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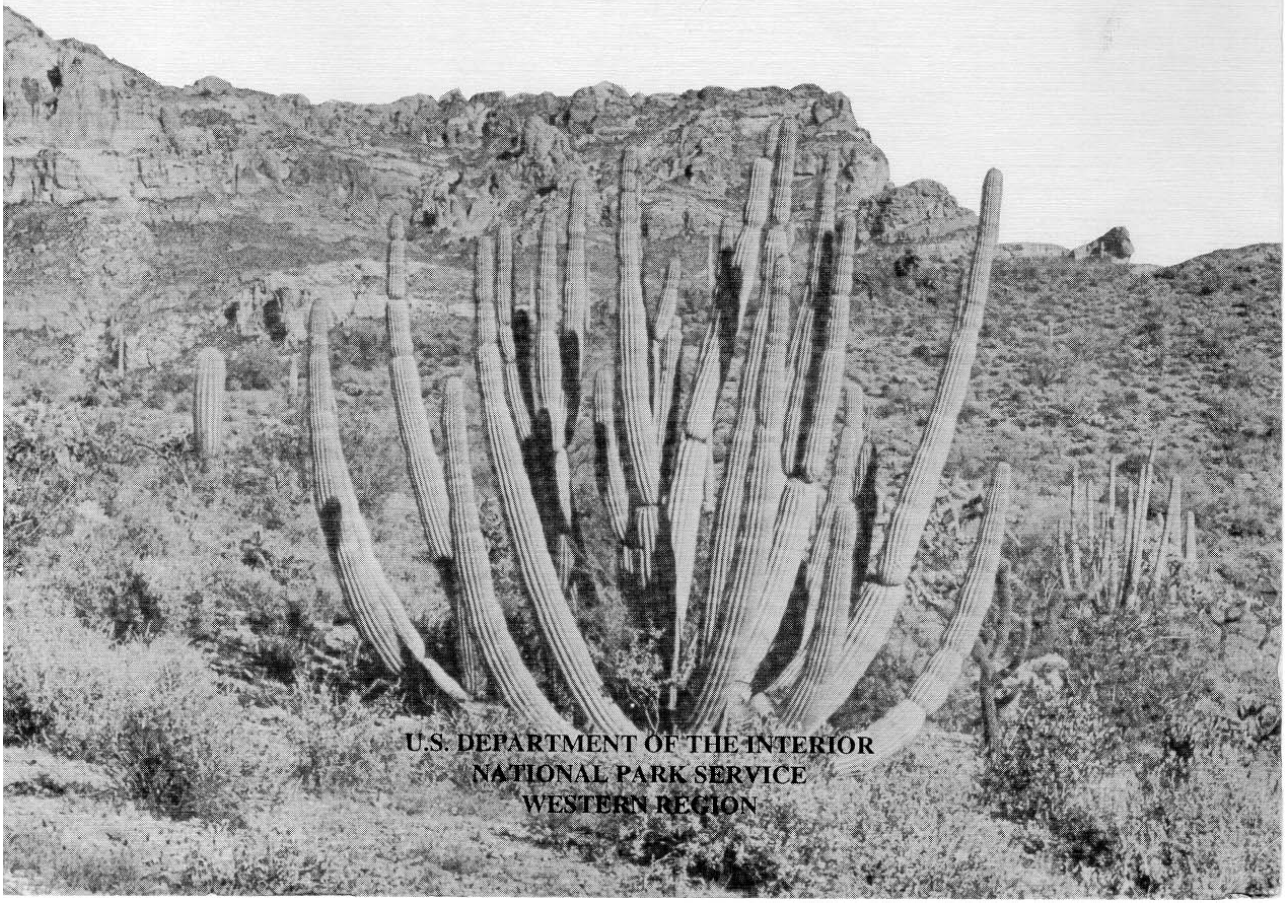
WATER RESOURCES MANAGEMENT PLAN

ORGAN PIPE CACTUS NATIONAL MONUMENT
ARIZONA



U.S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
WESTERN REGION

WATER RESOURCES MANAGEMENT PLAN

ORGAN PIPE CACTUS NATIONAL MONUMENT

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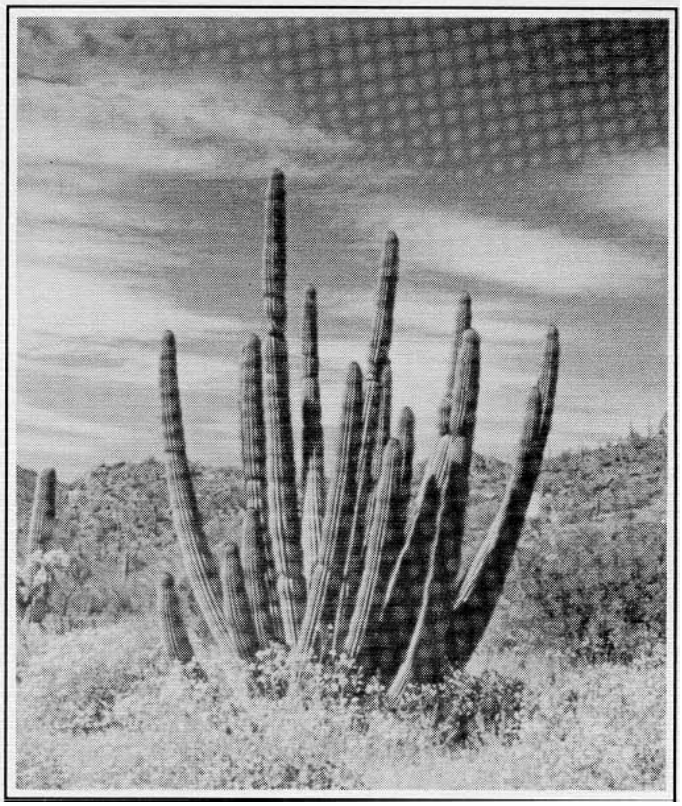


I. INTRODUCTION

I.A. Purpose of the Plan

This Water Resources Management Plan describes the water resources of Organ Pipe Cactus National Monument and the issues affecting them. Management actions to address many of these issues are presented in project statements.

Organ Pipe Cactus National Monument was established by Presidential Proclamation No. 2232 on April 13, 1937. The proclamation states that since "certain lands in the State of Arizona contain historic landmarks, and have situated thereon various objects of historic and scientific interest," it is therefore "in the public interest to reserve such lands as a national monument, to be known as Organ Pipe Cactus National Monument..." The location is shown on the Vicinity Map of Organ Pipe Cactus National Monument (Figure 1).

