS, BLM, Colorado Division of Wildlife, US Forest Service, and the US Fish and Wildlife Service. The authors question whether Curecanti, West Elk Creek and East Elk Creek afford the greatest potential for introduction success. They suggest that all interested parties participate in a thorough review of streams in the basin that have suitable habitat. To date, the US Forest Service has surveyed many stream reaches in the Paonia District of the Gunnison National Forest. This information would serve as the basis for the larger review of suitable stream reaches. In their conclusions and recommendations section Gowan and Fausch (1996) note that of all three streams surveyed, West Elk Creek offers the best potential for expedient introduction of Colorado River cutthroat trout. Curecanti Creek offers good biological potential for introduction of cutthroat, but a portion of the up to 20 mile stretch is private and could lead to difficulties. East Elk Creek has potential, but the beaver ponds must be destroyed and a barrier created.

More importantly, the authors emphasize that interested parties must participate in a basin-wide effort which assesses additional candidate streams that may provide suitable habitat for introduction of Colorado River cutthroat trout. Curecanti NRA would initiate this review by 1) coordinating a meeting with the interested parties to list potential streams, 2) contracting with an investigator to walk the those streams listed during the initial meeting and to prepare a report summarizing findings, and 3) initiating the introduction of Colorado River cutthroat trout if the most suitable stream is located flowing into or within Curecanti NRA boundaries.

Personnel: This project requires the Chief of Resources Management, GS-12, to coordinate the initial meetings. In the following year, investigators will be contracted to walk and review additional stream mileage. The last year of the project will include introduction of cutthroat trout to waters. This project will be carried out in coordination with other agencies which will be contributing funds or in-kind services as well.

Compliance: Environmental Assessment

Relationships: This project is related to project statement CURE-N-006.000

Funding:

CURE-N-006.000	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personnel	7,804	8,000	5,000	0
Other	0	0	0	5,000
TOTAL	7,804	8,000	5,000	5,000
Funds Available in Park	7,804	0		0
Additional Funds Needed	0	8,000	5,000	5,000

Annual Project Status and Accomplishments: This report will be initiated once work begins on this project.

Behnke, R.J. 1992. Native trout of western North America. American Fisheries Society Monograph 6, Bethesda, MD.

Behnke, R.J. 1993. The Gunnison River Drainage and its Changing Fish Fauna. Part I: Historical Perspective and Part II: The Native Cutthroat Trout of the Gunnison Drainage and Potential for Restoration. Curecanti National Recreation Area, Gunnison, CO.

Gowan, C. and K.D. Fausch. 1996. Feasibility of establishing new populations of Colorado River cutthroat trout in streams draining into Curecanti National Recreation Area. Dept. of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO.

Young, M.K. 1995. Colorado River cutthroat trout, p. 16-23. In:Conservation assessment for Agriculture, U.S Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Project Statement CURE-N-042.000
Last Update: 02/08/96
Initial Proposal: 1996
Title: PRODUCTIVITY OF MORROW POINT AND CRYSTAL RESERVOIRS
Funding Status: Funded: 0.00 Unfunded: 100.14
Servicewide Issues: N11 (WATER QUAL-EXT)
N-RMAP Program codes : Q00 (Water Resources Management)

Problem Statement: One of the compelling features of Curecanti National Recreation Area is its series of three reservoirs. Blue Mesa serves as the primary water storage facility, Morrow Point Dam as the primary producer of hydro-power, and Crystal Reservoir as the re-regulation reservoir. Few reservoir systems in the United States are planned with re-regulation as a means of dissipating the vagaries of discharge related to storage and hydropower production. The lower two reservoirs, Morrow Point and Crystal Reservoirs, receive deep discharge waters from Blue Mesa Reservoir. As such, productivity of the latter two systems is likely to be less than if no impoundment were located upstream. Kimmel et. al. (1990) note that an upstream reservoir reduces the annual nutrient loading and also alters the seasonal patterns of hydrologic and nutrient input to downstream reservoirs as a result of sedimentation accumulation in the upper reservoir.

Of all the purposes of the Aspinall Unit, as noted in Section 8 of the Colorado River Storage Project Act of April 11, 1956, provision of recreation and preservation of natural resources are within the purview of Curecanti NRA. For this park unit, recreation on the reservoir translates into insuring a healthy fishery. For several years investigators from Colorado State University have focused on the direct and indirect effects of reservoir operation on the productivity of Blue Mesa Reservoir. Re-operation of the Aspinall Unit is imminent with demands for water for the endangered fish recovery program, for the Black Canyon of the Gunnison NM water right, and for replacement power needed by Western Area Power Administration (WAPA).

Johnson et.al. (1995), investigators from Colorado State University, in their annual progress report on Blue Mesa Reservoir, note that reservoir re-operation can reduce nutrient input and internal cycling, retention times, and alter angler access to the reservoir. Water level changes can shift the epilimnetic, metalimnetic, and hypolimnetic volumes which alters the density of plankton in each layer of water. Also, water level influences epilimnetic warming which affects a multitude of biological interactions including zooplankton community structure, phytoplankton production, consumption rates of planktivores, competition between planktivores, and predation rates of piscivores.

Reservoir retention time, basin morphometry, and climate interact to determine the thermal structure of reservoirs. This basic premise directs the investigators in their research towards understanding the mechanisms by which reservoir operations can impact productivity, and thereby, the quality of the fishery the reservoir supports. In their first annual report covering a period from May to August 1994 (Johnson et. al., 1995), reservoir discharge was below average and reservoir surface elevation was above average during 1994. Temperature profiles, which reflect thermal structure, did not show any effects of reservoir discharge on small scale patterns in temperature profiles at Sapinero Basin. The 1995 discharge pattern, from Blue Mesa Reservoir exceeded average discharge and, as a result, may reveal impacts to temperature profiles near the dam. Overall, changes in the thermal structure can affect density of plankton and piscivores at various depths in the reservoir.

Their efforts to determine relationships between the physical and biological aspects of the reservoir provide Curecanti NRA and the BoR with the ability to assess re-operation of the Aspinall Unit on the productivity of the fishery. However, the study ends at Blue Mesa Dam and does not incorporate effects of reservoir re-operation on Morrow Point or Crystal Reservoirs. These two reservoirs provide a backcountry and more primitive fishing experience while producing some very large fish. Because water requirements for endangered fish species, water rights for Black Canyon of the Gunnison NM, and replacement power production below the Aspinall Unit may affect Blue Mesa, so too may the lower reservoirs be affected.