The Proclamation also made Organ Pipe Cactus National Monument a unit of the National Park System. The general statutes that guide National Park Service land management are applicable at Organ Pipe Cactus National Monument. Among the most important of these are the National Park Service Organic Act (16 U.S.C. sec 1 et seq.) and the Act for Administration (16 U.S.C. la-1). In the National Park Service Organic Act, Congress set forth the purpose of the National Park System which is: "To conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such manner and such means as will leave them unimpaired for the enjoyment of future generations..." (16 U.S.C. sec 1). These two acts also give the Secretary of Interior the authority to promulgate rules and regulations to effectively manage the National Park System.

The monument was established as a Biosphere Reserve on October 26, 1976. Biosphere Reserves are set aside by the Man and the Biosphere Programme, which is an international program of scientific cooperation dealing with human/environmental interactions throughout all geographic and climatic areas in the world. As of 1987, there were 261 biosphere reserves in 70 countries; 45 of these are in the United States and eight are in Mexico. The purpose of these Biosphere Reserves is to establish a network of protected samples of the world's major ecosystem types. Each reserve is devoted to the conservation of nature and scientific research and provides a standard against which human impact on the environment can be measured.

On November 10, 1978, Public Law 95-625 designated 312,600 acres as wilderness and 1240 acres as potential wilderness additions within the monument. Wilderness is an area "...where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain..." and "...which is protected and managed so as to preserve its natural conditions..." Approximately 95 percent of the monument is included in the Organ Pipe Cactus wilderness. Management of this area must comply with the Wilderness Act and NPS wilderness management policies. National Park Service Management Policies (USDI, NPS 1988) state "Wherever a wilderness area is designated within a park, the preservation of wilderness character and resources becomes an additional statutory purpose of the park."

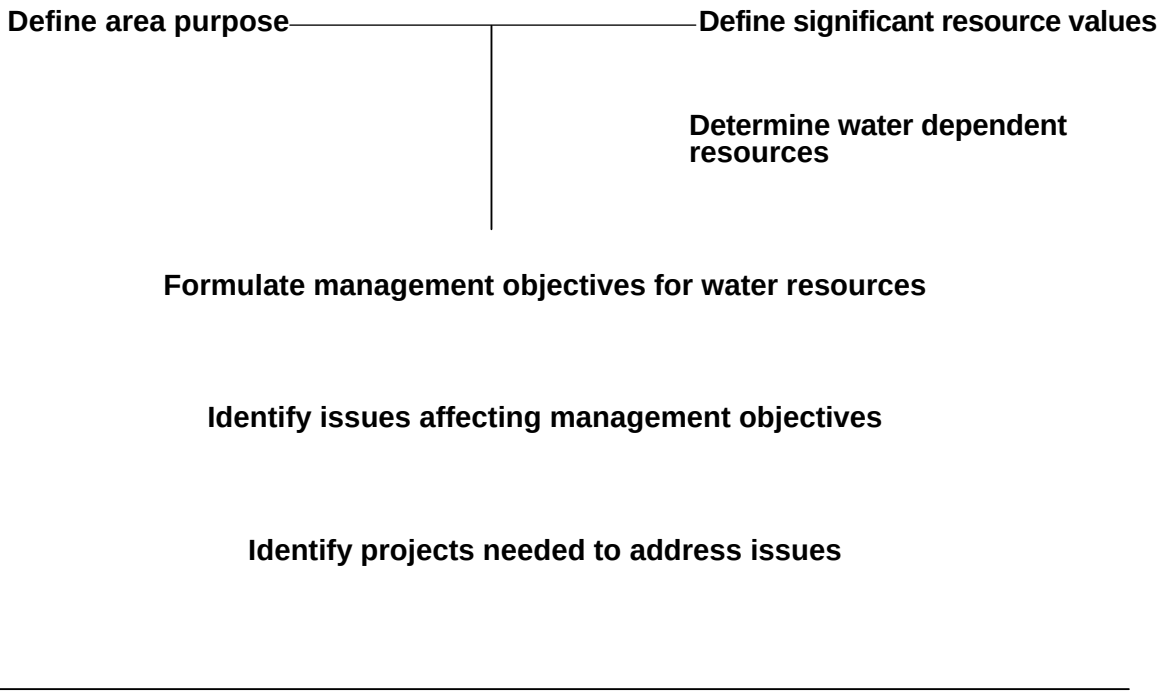
National Park Service policies require that a unit of the National Park System develop and implement a land and water use management plan, called a General Management Plan (GMP). It was initiated for the monument in 1988. The GMP provides the National Park Service with the overall basis for managing the monument's resources, uses and facilities. Included are specific provisions for addressing: public outdoor recreation benefits; preservation of scenic, scientific, and historic features contributing to public enjoyment; and such use of natural resources as is consistent with, and does not significantly impair, public recreation and

protection of scenic, scientific, and historic features contributing to public enjoyment.

More specific plans may be developed to address specific resource needs when warranted. This Water Resources Management Plan is being developed as an action plan to complement the monument's draft GMP and supplement the Natural and Cultural Resources Management Plan (RMP). It is very similar to the RMP, but focusses specifically on water resources and provides more extensive background information. Project statements in this plan will be incorporated directly into the RMP.

I.A.1. The Water Resources Planning Process: Management Assumptions

The diagram below describes the process used to define a future direction for managing the water resources at Organ Pipe Cactus National Monument. Area purpose is defined as the reason for the area's establishment and management as an NPS area. Purpose helps to identify management priorities and is based on the monument's legislative mandate, Biosphere Reserve and Wilderness designations, visitor use, management history, and natural and cultural resource values. Resource significance is determined on three levels: global; national; and National Park System, and is based on those natural and cultural values inherent on-site and from the monument's recreational and educational values. Significance helps to determine the primary visitor experience and is used to identify resource management, visitor use, and interpretive priorities. Management objectives describe primary goals for management and area development that ensure accomplishment of the area purpose.