Curecanti NRA, in order to continue to provide an exceptional recreational experience on Morrow Point and Crystal Reservoirs, must understand the biological and physical dynamics of these two reservoirs. Morrow Point Reservoir's surface area is 800 acres, whereas Crystal Reservoir's surface area is 300 acres. Both reservoirs have very short retention times - less than a week. Crystal's surface elevation, because it is a re-regulation facility can fluctuate as much as eight feet in one day. In addition to assessing impacts to the lower reservoirs due to re-operation, study of these two reservoirs must also incorporate research on the effects of an upstream impoundment on the productivity of waters in lower reservoirs. This effort should mirror that which has taken place on Blue Mesa. And, results from the Blue Mesa study cannot be used to imply similar impacts to the lower two reservoirs for several reasons including that the Blue Mesa impoundment most likely reduces nutrient inputs to the lower reservoirs, the lower reservoirs' retention times are much shorter than Blue Mesa's, they receive deep-discharge water which is very cold, they may not exhibit strong stratification, and their surface elevations very drastically on a daily basis.

This study is relevant because of

1) growing interest in native sport fish (e.g. cutthroat), and Crystal and Morrow might be logical places to foster such a fishery,
2) the prospects that re-operation of Blue Mesa Reservoir will affect the lower reservoirs in as yet unknown ways,
3) the continued interest in water development projects in the Gunnison Basin, particularly Union Park Reservoir, which will alter the water budgets of all three Aspinall reservoirs; this study would serve as important baseline data for assessing impacts of future water development projects in the basin.

Alternative Actions and Their Probable Impacts: No Action. This alternative would continue to place Curecanti NRA in a position of vulnerability with regards to management of the unit. Without knowing and understanding the ecological structure and function of the lower reservoirs, park management cannot make educated statements regarding productivity, affects from re-operation, and general fishery health.

Description of the Recommended Project or Activity: An ecological study of Morrow Point and Crystal Reservoirs would mirror the study which occurred on Blue Mesa Reservoir. The Blue Mesa effort was conducted by Brett Johnson and graduate students from Colorado State University and was funded by the Bureau of Reclamation. As noted, the Aspinall Unit consists of three reservoirs, of which Blue Mesa has been most studied. Yet, the lower two reservoirs also serve as excellent fisheries and provide a_remote experience for visitors. By understanding the relationship of biological and physical aspects, managers can assess impacts from re-operation of the reservoir system,

The studies would include a traditional limnological assessment of the two reservoirs entailing a spatially and temporally based collection of phytoplankton, zooplankton, and fish samples for abundance, density, and production rate estimates. Primary production levels would be assessed by collecting samples for chlorophyll analysis. Relationships between Blue Mesa release rates, current, surface elevation, storage, retention time, and depth of thermocline would be established. Previous attempts to conduct temperature-dissolved oxygen profiles are limited, but indicate that little stratification occurs. Profiles would be established along a transect from the respective dams upstream to substantiate the existence of a thermocline during some portion of the summer season.

Quantifying the existing fishery and collecting other data in this study would acknowledge which species are ecologically most adapted to these reservoirs, and predict how the existing fish community will be affected by reservoir re-operation. The study would include determination of kokanee, rainbow and cutthroat trout diet, and depth distribution by using vertical gillnetting if possible. Hydro-acoustic sampling would be used if more practical in a run-of-the-river setting such as exits in Morrow Point and Crystal Reservoirs. The data wrought from such studies would be used to develop a model that could predict production based on releases from Blue Mesa Reservoir, thermal structure of the receiving reservoirs, and changes in elevation of the reservoirs.

This type of study must include basic information on the quality of water which exists in the reservoir. Little information is available on nutrient inputs from upstream reservoirs or from side channels. A present water monitoring program includes sites on both lower reservoirs. Basic parameters and nutrients are measured from grab samples only. This effort, however, will not reveal anything regarding vertical, horizontal distribution, or internal cycling of nutrients. A study of the reservoirs would include collection of discrete depth samples (3 depths) for Year 1 and integrated water column samples for Years 2 and 3 from the same stations chosen for the plankton studies. Samples would be analyzed for total phosphorus, soluble reactive phosphorus, total Kjeldahl nitrogen, nitrate, and ammonia. Once per sampling season a sample for metals analyses would be collected. Cadmium, copper, iron, lead, manganese, mercury, silver, and zinc would be measured along with alkalinity and hardness.

Algal production along the banks of the reservoirs would be measured. These reservoirs receive some allochthonous material which serves as a food base for consumer organisms, but noticeable amounts of autochthonous material grows on large rocks that line both reservoirs. Many side channels flowing into the reservoirs also serve as tremendous sources of sediments and nutrients. Inclusion of the dynamics of these side channels including their temperature regime and sediment contributions is essential for establishing a supply and demand model for fish production in the reservoirs.

Such a comprehensive study as this cannot proceed without the review and cooperation of the Colorado Division of Wildlife .The CDOW controls the stocking efforts in these reservoirs and basically manages the fishery by instituting fishing regulations. Stocking rates and numbers of fish caught per angler hour are crucial for development of a model. Lastly, information about natural reproduction of brown or cutthroat trout is also crucial to developing a bioenergetic model for the two lower reservoirs.

Personnel: This project would involve contracting the study to a cooperative entity. The project will require a principal investigator and two assistants. Park staff will assist with sampling, transport and housing.

Compliance: CATEGORICAL EXCLUSION based on 516 DM2 APP. 2, 1.6 Relationships:

This project is indirectly related to CURE-N-040.000 and CURE-N-043.000 Funding:

CURE-N-006.000	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personnel	35,000	20,000	20,000	
Other	13,420	5,860	5,860	
TOTAL	48,420	25,860	25,860	
Funds Available in Park	0	0	0	
Additional Funds Needed	48,420	25,860	25,860	

Explanation:

	Year 1	Year 2	Year 3
Principal Investigator	5000	5000	5000
2 Grad Student 2 year each (Years 2&3)	30000	15000	15000
Travel	1000	1000	1000
Chlorophyll & Zooplankton Year 1: 7 times, 3 depths, 10 samples @ $20.00/sample Year 2: 7 times, 1 integrated, 10 samples @$20.00/sample	4200	1400	1400
Nutrients (TKN, Total Phosphorus, Ortho-phosphate, Nitrate, Ammonia) Year 1: 7 times, 3 depths, 10 samples @ $20.00/sample Year 2: 7 times, 1 integrated, 10 samples @$20.00/sample	7140	2380	2380
Metals 7 times, 1 integrated, 10 samples @ $108.00/sample	1080	1080	1080
	$48420	$25860	$25860

Annual Project Status and Accomplishments: This report will be initiated once work begins on this project.

Kimmel, B.L., O.T. Lind, and L.J. Paulson. 1990. Reservoir Primary Production. In Reservoir Limnology. Editors: K.W. Thornton, B.L. Limmel, and F.E. Payne. John Wiley&Sons, Inc., New York.

Johnson, B. 1995. Ecological effects of reservoir operations on Blue Mesa Reservoir. Annual Progress Report, May 1, 1994 - April 30, 1995. Department of Fishery and Wildlife Biology. Colorado State University, Fort Collins, CO.