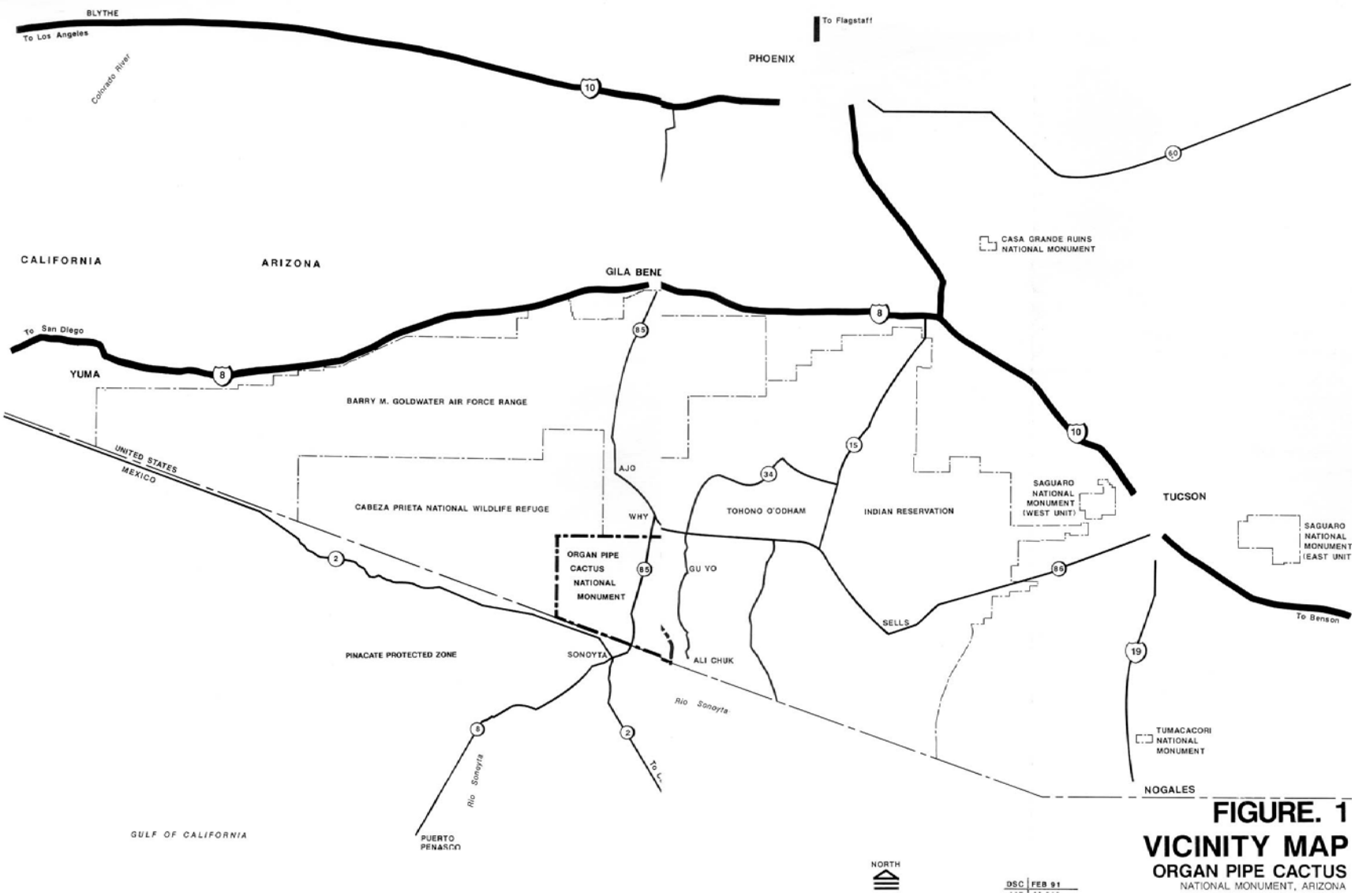


FIGURE. 1
VICINITY MAP
ORGAN PIPE CACTUS
NATIONAL MONUMENT, ARIZONA

I.A.2. Monument Purposes

Based on the establishing proclamation, Biosphere Reserve, and Wilderness designations, the following purposes were identified for Organ Pipe Cactus National Monument in the draft GMP:

Perpetuate for future generations a representative sample of the natural and cultural resources of the Sonoran Desert and provide for public understanding, use, and enjoyment of same.

- Serve as a natural laboratory for understanding and managing Sonoran Desert ecosystems.

Serve as a baseline indicator against which environmental changes can be identified.

Preserve for future use and enjoyment the character and values of designated wilderness within the monument.

I.A3. Summary of the Significant Resource Values of Organ Pipe Cactus National Monument

The draft GMP identifies the following significant resources:

Globally significant, pristine Sonoran Desert ecosystem that has been continuously researched for 50 years and has been designated a Biosphere Reserve under the international Man and the Biosphere Programme.

The most pristine and biologically diverse area of the Sonoran Desert occurring within the United States.

A protected ecosystem providing habitat for highly diverse flora and fauna, including threatened or endangered plant and animal species, or species of special concern.

A protected natural area, with wilderness character, that provides opportunities for solitude and primitive recreation, enjoying the night sky, and spiritual replenishment in a Sonoran Desert setting.

Expansive vistas of pristine Sonoran Desert landscapes including such elements as dramatic mountains and plains, eroding bajadas and alluvial fans, and magnificent specimens of columnar cacti.

Cultural resources that reflect long, widespread, and diverse occupations by Native American, Spanish, and Anglo groups.

The interaction of three cultures within the monument is geographically and internationally significant.

I.A.4. Water Dependent Resources

Although the area was not established specifically to protect water resources, they are an integral part of the Sonoran Desert ecosystem which the monument was established to protect. Almost all of the significant resource values listed above are dependent on maintenance of relatively undisturbed water resources, both surface and underground. One of the predominant features of the Sonoran Desert is high natural species diversity. There are several reasons for this diversity: geographical location, topographical range, climate, soils, and bimodal pattern and quantity (high for desert areas) of rainfall. In order for the monument to retain value as a pristine natural area and biosphere reserve suitable for scientific research, this high species diversity must be maintained.

This can only be accomplished if unnatural environmental stresses from both within and outside the boundaries are reduced and kept at a minimum. Such stresses include many of the factors associated with increased human development, such as air and water pollution, the introduction of exotic species and physical impacts from human and vehicular traffic. The

potential for impact from these stresses is presently greatest from outside the boundaries. In general, the most critical stresses in terms of threat to water resources (and the natural resources and species diversity which they support) are air and water pollution. Fortunately, due to the monument's remote location, these two stresses are presently not very severe. How-ever, the amount of stress which the system can absorb without adverse effects is currently unknown. Presently, overuse of groundwater, mainly in the Sonoyta Valley, is the primary threat/stress to water resources and all that they support. **This threat is of immediate concern,** due to the urbanization and agricultural development occurring to the south of the border.

New stresses on water resources and their potential effects need to be carefully evaluated, and management actions developed so that the monument's value as a protected natural area, wilderness area, and biosphere reserve will not be jeopardized. Following is a specific listing of some of the resources within the monument which are dependent upon water resources:

Surface Water

Most wildlife are dependent on a reliable supply of high quality water in the springs, seeps, and tinajas. This need is particularly critical for the endangered desert pupfish *(Cyprinodon macularius eremus),* most amphibians and birds, some invertebrates, and large mammals. A high quality water supply is dependent on a natural and uncontaminated supply of rainwater, surface flow, and groundwater.

Sonoran Desert vegetation, which comprises some of the monument's most significant resources, is dependent on this reliable quantity of high quality rainwater.

Groundwater

The lower elevation springs are dependent on the supply of groundwater. Monument wildlife are dependent on these springs.

Visitor use and NPS support facilities are dependent on reliable supplies of high quality groundwater in the headquarters area.