Project Statement CURE-N-043.000
Last Update: 02/08/96
Initial Proposal: 1996

Title: CONTROL OF NONPOINT SOURCE POLLUTION TO CIMARRON CREEK
Funding Status: Funded: 0.00 Unfunded: 24.00
Servicewide Issues : NI1 (WATER QUAL-EXT)
N-RMAP Program codes : Q00 (Water Resources Management)

Problem Statement: The Curecanti NRA Water Resources Scoping Report (NPS, 1995b) identified Cimarron Creek as having high turbidity levels, and total dissolved solids ranging from 100 to 700 mg/L. Fecal coliform counts approach the state standard of 2000 colony forming units/100ml. Of all the creeks leading to the reservoir systems, Cimarron Creek carries water of the poorest quality. The quality problem not only reduces habitat requirements of aquatic organisms, but also leads to problems in Crystal Reservoir.

Park rangers (Bob Cornelius, Report on Cimarron Creek, 1994) note that boaters experience great difficulty in getting off the reservoir as a result of maneuvering around the gravel deposition areas near the mouth of Cimarron Creek. Most of the debris at the mouth of the Cimarron was left after a flood carried a large amount of material was carried to the mouth and remains in the channel downstream of Morrow Point Dam. This material shifts depending on releases from the dam, and exposure of the material depends on level of Crystal Reservoir. A combination of low reservoir level with high release levels from Morrow Point Dam confronts the river runner with the greatest difficulty in maneuvering upstream.

Structurally, the Cimarron Creek drains from a northwest trending slope through weak materials and soft sedimentary rock. The stream-deposited valley alluvium consists mostly of poorly sorted gravel, sand, and silt deposits incised by recent gullying. Landslides, slumps, mudflows, and debris flows consist of a heterogeneous mixture of clay, silt, sand, pebbles, cobbles, and boulders including eroded remnants and bouldery residue. Mancos Shale consists of dark-gray silty clay shale (Hansen,1971; Heland, 1973, 1974; Olsen and Hedland, 1973; Hedland and Olson,1974, 1975). The Mancos Shale is notorious for its unstable nature and its shrink-swell attributes.

Processes shaping the present topography of the Cimarron Creek area are primarily the result of physical weathering of rock and mass wasting by slides and slumps from saturation of weak materials and soils. Physical and geomorphological forces from hot/cold-wet/dry climate changes over the last 10 million years caused natural denudation which formed various soils surrounding present tributary drainages. Alluvial Land is the common soil within the drainages, and consists of dark colored stratified sandy to clay loam derived from mixed alluvium with numerous stones and cobbles on the surface and throughout the soil materials. Slopes are 0 to 5 percent with the water table at the surface or usually within a depth of 1 foot. It has good plant cover and supports meadow vegetation, willows, and narrowleaf cottonwood. Youman-Leaps and Youman-Passar Loams are the soils above the drainages. The Leaps series formed in materials weathered from silty shale and other sedimentary rock, while the Passar series formed in locally transported stony alluvium that was derived from rhyolite and tuff. Soils range from grayish-brown silty clay to reddish-brown stony clay foams on slopes of 5 to 35 percent, and both soils support similar vegetation consisting of grasses, sagebrush, gambel oak, and widely scattered clumps of aspen. A large proportion of the acreage is in native range and the rest is irrigated for livestock grazing and wildlife. All three soils have high organic-matter content. Runoff is medium to rapid with moderate erosion hazards. The erosional features are the

result of karsts and streams which level off in the floodplain at the streams base level (presently channelized as a result of the construction of Morrow Point Dam) on the south side of the hard mica schist and layered quartzitic gneiss of the Cimarron Fault Monocline (USDA, 1967, 1975).

Stage of the Cimarron Creek is presently a balanced and mature stream - meandering except where channelized. Above the floodplain or base level, the suspended load of the stream is carried from the headward erosion of the upper alluviums where downcutting is taking place to mouth at Crystal Reservoir. High velocity and low viscosity of the stream's turbulent flow transports a suspended load consisting mainly of silt and clay in the size range of <0.5 mm. Erosion from materials <0.5 mm is not significant due to the cushioning effect of water. Abrasive materials from weathered harder rock >0.5 mm are required to overcome any cushioning effect and create significant erosion. As the flow reaches base level, the suspended load also picks up river rock cobbles and boulders > 0.5 mm, and the erosion changes from downcutting to the lateral cutting of hydraulic action as it meanders back and forth across the floodplain. Erosion from this larger and more abrasive load is minimal as it flows through harder more resistant layered quartzitic gneiss and mica schist at the fault. Eventually this load is deposited where the Cimarron Creek intersects with the Gunnison River creating a large gravel river bar below Morrow Point Dam in Crystal Reservoir.

Because Cimarron Creek cuts through weak materials and soft sedimentary rock, turbidity and dissolved solid levels are be high. Land use activities exacerbate the natural conditions resulting in nonpoint source pollution. Improvement of Cimarron Creek water quality and reduction of sediment inputs to Crystal Reservoir would enhance the aquatic habitat and the visitor experience on Crystal Reservoir. Control of nonpoint source pollution might include experimentation with stream structures and constructed wetlands designed to trap sediment and associated pollutants.

Alternative Actions and Their Probable Impacts: No Action. This alternative would contribute to the further decline of water quality in Cimarron Creek as well as the Crystal Reservoir.

Description of Recommended Project or Activity: The State of Colorado's voluntary Nonpoint Source Management Program (Water Quality Control Division, 1990) recognizes many best management practices (BMP) for agriculture and silviculture which can improve water quality and aquatic habitat. By implementing BMPs, Curecanti NRA anticipates improvements to Cimarron Creek water quality.

The state program which deals with agricultural and silvicultural based nonpoint pollution requires extensive local participation and sponsorship and an extensive watershed analysis. Local participation, i.e., landowners and local agencies, with the assistance of the Natural Resources Conservation Service, NPS and BoR would develop a project implementation plan.

The plan should examine

> the number of landowners willing to participate in an improvement project and shall set goals on the level of improvement that will be achieved in the affected waterbody. The plan shall outline BMP's to achieve the water quality goal for the river or stream. The plan shall include timeline describing when BMP's will be constructed and water quality improvements obtained. The timeline should include intermediate water quality goals for each year showing steady -progress to obtain the optimal water quality goal (Water Quality Control Division, 1990).

Curecanti NRA has established that Cimarron Creek experiences water quality problems; data are available regarding that assumption (NPS, 1995d;NPS, Unpublished Water Quality Data). The park feels further monitoring would delay the possibility of improving the system and continue to increase the deposition problem at the mouth of Cimarron Creek. By seeking assistance from the Colorado Nonpoint Source Program, Curecanti NRA anticipates improvements to its water resources.

Specifically, funds would be made available for personnel to pursue coordination with the Natural Resource Conservation Service on this project. The outcome would be:

A Memorandum of Understanding with Natural Resources Conservation Service to develop a project implementation plan and to seek funds for plan development and implementation.

Participation in development of a project implementation plan.

Participation in implementing the project plan in the Cimarron drainage.

Personnel: This project requires a Biological Science Technician GS-7 for 3 months for 3 years.

Compliance: : CATEGORICAL EXCLUSION based on 516 DM2 APP. 2, 1.6

Relationship: This project is indirectly related to CURE-N-040.000 and CURE-N-042.000

Funding:

CURE-N-006.000	YEAR	IN	SEQUENCE	
	1st	2nd	3rd	4th
Personnel	8,012	8,012	8,012	
Other	0	0	0	
TOTAL	8,012	8,012	8,012	
Funds Available in Park	0	0	0	
Additional Funds Needed	8,012	8,012	8,012	

Annual Project Status and Accomplishments: This report will be initiated once work begins on this project.

Hansen, W.R. 1971. Geologic Map of the Black Canyon of the Gunnison River Vicinity, Western Colorado.

Hedland, D.C. and J.C. Olsen. 1973. Geologic Map of the Gateview Quadrangle, Gunnison County, CO.

Hedland, D.C. and J.C. Olsen. 1973. Geologic Map of the Carpenter Ridge Quadrangle, Gunnison County, CO.

Hedland, D.C. and J.C. Olsen. 1973. Geologic Map of the Powderhom Quadrangle, Gunnison, Saguache Counties, CO.

Hedland, D.C. 1974b. Geologic Map of the Big Mesa Quadrangle, Gunnison County, CO.

National Park Service. Unpublished Water Quality Data. Resources Management Division. Curecanti National Recreation Area, Gunnison, CO.

NPS. 1995b. Curecanti National Recreation Area Water Resource Scoping Report. Curecanti National Recreation Area and Water Resources Division Technical Report NPS/NRWRS/NRTR-95/54.

National Park Service. 1995d. Water quality data analysis and interpretation: Curecanti National Recreation Area. Technical Report NPS/NRWRD/NRTR-95/68. Fort Collins, CO.

Olsen, J.C. and D.C. Hedland. 1973. Geologic Map of the Gateview Quadrangle, Gunnison County, CO.

USDA. 1967. Soil Survey of Delta-Montrose Area. Colorado. Soil Conservation Service.

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Project Statement CURE-N-040.000
Last Update: 05/08/96
Initial Proposal: 1996

Title: GIS-BASED WATERSHED ASSESSMENT

Funding Status: Funded: 0.00 Unfunded: 47.25

Servicewide Issues: N11 (WATER QUAL-EXT)
N12 (WATER FLOW)

N-RMAP Program codes : Q00 (Water Resources Management)

Problem Statement: Since the water quality monitoring program began in 1981, few problems relating to elevated levels of any one attribute have been identified. Isolated occurrences of high fecal coliform counts are documented, and so too is poor water quality in Cimarron Creek (NPS, 1995d). Understanding that the sampling program at Curecanti NRA is based upon a grab sample technique and conducted once every three weeks during the summer only, a large part of what flows through the park goes un-monitored. As a means of predicting existing water quality and anticipating where water quality problems may occur, another approach, in addition to the existing sampling programs, offers extraordinary opportunities in monitoring a very important park resource.

Through an extensive inventory of Curecanti NRA's watershed, the park, using a geographic information system (GIS), can collate data layers of soils, geology, vegetation, stability, channel type, and land use as a means of assessing impacts to reservoir water resources. Clark et.al. (1995) note that 92 percent of suspended sediment in American waterways comes from non-point source pollution. Siltation or sedimentation can in some streams serve as the greatest pollutant compared to other contaminants. From clogging feeding mechanisms of macroinvertebrates to covering habitat on stream bottoms, siltation can disturb a healthy aquatic system.

Case-in-point, Cimarron Creek, which flows into Crystal Reservoir, demonstrates high turbidity levels and elevated dissolved solids (NPS, 1995d). This drainage cuts through weak materials and soft sedimentary rock which contributes to the load carried by the stream. In addition, land use activities including grazing, roads, irrigation, logging, mining, and development exacerbate the problem. Other drainages may exhibit similar problems, yet they escape detection, because the waters within the drainages are not sampled.

Fraser et.al. (1995) document that analysis of Landsat data from thematic mapper images work well to predict soil losses based on the modified universal soil loss equation (MUSLE). Assuming that most of the water quality problems in Curecanti NRA, i.e., the sediments themselves, or the nutrients adsorbed to the soil particles, are soil loss-based, use of GIS, Landsat data, and this equation could facilitate assessing which watersheds contribute the greatest amount of sediment to Curecanti NRA water resources. Determining which drainages contribute the greatest loads will allow park staff to 1) adjust its water quality monitoring program, 2) anticipate problems if land ownership changes and development of roads and other activities occur, and 3) execute solutions to abate anticipated water quality problems.

Alternative Actions and Their Probable Impacts: No action. Without this alternative Curecanti NRA has no ability to assess inputs to its reservoir system from tributaries and other difficult to sample sites.

Description of Recommended Project or Activity: Geographic information systems (GIS) are used to assess a watershed's propensity to contribute to soil erosion and non-point pollution (Tim et.al., 1992: Robinson and Ragan, 1993; Fraser et.al., 1995). Watershed assessment using a GIS-based approach requires many sets of data including the following layers: vegetation or cover type, soils, geology, land use or classification, elevation, and slope. To develop indices of non-point pollution for specific watersheds in Curecanti NRA, additional information is required for the modified universal soil loss equation:

$$A\ [\text{erosion(tons/acre)/yr}] = L \times S \times R \times K \times VM$$

Slope length (L) and slope steepness (S) are calculated from an elevation layer (USGS 7.5 minute digital elevation model). The rainfall erosivity factor (R) is developed by linearly interpolating a iso-erodent map of the United States (US Forest Service, 1980). For our area a factor of 35 appears reasonable. Soil erodibility (K) factors can be developed from the Gunnison and Montrose Soil Surveys (US Dept of Agriculture, 1967, 1975) and Soil Conservation Service (1983). Lastly the vegetation management factor is based on the US Forest Service (1980) estimates, and the unsupervised vegetation classification performed on Landsat imagery by the park's GIS specialist.

In 1994, field personnel ground-truthed every drainage that entered the three reservoirs. At each drainage and within the boundaries of Curecanti NRA, staff recorded dominant vegetation using Rowlands (1994), drainage stability using a rating developed by the US Forest Service (1990), soils texture and color, and channel type based on Rosgen (1994). Because any one of the smaller drainages extends for a very short length within Curecanti NRA boundaries, only one representative site was sampled at each drainage. Longer drainages were assessed by a stratification based on channel type and overall vegetative formation. Associated wetland areas were also identified.