Important plant species, such as mesquite *(Prosopis sp.)* are dependent on groundwater levels. In addition, one plant species, Desert Tree Caper *(Atamesquia emarginata),* which is of limited distribution and of special concern, may be dependent on groundwater levels.

The physiography of the area is dependent on water as an erosive force (washes, bajadas, alluvial fans) and on the maintenance of groundwater levels, i.e., substantial withdrawals could cause subsidence.

Water levels in the Quitobaquito Springs and the endangered species of pupfish inhabiting them may be dependent on groundwater levels.

I.B. Water Resources Management Objectives

In order to fulfill the purpose of Organ Pipe Cactus as a national monument, an international biosphere reserve, and a wilderness area, the following six management objectives have been developed to protect the significant water resource values of the area:

To protect the natural processes of the water cycle from disturbance and thus preserve the diverse ecological systems dependent on natural water levels, flows, and quality.

To maintain or restore the quality of water resources through resource management actions and through cooperation with local

communities and peoples and regional, state, federal, and international agencies.

To contribute to the scientific base for water resources management and perform and/or coordinate water resources research.

To promote public awareness of the water resources of Organ Pipe Cactus National Monument and an understanding of current and potential human impacts upon these resources on an aquifer-affected regional basis.

To promote water conservation through direct NPS action and through cooperation with local communities and with regional, state, federal, and international agencies.

To provide for visitor safety by evaluating flash flood hazards, locating new facilities out of hazardous areas, and relocating existing facilities if flood hazards cannot be mitigated.

I.C. Water Resources Legislative and Planning Relationships

This section describes the laws and regulations applicable to the water resources of Organ Pipe Cactus National Monument. National Park Service enabling legislation, wilderness legislation, Man and the Biosphere establishment, international agreements, and major state and federal water resources legislation is presented.

I.C.1 International Legislation and Agreements

I.C.1.a. United Nations and the United States

On October 26, 1976, the United Nations Education, Scientific and Cultural Organization (UNESCO) designated Organ Pipe Cactus National Monument as a Man and the Biosphere Reserve. Biosphere reserves provide the framework for cooperation in building the knowledge, skills, and attitudes required to maintain biological diversity in large geographical areas which include a range of representative human uses and activities.

To carry out the complementary activities of resource conservation and development of sustainable resource uses, biosphere reserves consist of three interrelated zones: a core area, a buffer zone, and a transition area. The **core area** consists of examples of minimally disturbed ecosystems characteristic of one of the world's terrestrial or coastal/ marine regions. It may also contain places of exceptional scientific interest for observing particular species, features, or processes. A core area has secure legal protection, and only activities that do not adversely affect natural processes and wildlife are allowed. For this reason, strict nature reserves and "wilderness" portions of national parks serve as core areas of biosphere reserves.

In the **buffer zone,** which adjoins or surrounds the core area, uses and activities are managed in ways that help protect the core. The boundaries of this zone often coincide with those of a national park unit, wildlife refuge, or multiple use area.

The outermost area of a biosphere reserve is the **transition area,** which typically surrounds the core area and buffer zone. This is usually an undelineated, dynamic "zone of cooperation" where conservation knowledge and management skills are applied, and uses are managed cooperatively in harmony with the purposes of the biosphere reserve. The area may contain settlements, croplands, managed forests, areas for intensive recreation, and other economic uses characteristic of the region. The varied yet characteristic uses of the landscape make it particularly suitable for interdisciplinary studies to support regional planning for conservation and rural development.

The buffer zone, and more often the transition area, include places where manipulative management is practiced. **Experimental Research Areas** are used for discovering ways to manage

vegetation, wildlife, croplands, forests, and other natural resources to enhance production while conserving natural processes and biological diversity to the greatest extent possible.

Both Mexico and the United States are implementing active biosphere reserve programs through their respective National Committees for Man and the Biosphere Programme (MAB). In Mexico, biosphere reserves are established by law as management units that carry out integrated programs of research, education, and demonstration of culturally and ecologically appropriate economic uses. The management structure typically provides for the participation of local communities in planning and management. In the US, the emphasis is on developing voluntary cooperative programs for particular geographical areas under the sponsorship of MAB. The programs may involve many biosphere sites managed by a variety of governmental and private entities. The US program priorities focus on biological diversity, global climate change, sustainable human uses, and their interactions.

Resource studies to support designation of biosphere reserves in Mexico are typically conducted by government-supported research institutions. The Secretaria de Desarrollo Urbano y Ecologia (SEDUE) must approve an area as a biosphere reserve prior to legal establishment by Presidential Decree and before the Mexican National MAB committee nominates the area for international designation by UNESCO. Research institutions play key roles in developing biosphere reserve programs and, in some reserves, have significant management responsibilities.

The Organ Pipe Cactus Biosphere Reserve, designated in 1976, has a dedicated research and resources management facility, the Sonoran Desert Biosphere Reserve Center. It also has an active science program which focuses on regional issues. The US MAB National Committee has commissioned a feasibility study to explore possibilities for establishing a Regional MAB/Biosphere Reserve Program involving the monument and adjacent areas administered by the Bureau of Land Management (BLM), the Air Force, the US Fish and Wildlife Service (USFWS), and the Tohono O'odham Nation. In Sonora, studies to support nomination of the adjacent Pinacate Protected Zone were completed several years ago, but nomination has not yet been made. In October 1988, the Sonora-Arizona Commission coordinated the First International Symposium on the Pinacate, which has generated considerable interest in designating the Pinacate Biosphere Reserve. The ongoing efforts could eventually provide the basis for a binational MAB/Biosphere Reserve Program involving biosphere reserve sites in both countries.

I.C.1.b. Mexico and the United States

Most of the information in this section and section I.C.1.c is taken from Special Report No. 8 on Treaties, Agreements, and Accords Affecting Natural Resource Management at Organ Pipe Cactus National Monument, by Carlos Nagel (1988). According to that report, the following laws and agreements (the full text of which is located in the appendix of the report) will affect water resources management at Organ Pipe Cactus National Monument.

Water Utilization Treaty of 1944

Surface Waters

The most important bilateral treaty concerning water resources is Treaty Number 994 "Utilization of the Colorado and Tijuana Rivers and of the Rio Grande" signed on February 3, 1944. Under this treaty both governments agreed to establish the International Boundary and Water Commission (IBWC) and spelled out the responsibilities of the Commission under the direction of two commissioners, one representing Mexico and one the United States.

The commission has assigned the following priorities for the joint use of international waters:

1. Domestic and agricultural use
2. Agricultural and stock raising
3. Electric power
4. Other industrial uses
5. Navigation
6. Fishing and hunting
7. Any other beneficial uses determined by the Commission.