ArcInfo will be used to determine predicted soil erosion rates from the values derived for the MUSLE for each 30m cell within Curecanti NRA boundaries. The slope length and steepness will also be calculated for each cell. The assessment provides only a prediction of potential for soil loss and not the amount of soil that actually reaches the reservoirs. This amount could be derived by multiplying the predicted erosion potential by an empirically derived sediment delivery ratio. Acquiring the data for the delivery ratios for all drainages leading to the reservoirs would require sampling all drainages during storm events and during low flow. A project of this magnitude would negate the modeling approach which allows park staff to focus on those drainages in which soil erosion is predicted to be the highest, and thereby saves time and money.

Specifically, the park has soils and geology layers, however, the soils maps were translated from MOSS to GRASS and need major corrections. The park is in the process of correcting the geology data in ArcInfo. The vegetation layer is classified and truthed based on field work completed in 1994. Land use or classifications are required upstream of Curecanti NRA boundaries in order for the park to assess impacts outside park boundaries. For cells that encompass land within agricultural areas, the traditional universal soil loss equation can be used:

$$A = 2.24 R \times K \times L \times S \times C \times P$$

where C (cropping management factor) and P (conservation practice factor) relate to type of agriculture the owner practices on the property. These numbers can be obtained by referring to established indices (Schwab et.al., 1981).

Products of the project would include a digital database and maps which identify specific drainages that are prone to soil erosion. This project also provides the park with compatible and working layers of data that can be used for other analyses: Additionally, the vegetation data collected in 1994 will be subjected to ordinate analysis with the intent of summarizing the types of plant associations present in drainages. Relationships between given specific plant associations and the vegetation management (VM) factor may be modified from the US Forest Service (1980) estimates. Modification would be based on knowing the plant association, i.e., cover type and measuring suspended solids in receiving water bodies below sites predicted to have high soil erosion.

Personnel: This project will require a GIS Specialist GS-11 for 6 months, a Biological Science Technician, GS-7 for 3 months, and a GIS Technician GS-5 for 8 months.

Compliance: CATEGORICAL EXCLUSION based on 516 DM2 APP. 2, 1.6

Relationship: This project is indirectly related to Project Statement CURE-N-042.000 and CURE-N-043.000

Funding:

CURE-N-006.000	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personnel	47,170			
Other	0			
TOTAL	47,170			
Funds Available in Park	14,835			
3Additional Funds Needed	32,315			

Explanation:

		Park Funds	NRPP Funds
GIS Technician	8 mos. GS-5 Corrects and prepares soils map and other data layers		$13,312
Biological Science Technician	3 mos. GS-7 Completes vegetation ordination Prepares final map		$ 4,568
GIS Specialist	6 mos. GS-11 Models the soil erosion potential	$14,435	$14,435
SYSTAT Software		$400	
		$14,835	$32,315

Annual Project Status and Accomplishments: This report will be initiated once work begins on this project.

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Fraser, R.H., M.V. Warren, and P.K Barten. 1995. Comparative evaluation of land cover data sources for erosion prediction. Wat. Res. Bull. 31(6):971-1174.

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Robinson, K.J. and R.M. Ragan. 1993. Geographic information system based nonpoint pollution modeling. Wat. Res. Bull. 29(6):1003-1008.

Rosgen, D.L. 1994. A classification of natural rivers. Catena. 22:169-199.

Schwab, G.O., R.K. Revert, T.W. Edminster, and K.K. Barnes. 1981. Soil and Water Conservation Engineering. 3rd Edition. John Wiley & Sons, Inc., New York.

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Tim, U.S., S. Mostaghimi, V.O. Shanholtz. 1992. Identification of critical nonpoint pollution source areas using geographical information systems and water quality modeling. Wat. Res. Bull. 28(5):877-887.

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Project Statement CURE-N-006.000
Last Update: 05/08/96
Initial Proposal: 1992

Title: DEVELOP FISHERIES MANAGEMENT PROGRAM

Funding Status: Funded: 0.00 Unfunded: 12.00
Servicewide Issues : N00 (FISHERIES) N17 (BIODIVERSITY) N-RMAP
Program codes : N00 (Resource and Visitor Use Management)

Problem Statement: According to Behnke (1993), the upper reaches of the Gunnison River no longer host native species of fish. since the late 1880's various species of trout have been stocked these water. As a result, the world- renowned trout fishery so well publicized in the early 1900's was based on a stocked fishery that began to naturally reproduce.

Prior to the introduction of nonnative trout species, cutthroat trout, bluehead and flannel mouth suckers, and speckled dace flourished in the upper Gunnison Rive: this lack of biodiversity reveals that a changing environment and introduction of nonnative fish species could expose the community to replacement (which is the case) and possible extinction (which has locally occurred in the upper Gunnison River).

Moreover, prior to 1965, the initial 96.5 kilometer (60 mile) section of the Gunnison River below Almont was a world- renowned trout fishery. Between 1965 and 1977, 64 kilometers (40 miles) of this section of river were inundated by the three reservoirs of the Wayne N. Aspinall Unit. The three reservoirs provide an incredible flatwater fishing experience ranging from ready access to a backcountry experience. The tributaries and the Gunnison River above and below the dam system also provide and unparalleled fishing experience. Considering the continued and growing interest in fly-and flatwater fishing, and its ultimate effect on local economies, there is a need to supply an adequate through proper and effective management. In addition, enhancement and maintenance of a native fishery in tributaries to the Aspinall Unit avoids potential listing of species as threatened or endangered, and may add another aspect of angling to what is offered already in the area.

One factor that historically contributed greatly to the fame of the Gunnison River fishery as well as to the well being and growth of trout was the exceptional abundance of the nymphs of the giant stonefly *(Pteronarcys californica).* With the inundation of most of this section of river by Blue Mesa Reservoir, *P. californica* has largely disappeared. Another species that has all but disappeared from the area is the cutthroat trout *(Oncorrhyncus clarla).* Behnke (1993) notes that, historically, tributaries and the Gunnison River harbored the Colorado River *pleuriticus* subspecies of the cutthroat trout.

National Park Service (NPS) involvement in fisheries management within Curecanti NRA is limited, and is done in cooperation with the Colorado Division of Wildlife (CDOW). The CDOW has determined that a native, self-sustaining fishery can not be maintained within the reservoirs of the park. Studies by fishery specialists at Colorado State University are ongoing and question how re-operation of the reservoir would affect the productivity of Blue Mesa Reservoir and its ability to support even a stocked fishery. *P. californica* nymphs have been reintroduced to the Gunnison River section above Blue Mesa Reservoir with limited success. Water quality monitoring continues since 1981 in order-to establish baseline information and to detect trends. Active programs of stocking and transplanting have historically included introduction of non-native species. For the past several years, creel surveys on Blue Mesa Reservoir have been used to measure the efficacy of the stocking program

as it relates to the ability of anglers to catch fish. This effort was the primary means of determining that the fishery in the Gunnison River and in the reservoirs were infected with the whirling disease, an illness caused by the parasite, *Myxobolus cerebralis.*

All these efforts take place within park boundaries, but outside of a cohesive and directed program that is park-based. The NPS and CDOW need to cooperatively determine the direction of the fishery as relates to existing programs, the interest in native and non-game fish, and the whirling disease. Executive Order 12962 requires that federal agencies identify recreational fishing opportunities that are limited by water quality and habitat degradation, and to promote restoration of viable, healthy, and, where feasible, self-sustaining recreational fisheries. The intent of the Order requires that the NPS and BoR work cooperatively, and develop partnerships with the Colorado Division of Wildlife to avoid losses of fishery resources, and to restore and enhance these fisheries where practical, and when within the context of the agencies missions and policies. A fisheries management plan would carry out the intent of the Recreational Fisheries Executive Order 12962.

Alternative Actions and Their Probable Outcome: No action. This alternative would allow the park to continue working without a plan and would impede the park's ability to provide the best information and fishing opportunities for the visiting public.

Description of the Recommended Project or Activity: Develop Interagency Fishery Management Plan. The NPS, in conjunction with the CDOW, the Bureau of Reclamation and the U.S. Fish and Wildlife Service, would develop a Fishery Management Plan. This plan would better define the goals of the stocking program and outline considerations for determination of species for stocking. Also the plan would discuss the need and viability of re-introduction of cutthroat trout to tributaries north of Blue Mesa Reservoir. The plan would document areas for potential stream habitat improvements specifically where the Gunnison River has forged a new course above Blue Mesa Reservoir. Ongoing studies discussing the bioenergetics and productivity of the reservoir system would be included in the plan.

The 1965 Memorandum of Agreement between the Bureau of Reclamation and the NPS calls or establishment of a water quantity regime based on optimum and minimum pool levels desirable for public recreational use. A cooperative agreement would be established with the Bureau of Reclamation and affected agencies to mitigate seasonal flow manipulations from the Aspinall Unit. This type of agreement would stem from consultation with the BoR on 1) a matrix designed to elucidate desired reservoir levels, 2) consideration of a federal reserve right and needs for flows through the Black Canyon of the Gunnison River NM, 3) knowledge of releases required for hydropower production, and 4) recognition that Blue Mesa Reservoir stores 148,000 acre feet of water designed for recovery of the four endangered fish species on the Gunnison and Colorado Rivers.

Behnke, R. J. 1993. The Gunnison River Drainage and its Changing Fish Fauna. Part I: Historical Perspective and Part II: The Native Cutthroat Trout of the Gunnison River Drainage and Potential for Restoration. Report to the National Park Service, Curecanti National Recreation Area, Gunnison, CO.

Personnel: This project would be conducted by a GS-9 Biologist (Fisheries) and would include literature search, coordination with the Colorado Division of Wildlife and other agencies, and development of a fishery management plan.

Compliance: CATEGORICAL EXCLUSION based on 516 DM2 APP. 2, 1.1

Relationships: This project is related to project statement CURE-N-023.001

Funding:

CURE-N-006.000	YEA	IN	SEQUENC	
	1st	2nd	3rd	4th
Personnel	12,000			
Other	0			
TOTAL	12,000			
Funds Available in Park	0			
Additional Funds Needed	12,000			

Annual Project Status and Accomplishments: This report will be initiated once work begins on this project.

Appendix A. Corrected Tables 2 and 3 from the Curecanti NRA Water Resources Scoping Report

Table 2. **Water Quality Monitoring Sites and Associated Threats, 1987-1992.**

							Issues					
Site	Site Name	'Septic	Mining	Oil/ Gas	Road	Recre-ation	Marinas	Grazing	Upstream	Logging	UST	Develop-ment
BM01	Lake Fork Arm		x		x	x		x				
BMO2	Lake Fork Marina	x					x					
BM03	Haystack Gulch	x										
BM04	Sunnyside	x										
BM05	Iola	x				x		x				
NW06	Lower N Willow	x				x						
GR07	Gunnison River								x			
CM08	Cimarron a. Squaw	x									x	
SC09	Squaw a. Cimarron	x						x				
CM10	Cimarron b. Squaw	x						x				
NW11	Upper N Willow						x	x				
CM12	Cimarron Benny's	x						x				
BM13	McIntyre Gulch	x			x							x
BM18	Blue Mesa High	x				x						x
14	Old Hwy 50					x						
15	Bay of Chicks W					x						
16	Bay of Chicks E					x						
17	Iola Beach					x						

Water Quality Monitoring Sites and Associated Threats , 1993 to Present.

							Issues					
Site	Site Name	Septic	Mining	Oil/ Gas	Road	Recre-ation	Marinas	Grazing	Upstream	Logging	UST	Develop-ment
BM01	Lake Fork Arm		x		x	x		x				
BM03	Haystack Gulch	x										
BM04	Sunnyside	x										
BM05	Iola	x				x		x				
BM18	BM Highlands	x				x						x
BM19	Elk Cr. Marina					x	x					
GR07	Gunnison River								x			
GR4A	Cooper Ranch										x	
GR01	Gunnison River	x				x						
WEC1	West Elk Creek	x										x
PCO1	Pine Creek	x				x		x			x	
BC01	Blue Creek				x							
CUR2	Curecanti Creek			x				x				
CM 10	Cimarron Creek	x			x	x		x			x	x
CYC1	Crystal Creek			x		x		x				
14	Old Hwy 50				x							
15	Bay of Chicks W					x						
16	Bay of Chicks E					x						
17	Iola Beach					x						

Appendix B. Aspinall Unit Operations Draft Matrix: National Park Service

RESERVOIR LEVELS

Blue Mesa

Month	Elevation (feet)	Contributing Resource(s)
January	< 7490	Icing
February	< 7490	Icing
March	<7490	Recreation, Facilities
April	> 7490	Aesthetics, Recreation, Facilities
May	> 7490	Aesthetics, Recreation, Facilities
June	> 7490*	Aesthetics, Recreation, Facilities
July	> 7490*	Aesthetics, Recreation, Facilities
August	> 7490*	Aesthetics, Recreation, Facilities
September	> 7490	Aesthetics, Recreation, Facilities
October	> 7490	Aesthetics, Recreation, Facilities
November	> 7490	Recreation, Facilities
December	<7490	Icing

Morrow Point

Month	Elevation (feet)	Contributing Resource(s)
January	NA	
February	NA	
March	NA	
April	> 7148	Facilities
May	_	Tour Boat, Facilities, Campsites
June	> 7148	Tour Boat, Facilities, Campsites
July	> 7148	Tour Boat, Facilities, Campsites
August	> 7148	Tour Boat, Facilities, Campsites
September	> 7148	Tour Boat, Facilities, Campsites
October	> 7148	Facilities, Campsites
November	NA	
December	NA	