The treaty makes provision for the equitable allocation of water based on drainage basins and the rate of flow, with an accounting for surpluses and deficits based on periodic cycles. It also specifies water conservation, storage, and diversion. In the case of the Colorado River, very specific amounts of water of a certain quality are to be delivered to Mexico. Other provisions include research, the administration of all treaties between the two countries that are entrusted to the Commission, settling differences, providing information, recording hydrographic data, preparing reports, and the general administration of the treaty.

The importance of this treaty is two-fold: it provides a mechanism for resolving conflicts over international surface water resources; and it points the way for the resolution of the increasingly acute problem of competition for groundwater in the border region of the US and Mexico.

Groundwater Sources

Some underground aquifers in the border region have a southern flow, while others flow north. Conflicts arise where pumping on one side of the border adversely affects the availability of water on the other and domestic legal remedies are not applicable. Aquifers most acutely affected include the Las Cruces, New Mexico area; the Yuma, Arizona area; the Canaiiea and Sonoyta area in Sonora, Mexico; and several locations in Texas. Wells installed at these sites are pumping large volumes of water on one or both sides of the border from aquifers that recharge very slowly. Although efforts have been underway for several years to develop a groundwater treaty, no international regulation presently exists.

United States Fish and Wildlife Service Agreement with the Ministry of Urban Development and Ecology in Mexico

This is an agreement that is based on the June 1972 Agreement on Scientific and Technical Cooperation between Mexico and the United States.

The agreement recognizes the shared responsibility in management of wildlife between the two countries because of shared habitats and is based on international conventions with Mexico and within the Western Hemisphere. A bilateral Joint Committee has been established to set priorities, allocate resources, define and evaluate projects, and promote cooperation. The principal areas of concern are conservation of endangered species, research of flora and fauna, management of protected natural areas, training and education, and mutual support in enforcement activities.

Since the agreement is contingent on funding from each side, it has not been an effective instrument of bilateral public policy.

Minute 242 of the International Boundary and Water Commission, United States and Mexico

In 1973, the United States and Mexico signed an addendum known as Minute 242, that provides in Section 6, for the "objective of avoiding future problems, the United States and Mexico shall consult each other prior to undertaking any new development of either the surface or the groundwater resources, or undertaking substantial modification of present developments, in its own territory in the border area that might adversely affect the other country."

Agreement Between the United States of Mexico and the United States of America on Cooperation for the Protection and Improvement of the Environment in the Border Area (La Paz Agreement, 1984)

The La Paz Agreement acknowledges the importance of a healthy environment and is designed to build on existing agreements between the United States and Mexico. It supersedes a 1978 Memorandum of Understanding concerning environmental cooperation, which set the stage for focusing on environmental issues from a global perspective.

There are several articles of the La Paz Agreement that are applicable to water resources management at Organ Pipe:

Article 1 - "The objectives of the present agreement are to establish the basis for cooperation between the Parties for the protection, improvement and conservation of the environment and the problems which affect it, as well as to agree on necessary measures to prevent and control pollution in the border area, and to provide the framework for development of a system of notification for emergency situations."

Article 6 - provides for "...coordination of national programs, scientific and educational exchanges, environmental monitoring, environmental impact assessment and periodic exchanges of information and data on likely sources of pollution in their respective territory which may produce environmentally polluting incidents..."

Article 7 - "The parties shall assess...projects that may have significant impacts on the environment of the border area, so that appropriate measures may be considered to avoid or mitigate adverse environmental effects."

The agreement provides for international coordination through the Environmental Protection Agency (EPA) in the United States, and the Secretaria de Desarrollo Urbano y Ecologia (SEDUE) in Mexico. It also provides for the national coordinators to meet no less than once a year and grants them the authority to invite the participation of state and municipal authorities, as well as international and non-governmental organizations.

Ixtapa Agreement Draft

The most recent accomplishment has been the 1985 Ixtapa Agreement Relating to the Use of Transboundary Groundwaters. This draft has been updated in a version known as the Bellagio Conference Report. It provides for a framework for consistent identification of transboundary groundwater issues, resolution of conflicts and sound management of ground water resources.

Memorandum of Understanding on Cooperation in Management and Protection of National Parks and Other Protected Natural and Cultural Heritage Sites

While the earlier international agreements and treaties allow for exchanges between various levels of government, this memorandum applies specifically to the Director of the National Park Service in the United States and his or her counterpart in Mexico. It establishes a framework for the regular exchange of information on issues and projects of mutual concern, and annual meetings for person-to-person discussions.

The stated objective of this memorandum is,

> ... the creation of a framework for the cooperation between the parties concerning: the conservation of protected natural areas and their biodiversity, the preservation of cultural heritage and natural resources, and when possible recognition of sustainable development alternatives for rural mexican communities located in those areas, the exploration of strategies for related cooperation with rural communities, citizens groups and scientific and

other organizations acceptable to both countries within the legal framework of each country.

The text of this memorandum and its Annex are included in Appendix F. The full title of this agreement signed on November 30, 1988 is; Memorandum of Understanding between National Park Service of the Department of the Interior of the United States of America and Secretariat of Urban Development and Ecology, United Mexican States on Cooperation in Management and Protection of National Parks and Other Protected Natural and Cultural Heritage Sites.

Miscellaneous Agreements

Protection of Migratory Birds

On February 7, 1936, a Convention was signed between the United States and Mexico for the protection of migratory birds and game mammals. In 1972, the convention was expanded with the addition of 31 species.

Cooperative Agreement Between the Arizona Nature Conservancy and the Centro Ecologico De Sonora

These organizations recently signed a collaborative and coordinating agreement on scientific research for the purpose of proposing and designing effective natural resource conservation systems for eventual recommendation to their respective national governments.

I.C.I.c. Native Americans and the United States

There are a number of laws, agreements, and treaties that affect natural and cultural resources management within the monument, however only one would affect water resources. Special Use Permit 8660-3-0001, dating back to 1939, allows the Tohono O'odham to graze livestock on 1,600 acres in the southeastern corner of Organ Pipe Cactus, on the eastern side of the crest of the Ajo Mountains.

LC.2. Federal Legislation and Authorities

I.C.2.a. Establishment of Organ Pipe Cactus National Monument

As discussed in the Introduction, Organ Pipe Cactus National Monument was established as a unit of the National Park System by Presidential Proclamation No. 2232 in 1937. The implications of the proclamation are described in the Introduction.

In 1978, Congress added the Organ Pipe Cactus Wilderness to the National Wilderness Preservation System (16 U.S.C. 1017). This system of nationally significant wilderness areas was established by Congress in 1964 through the passage of the Wilderness Act (16 U.S.C. 1013).

The designation of 312,600 acres as a Wilderness area gives additional impetus to preservation of the pristine quality of the area's water resources. The purpose of the National Wilderness Preservation System is to "... secure for the American people of present and future generations the benefits of an enduring wilderness resource." The Act defines wilderness as:

> ...an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain....retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) ... is of sufficient size to make practicable its preservation and use in an unimpaired condition, and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

The vital role the scarce water resources play in maintaining the wilderness character of this

area makes their preservation of paramount importance.