Crystal

Month	Elevation (feet)	Contributing Resource(s)
January	NA	
February	NA	
March	NA	
April	NA	Facilities
May	> 6741	Facilities
June -•	> 6741 -	Facilities
July	> 6741	Facilities
August	> 6741	Facilities
September	> 6741	Facilities
October	> 6741	Facilities
November	NA	
December	NA	

Appendix C. Visitor Use Questionnaire (provided by Dr. Steve Burr from Western Illinois University)

Date: _____ Time:_____Interviewer: _____
ID#: _____
Specific Location: _____

CURECANTI NATIONAL RECREATION AREA
VISITOR SATISFACTION SURVEY

INTRODUCTION: Hello, I am with the Curecanti National Recreation Area and we are doing a study of visitor satisfaction and recreational use. Will you answer some questions about your recreational experience here today? Yes or No IF YES GO TO QUESTIONS #1 BELOW:

IF RESPONDENT SAYS NO, CONTINUE: My questions should take only about 10 minutes of your time. As a recreational user, you have been selected as par of a representative sample, so your answers are very important to us. Your answers will be confidential and will be only reported as statistics. would you be willing to help us out?

IF RESPONDENT REFUSES AGAIN, SAY: Thank you. Please enjoy your visit. CHECK REFUSAL:

1. Where is your principal home residence? (state) _____ (city/town)

2. About how many miles is it from your residence to Curecanti National Recreation Area? CHECK TO SEE THAT MILEAGE IS ONE-WAY _____
3. How many people in your group today including yourself?

4. Which of the following best describes your group today?

1. **Alone**
2. **Friends**
3. **Family**
4. **Family and Friends**
5. **Business Associates**
6. **Other** _____

5. Where did you access the water today?

_____
(GET SPECIFIC INFORMATION)
_____

6. What time did you start boating today?

(Time launching boat or earliest time on water)

_____

7. Have you finished boating today Yes No

8. What kind of boat do you have on the water today? _____

1. Cabin Cruiser	**6. Row Boat**
2. Runabout	**7. Canoe or Kayak**
3. Houseboat	**8. Pontoon Boat**
4. Sailboat	**9. Bass Boat**
5. Waverunner/Jet Ski	**10.Sailboard**

11. Other _____

Here is a listing of activities you might have participated in today.

HAND RESPONDENT INFORMATION CARD

9. What is the primary activity you are participating (participated) in today?

RECORD BELOW IN #11 LEFT AS #1

10. What percentage of your time will (did) you participate in this activity today?

RECORD BELOW IN #11 RIGHT AS %

11. Please tell me what other activities you are doing (did) What percent of time will you spend on each of these activities?

Fishing
Anchored
Swimming from boat
Waterskiing
Pleasure cruising
Sailing
Sailboarding
Jet skiing
Canoeing
Kayaking
Rowboating
Skulling -
Other
Other Other _____

_____

TOTAL **CHECK TO SEE THIS ADDS UP TO 100%**

12. On a scale of 1 to 10, with 10 being the perfect trip, how would you rate the quality of you recreational experience today?

13. What were the most enjoyable aspects of your recreational experience? RECORD EXACTLY:

_____

14. What were the leas enjoyable aspects of your recreational experience today? RECORD EXACTLY:

_____
_____

15. Using the enjoyment scale on your card, how did the number of boaters on the lake today affect your overall experience? CIRCLE NUMBER: 1 2 3 4 5 6 7 8 9

Increased my enjoyment No effect Reduced my enjoyment

16. Using the crowding scale on your card, how would you describe the boating conditions at each of the following areas today? CIRCLE NUMBER: 1 2 3 4 5 6 7 8 9

Not at all Crowded	Slightly Crowded	Moderately Crowded	Extremely Crowded

At the access area at the start of your trip?
Out on the water while boating?
At the access area when you stopped boating?

17. Prior to this trip, when was your last visit to Curecanti National Recreation Area?
Month Year

18. On that trip, where did you access the water?

_____

19. On that trip, what was your primary recreational activity?

_____

20. Next I am going to read some statements about boating here at Curecanti National Recreation Area. Based on your experience today, please rate your level of agreement or disagreement with each statement I read, using the scale on your card.

	SA	A	U	D	SD
I thoroughly enjoyed my boating trip today.					

My boating trip was not as enjoyable as I expected it to be.	**SA**	**A**	**U**	**D**	**SD**
The view of the shoreline scenery was pleasing today.	**SA**	**A**	**U**	**D**	**SD**
I cannot imagine a better boating trip.	**SA**	**A**	**U**	**D**	**SD**
I do not want to go on any more boating trips like this one.	**SA**	**A**	**U**	**D**	**SD**
My boating trip today was well worth the money spent to take it.	**SA**	**A**	**U**	**D**	**SD**
If I had known what it was going to be like here today, I would not have come on this visit.	**SA**	**A**	**U**	**D**	**SD**
I was disappointed with some aspects of my boating trip.	**SA**	**A**	**U**	**D**	**SD**
I did not enjoy the shoreline scenery today.	**SA**	**A**	**U**	**D**	**SD**
The water quality appeared good today.	**SA**	**A**	**U**	**D**	**SD**
The behavior of other boaters interfered with the quality of my boating experience today.	**SA**	**A**	**U**	**D**	**SD**

IF AGREE WITH THIS STATEMENT,
Can you describe how,

_____

The level of water made it difficult to launch my boat today.	**SA**	**A**	**U**	**D**	**SD**
I did not like the amount of time I had to wait to get on the water today.	**SA**	**A**	**U**	**D**	**SD**

IF AGREE, How _much time did you have to wait?
How much time are you willing to wait? _____

_____

Boating conditions on the water were safe today.	**SA**	**A**	**U**	**D**	**SD**
The water level made it easy to launch my boat today.	**SA**	**A**	**U**	**D**	**SD**
It was difficult getting my boat off the water today.	**SA**	**A**	**U**	**D**	**SD**

12. On a scale of 1 to 10, with 10 being the perfect trip, how would you rate the quality of you recreational experience today?

13. What were the most enjoyable aspects of your recreational experience?
RECORD EXACTLY:

_____
_____

14. What were the leas enjoyable aspects of your recreational experience today?
RECORD EXACTLY:

_____
_____

15. Using the enjoyment scale on your card, how did the number of boaters on the lake today affect your overall experience? CIRCLE NUMBER: 1 2 3 4 5 6 7 8 9

Increased my enjoyment No effect Reduced my enjoyment

16. Using the crowding scale on your card, how would you describe the boating conditions at each of the following areas today? CIRCLE NUMBER: 1 2 3 4 5 6 7 8 9

Not at all Crowded	Slightly Crowded	Moderately Crowded	Extremely Crowded

At the access area at the start of your trip?
Out on the water while boating?
At the access area when you stopped boating?