I.C.2.b. National Historic Preservation Act (NHPA) (1966)

This National Historic Preservation Act (16 USC 470 et seq.) sets forth the basic concern of the nation for the preservation of its heritage. Section 106 of the act requires an evaluation for any project which might impact historic features. All actions proposed in this plan will be evaluated for compliance with this and other cultural resource protection mandates prior to initiation of the project.

I.C.2.c. **National Environmental Policy Act (NEPA) (1969)**

The National Environmental Policy Act (42 USC 4371 et seq.) requires that any major federal action which may significantly affect the human environment include review through the NEPA process. This is applicable to actions involving water resources, including changes to or increases in water use and treatment (i.e., constructing of sewage treatment plants, pipelines, residences, and visitor facilities). All actions proposed in this plan will be evaluated for compliance with NEPA at a level identified in each project statement.

I.C.2.d. Federal Water Pollution Control Act (Clean Water Act)

The Clean Water Act (33 U.S.C. 1251, et. seq.), passed in 1972, and significantly amended in 1977 and 1987, was designed to restore and maintain the integrity of the nation's water, including the waters of the National Park System. The law sets ambitious goals for the nation's waters: swimmable and fishable waters by 1983 and no further discharge of pollutants into the nation's waterways by 1985. The two strategies for achieving these goals, incorporated into the Act, encompassed a major grant program to assist in the construction of municipal sewage treatment facilities and a program of "effluent limitations" designed to limit the amount of pollutants that could be discharged. Effluent limitations are the basis for permits issued for all point source discharges, known as the National Pollutant Discharge Elimination System (NPDES). The Environmental Protection Agency (EPA) has set limits for pollutants that may be released based on available technology and cost of treatment for various industrial categories.

Also as part of the Act, Congress recognized the primary role of the States in managing and regulating the nation's water quality, within the general framework developed by Congress. Part of that framework, namely section 313, requires that all federal agencies, including the National Park Service, comply with the requirements of state law for water quality management, regardless of other jurisdictional status or land ownership. The Act states:

> Each department, agency, or instrumentality of the executive, legislative, and judicial branches of the Federal Government (1) having jurisdiction over any property or facility, or (2) engaged in any activity resulting, or which may result, in the discharge or runoff of pollutant, and each officer, agent, or employee thereof in the performance of his official duties, shall be subject to, and comply with, all Federal, State, interstate, and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water pollution in the same manner and to the same extent as any nongovernment entity including the payment of reasonable service charges. The preceding sentence shall apply (A) to any requirement whether substantive or procedural (including any record keeping or reporting requirement, whatsoever), (B) to the exercise of any Federal, State, or local Administrative Authority, and (C) to any process and sanction, whether enforced in Federal, State, or local courts or in any other manner. This subsection shall apply notwithstanding any immunity of such agencies, officers, agents, or employees under any law or rule of law.

States implement the protection of water quality under the authority granted by the Clean Water Act through water quality standards. Standards are composed of the designated use or uses made of a water body or segment, the water quality criteria necessary to protect that use or uses, and an antidegradation provision to protect the existing water quality. Criteria are descriptions of maximum or minimum physical, chemical, and/or biological characteristics of water that reflect tolerances and requirements for human health, aquatic biota, and aesthetics which will protect the designated uses. Designated uses are usually expressed as such categories as drinking water, fish and wildlife propagation, primary contact recreation, or industrial uses. The standards also serve as the basis for water quality-based treatment and establish the water quality goals for the specific stream segment or water body. A triennial review of a state's water quality regulatory program is conducted by a states' water quality agency to determine if the standards are adequate. These standards are then forwarded to the EPA for approval.

The EPA promotes the concept that a state's antidegradation policy (adopted as part of the States' Water Quality Standards) represents a three-tiered approach to maintaining and protecting various levels of water quality and uses. At its base, the existing uses of a water segment and the quality level necessary to protect the uses are maintained (i.e., water quality can be degraded as long as the designated uses are protected). This establishes the absolute foundation for water quality.

The second level provides protection of existing water quality in segments where quality exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water (i.e., those segments meeting the "fishable/swimmable" goals of the Clean Water Act). In such segments, only limited water quality degradation can be allowed after it has been shown through a demonstration process, which includes public participation, that the quality will continue to support the "fishable-/swimmable" uses.

The third tier provides special protection for waters for which ordinary use classification may not suffice and which are classified as "Outstanding National Resource Waters" (ONRW) or with a similar state designation. The purpose of this special designation is to safeguard a state's highest quality waters and also to maintain the quality of waters that have ecological importance. Antidegradation policies will be further discussed in Section III.

The Clean Water Act recognizes that water quality management is a complex, multi-phase process, with the adoption of water quality standards being one manifestation of clean water goals. The 1987 Water Quality Act, for example, presents several new initiatives, including those that emphasize non-point source control programs, toxics control, management of coastal or near-coastal waters, and others. In addition, the Act continues the shift of the national control strategy away from technology-based effluent limitations to water quality-based controls and programs. Federal legislation and regulations are generally implemented by the states with the EPA serving in an oversight role.

I.C.2.e. Safe Drinking Water Act (1974) and Amendments (1986)

This legislation applies to drinking water supplies. Provisions of the recent amendments include more stringent regulation of contamination, with which utility managers should be familiar.

I.C.2.f. Endangered Species Act (1973)

This act requires all entities using federal funding to consult with the Secretary of the Interior on activities that potentially impact endangered flora and fauna. It requires agencies to protect endangered and threatened species as well as designated critical habitats.

1.C.2.g. Federal Executive Orders

Two Executive Orders addressing Floodplain Management (E.O. 11988) and the Protection of Wetlands (E.O. 11990) apply to water resources management at Organ Pipe Cactus National Monument.

The objective of E.O. 11988 (3 CFR 121(Supp 177)) 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."

The Protection of Wetlands Executive Order (E.O. 11990) (3 CFR 121 (Supp 177)) furthers the purposes of the National Environmental Policy Act (NEPA) (42 U.S.C. 4321) by directing 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..." These directives are discussed in greater detail in Section II.B.3. Description of Watersheds.

There are two additional Executive Orders related to water resources management at Organ Pipe Cactus National Monument. These are: Executive Orders 11987 on Exotic Species and 12088 on Environmental Pollution.

The objective of E. O. 11987 is to "...restrict the introduction of exotic species into the natural ecosystems on lands and waters which they (federal agencies) own, lease, or hold for purposes of administration; and, shall encourage the States, local governments and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States."

E.O. 12088 requires that federal agencies, including the NPS, cooperate with state, intrastate, and local agencies in the prevention, control, and abatement of environmental pollution.