17. Prior to this trip, when was your last visit to Curecanti National Recreation Area?
Month Year

18. On that trip, where did you access the water?

_____

19. On that trip, what was your primary recreational activity?

_____

20. Next I am going to read some statements about boating here at Curecanti National Recreation Area. Based on your experience today, please rate your level of agreement or disagreement with each statement I read, using the scale on your card.

	SA	A	U	D	SD
I thoroughly enjoyed my boating trip today.					

My boating trip was not as enjoyable as I expected it to be.	**SA**	**A**	**U**	**D**	**S**
The view of the shoreline scenery was pleasing today.	**SA**	**A**	**U**	**D**	**S**
I cannot imagine a better boating trip.	**SA**	**A**	**U**	**D**	**SD**
I do not want to go on any more boating trips like this one.	**SA**	**A**	**U**	**D**	**SD**
My boating trip today was well worth the money spent to take it.	**SA**	**A**	**U**	**D**	**S**
If I had known what it was going to be like here today, I would not have come on this visit.	**SA**	**A**	**U**	**D**	**S**
I was disappointed with some aspects of my boating trip.	**SA**	**A**	**U**	**D**	**SD**
I did not enjoy the shoreline scenery today.	**SA**	**A**	**U**	**D**	**SD**
The water quality appeared good today.	**SA**	**A**	**U**	**D**	**SD**
The behavior of other boaters interfered with the quality of my boating experience today.	**SA**	**A**	**U**	**D**	**SD**

IF AGREE WITH THIS STATEMENT,

Can you describe how,

_____

The level of water made it difficult to launch my boat today.	**SA**	**A**	**U**	**D**	**SD**
I did not like the amount of time I had to wait to get on the water today.	**SA**	**A**	**U**	**D**	**SD**

IF AGREE, HOW much time did you have to wait? _____

HOW much time are you willing to wait? _____

Boating conditions on the water were safe today.	**SA**	**A**	**U**	**D**	**SD**
The water level made it easy to launch my boat today.	**SA**	**A**	**U**	**D**	**SD**
It was difficult getting my boat off the water today.	**SA**	**A**	**U**	**D**	**SD**

I did not like the amount of time I had to wait to get off the water today. **SA A U D SD**

IF AGREE, How much time did you have to wait? _____
How much time are you willing to wait? _____

****

IF FISHING WAS NOT IDENTIFIED AS THE PRIMARY ACTIVITY, GO ON TO QUESTIONS #29.

IF FISHING WAS IDENTIFIED AS THE PRIMARY ACTIVITY, CONTINUE BY READING: I

was satisfied with my fishing experience today. **SA A U D SD**

I caught the number of fish I expected to catch today. **SA A U D SD**

AND CONTINUE BY STATING:
With regard to fishing, please answer the following questions:

21. Would you be interested in catching Colorado native cutthroat trout ...

On tributaries to Blue Mesa Reservoir	**Yes**	**No**
On Morrow Point Reservoir	**Yes**	**No**
On tributaries to Morrow Point Reservoir	**Yes**	**No**

22. Colorado native cutthroat trout have been already introduced to north Beaver Creek.

Would like to see native cutthroat introduced to more tributaries the flow into Blue Mesa Reservoir? **Yes** **No**

23. To introduce cutthroat, tributary waters must be treated with chemicals to kill competing fish.
Do you support or oppose such an approach to re-introducing cutthroat trout in this area?
Support **Oppose** **No Opinion**

With regards to the health of the fishery here at Curecanti:

24. Are you concerned with the health of the fish

in Blue Mesa Reservoir	**Yes**	**No**	**No Opinion**
in Morrow Point Reservoir	**Yes**	**No**	**No Opinion**
in Crystal Reservoir	**Yes**	**No**	**No Opinion**

25. Do you think the fish caught here are safe to eat? **Yes** **No** **No Opinion**

26. Of the fish you catch, do you find any fish with deformities such as growths, parasites, or crooked bodied, or black tails. Yes No

27. Are you satisfied with the fishery on the Gunnison River upstream of the reservoirs in the areas known as Cooper Ranch and Neversink picnic areas? Yes No No Opinion

FOR ALL RECREATIONISTS (INCLUDING ANGLERS), ASK:

29. Have you had any experience in the Cooper Ranch and/or Neversink areas with regards to recreational activities? Yes No

IF YES, what activities have you participated in there?

_____

_____

Using the satisfaction scale on your card, how would rate your satisfaction with our recreational activities in these areas? CIRCLE NUMBER:

1 2 3 4 5 6 7 8 ____ 9
Very Satisfied Somewhat Satisfied Undecided Somewhat Dissatisfied Very Dissatisfied

WHY?

_____

_____

30. Are there opportunities for other recreational activities you would like to see developed in these areas?

IF YES, what types of activities would you like to see developed?

_____

_____

31. Using the satisfaction scale on your card, how would you rate the access to the Gunnison River in Cooper Ranch and Neversink areas? CIRCLE NUMBER:

1	2	3	4	5	6	7	8	9
Very Satisfied		Somewhat Satisfied		Undecided	Somewhat Dissatisfied			Very Dissatisfied

WHY?

---

32. Have you ever hunted in the Neversink and Cooper Ranch areas? Yes No
IF YES, what type of game have you hunted there? _____

CONTINUE BY SAYING:
We are interested in any other thoughts or comments you might have regarding recreational experiences and activities, lake/reservoir levels, and/.or the management of any of the areas in Curecanti National Recreation Area.

PLEASE NOTE BELOW:

CONCLUDE INTERVIEW BY SAYING:
Thank you for taking the time to answer our questions and provide your thoughts and comments. We appreciates your help and hope you enjoy the rest of your visit at Curecanti National Recreation Area.

CURECANTI NATIONAL RECREATION AREA
VISITOR SATISFACTION SURVEY
RESPONDENT INFORMATION CARD

BOATING ACTIVITIES:

Fishing
Anchored
Swimming from Boat
Waterskiing
Pleasure cruising
Sailing
Sailboarding
Jet skiing
Canoeing
Kayaking
Rowboating
Skulling
Other

Enjoyment scale:

1	**2 -**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Increased my enjoyment				**No effect**			**Reduced my enjoyment**	

Crowding scale: 1_ 2_____3 _____4 _____ 5_____6 _____ 7_____8 _____ 9

Not at all Crowded **Slightly Crowded** **Moderately Crowded** **Extremely Crowded**

Agreement Scale:

Strongly Agree **Agree** **Undecided** **Disagree** **Strongly Disagree**

Satisfaction Scale: 1____2 _____ 3_____4 _____5 _____6 _____ 7_____8 _____9

Very Satisfied **Somewhat Satisfied** **Undecided** **Somewhat Dissatisfied** **Very Dissatisfied**

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