LC3. State Water Resource Legislation

I.C3.a. Arizona State Water Quality Standards (1989)

State water quality standards were promulgated to aid in the enforcement of federal requirements of the Safe Drinking Water and Clean Water Acts and to protect the waters of the state (A.A.R.R. Title 18, Chapter 11). They include designated uses, water quality standards for those uses and provisions for anti degradation of existing water quality. Arizona Surface Water Quality Standards present the following statement of policy for surface and groundwater quality goals:

> Wherever attainable, surface water quality which provides for the protection of aquatic life and wildlife, for the protection of recreation in and on the water and for the protection of domestic water supply shall be achieved and maintained. For a particular surface water segment, the feasibility of attaining the above stated goals shall be based on a balanced consideration of technological, economic, social, legal, and environmental quality factors.
>
> It shall be Arizona's goal to assess and then manage and maintain groundwater quality at levels which:
>
> 1. Protect the public health;
>
> 2. Acknowledge and accommodate current and projected uses;
>
> 3. Support the long-term economic and environmental well-being of the State;
>
> 4. Recognize the current state of waste treatment and water treatment technology.
>
> Surface and groundwater quality goals are to be mutually supportive.

Allowable limits have been established for several chemical and physical parameters. The level of water quality protection is based on one or more protected uses designated by the state. The definitions of protected uses and allowable limits for most parameters are presented in Appendix E. Arizona Surface Water Quality Standards. Protected uses have not been designated for any of the waters of the monument.

Section 202 refers to antidegradation of existing water quality stating:

> Existing surface water uses and the level of water quality necessary to protect existing uses shall be maintained and protected. No further surface water quality degradation which would interfere with or become injurious to these existing uses is allowable.
>
> No further degradation shall be allowed in high quality waters which constitute an outstanding public resource or in waters of exceptional recreational or ecological significance. Streams and lakes which receive this protection shall be classified as unique waters by the council...
>
> No further degradation shall be allowed in any stream or lake which would destroy the critical habitat for a threatened or endangered species which is historically of presently known to be associated with such waters. Streams and lakes which receive this protection shall be classified as unique waters by the council...

Requirements for nomination and classification for unique waters are found at R18-11-303. In order to be classified as unique waters a surface water must meet at least three of ten criteria. Quitobaquito Springs and Pond appear to qualify under seven of the criteria. Once a source is designated as unique, specific water quality standards are established for that source that individual source.

I,C3.b. Arizona Groundwater Management Act (1980)

This act provides for management and use of groundwater and the determination of rights to withdraw and use groundwater in designated groundwater basins. Organ Pipe Cactus National Monument does not lie within a designated groundwater basin. Its water uses and rights are administered under this legislation but are not closely regulated and managed as are rights in designated groundwater basins.

1.C3.c. Arizona Environmental Quality Act (1986)

This act establishes the Arizona Department of Environmental Quality and prescribes definitions, powers, duties, procedures, rights, conditions, and enforcement actions relating to water quality statewide.

1.C3.d. Miscellaneous Arizona State Statutes Related to Water Resources Management

Arizona Wastewater Treatment Law

This law applies to wastewater collection and treatment facilities. It requires the Arizona Department of Environmental Quality to adopt and enforce rules relating to the design, construction, operation, and maintenance of all existing and proposed on-site wastewater treatment facilities.

Arizona Wastewater Disposal Regulations

These regulations apply to the reuse of wastewater; including specific standards and permit monitoring requirements for the reuse of wastewater, and for the construction and operation of sewage systems within the state.

Arizona Hazardous Substances Spill Response Law

This law designates the Arizona Department of Environmental Quality as the administering

agency for spill response. The law establishes a Water Quality Assurance Fund, defines its uses, and details responsible party, remedial action, and liability for remedial action costs criteria.

Arizona Remedial Action Regulations for Hazardous Substances Spills

This law details the regulations necessary to administer the Water Quality Assurance Fund established in the Arizona Hazardous Substances Spill Response Law.

I.D. Land Status, Uses, and Planning Relationships

The monument is operated under the Management Policies of the Executive Branch of the United States and is administered by the National Park Service. It contains about 516 square miles or 330,689 acres. Preserving elements of the Sonoran Desert, it is situated approximately 150 miles southwest of Phoenix and approximately 150 miles west of Tucson, in Pima County, Arizona's 2nd Congressional District.

Approximately 96 acres of land within monument boundaries are owned by business interests with existing enterprises in Lukeville, Arizona. The Lukeville area is currently in private commercial use, and contains facilities such as a hotel, grocery store, and gas station.

The monument shares a 30 mile common boundary with the state of Sonora, Mexico, to the south. The majority of the adjacent Mexican land is undergoing intensive agricultural development and urbanization. Groundwater to irrigate crops in the Sonoyta Valley is being pumped out of the aquifer at 2.5 times the recharge rate (Brown 1988). This aquifer is shared by the monument, and the subsequent lowering of the water table poses a major threat to the its natural resources.

To the west and northwest, a 26 mile border is shared with the Cabeza Prieta National Wildlife Refuge. The refuge is administered by the United States Fish and Wildlife Service. Approximately 860,000 acres of Sonoran Desert are encompassed in the refuge; 93 percent of which is designated as wilderness. Over 95 percent of the refuge is within the boundaries of the Barry M. Goldwater Air Force Range. Many low flying aircraft transit the refuge on their way to air-to-air bombing and gunnery ranges located to the north of the refuge. A Natural Resources Management Plan for the range was developed in 1986 with a stated goal of protection of environmental values. Implementation of this goal consists of managing the natural environment of the Range as a reserve in which natural processes prevail. All applicable federal, state, and county laws, regulations, and ordinances are enforced on the Refuge.

The Tohono O'odham Reservation borders the east and extreme northeast for approximately 33 miles. Overall, the reservation encompasses 2.8 million acres. Approximately 16,531 tribal members live on the reservation, scattered throughout 70 villages. The policy of the Bureau of Indian Affairs Papago Agency is one of tribal self-determination and full tribal involvement in all phases of natural resource and human resource development on the reservation. The Tohono O'odham people traditionally depend on natural resources for housing needs and on subsistence hunting for foods.

To the north, the monument shares a 12 mile boundary with the Bureau of Land Management. The major use made of the BLM land is pasture for livestock.

The monument is currently involved in a General Management Planning process. It is envisioned that the plan will provide a direction for dealing with adjacent land issues, including water resources concerns. A major goal of the General Management Plan is to incorporate the Man and the Biosphere philosophy into most management concerns. This involves recognizing

that problems such as the water drawdown in the Sonoyta Valley aquifer are issues which affect both the monument and Mexico; and that cooperation and understanding are paramount in deriving solutions.

I.E. Identification of Water Resources Issues

Fifteen water resources issues affecting Organ Pipe Cactus National Monument have been identified. They are presented below and grouped into six topic areas. Background information concerning these issues is presented in Section II. The Hydrologic Environment, and each is specifically addressed in Section III. Water Resources Management Program.

WATER RESOURCES ISSUES

. WATER RIGHTS - Identification of Water-Related Resource Attributes

. ALTERATION OF NATURAL FLOW REGIMES AND GROUNDWATER LEVELS -
Land Subsidence
Groundwater Depletion from Water Use on the Rio Sonoyta Watershed -
Water Conservation in Monument Operations

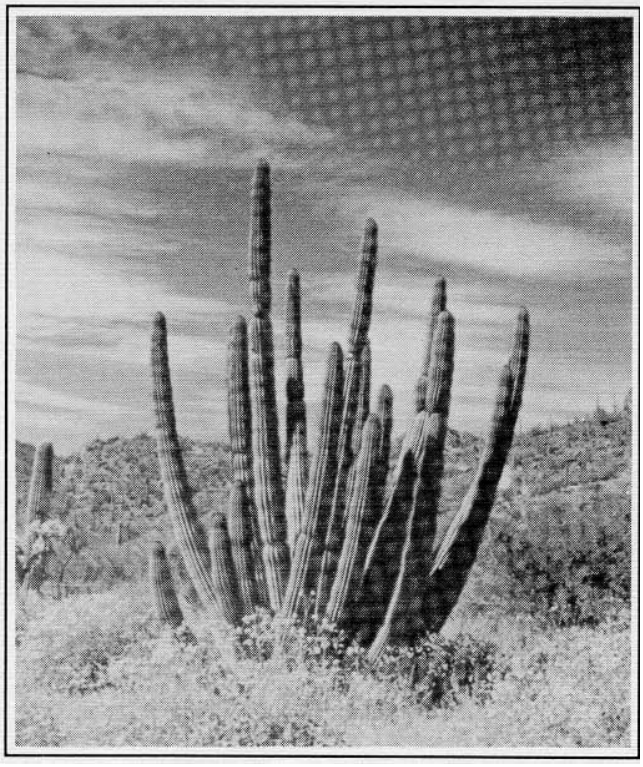
. LACK OF BASIC INFORMATION NECESSARY TO UNDERSTAND MONUMENT RESOURCES AND RELATED THREATS
- Characteristics of Regional Aquifers
- Geohydrology of Quitobaquito Springs
- Inventory and Monitoring of Water Resources
Pollution Threats from Kuakatch and Cuerda de Lena Washes

▪ DEGRADATION OF WATER QUALITY AND RESOURCES -
Abandoned Mine Tailings
Accelerated Erosion

▪ FLOODPLAIN MANAGEMENT AND WETLANDS PROTECTION -
Floodplain Hazards
Protection of Riparian Ecosystems

• OTHER WATER RESOURCES ISSUES - Geographic Information System Component for Water Resources
Chemistry of Monument Precipitation
Wastewater Management

II. THE HYDROLOGIC ENVIRONMENT



II. THE HYDROLOGIC ENVIRONMENT

ILA. Introduction

Water resources include both surface and groundwater. Surface water resources include springs, seeps, tinajas (or rock catchments), and Quitobaquito pond. Groundwater, which fills the alluvial basins and some bedrock underlying the monument, is the source of springs, seeps, and domestic water for the monument, and also supports riparian vegetation.

As this is a desert park, water matters are a high priority. Although the water resources are not very extensive, water quality problems, potential threats to major underground aquifer systems and airborne pollution problems emanating from Mexico, create potentially large scale issues.

II.B. Description of the Area

Organ Pipe Cactus National Monument preserves only a small portion of the vast 76.4 million acre Sonoran Desert, which contains one of the world's largest inventories of desert flora and fauna. The Sonoran Desert encircles the Gulf of California, and covers portions of southeastern California, southern Arizona, and most of the Mexican states of Sonora, Baja California, and Baja California Sur.

Two subdivisions of the Sonoran Desert, the Colorado River Lowland and the Arizona Upland, converge in the monument. The Lower Colorado is the hottest and driest subdivision. The Arizona Upland subdivision is characterized by its highly diverse flora and fauna. In addition, a few species of plants, representative of a third subdivision of the Sonoran Desert, the Central Gulf Coast, can also be found in Organ Pipe.

II.B.1. Climate

Organ Pipe Cactus is one of the driest of all of the NPS units. It is located at the approximate center of the Sonoran Desert, a biogeographic region characterized by relatively little rainfall, high summer temperatures, intense solar radiation, low humidity, and high evaporation. Surface water is a limited, often unavailable, resource in this area. The extensive alluvial valleys separating the mountains are quite permeable and allow rapid infiltration of runoff. Seasonal precipitation is often abrupt, causing brief flash floods which usually last from a few minutes to a few hours.

Typical of the Sonoran Desert, Organ Pipe Cactus National Monument is characterized by a bimodal precipitation pattern, nearly all of which falls as rain. Approximately 50 percent of the yearly precipitation falls during the monsoon season of July, August, and September. In some years, a much higher proportion of the total rainfall may occur during the monsoon season. For example, in 1950, 74% of the precipitation fell during the monsoon season. The summer monsoon precipitation commonly occurs abruptly, resulting in flash floods (Ives 1936). Due to the localized nature of these summer thunderstorms, the occurrence of precipitation may be patchy, although the amount and distribution presumably average out over the course of the summer (Petryszyn 1981). Precipitation at the monument during the winter is not as dependable as that provided by the summer monsoons. Virtually all of the winter precipitation occurs as rainfall, although light snow is occasionally recorded in the Ajo Range, and rarely, at the monument headquarters (Sellers and Hill 1974).

Moisture is least available during the three-month period of April, May and June, preceding the summer monsoon season. During this time, the skies are generally cloudless, with prevailing westerly winds; relative humidity is extremely low (15-20% or lower), and temperatures are among the highest of the year. An average of 0.45 inches of rain is typical for this three-month period. Between 1944 and 1972, weather records show that the month of May received no rainfall for 20 of 29 years, and June was rainless for 15 of these years. In 1972, only a

trace of rainfall occurred between January } and the end of May (Sellers and Hill 1974).

A slightly less intense dry period also occurs after the summer monsoons, from October to December. Though average precipitation is low in the fall, reaching an extreme of only 0.11 inches in 1944, this period can conversely also include some of the heaviest precipitation. When infrequent tropical storms pass through the Sonoran Desert, heavy precipitation can occur, such as in November, 1985, when 2.74 inches of rain fell, and in November, 1952, when 2.82 inches of rain fell.

Next to its scarcity, the most notable precipitation feature is its variability. Though average annual precipitation at monument headquarters is just over 8 inches, any ten year period will typically include two years with less than 4.5 inches and three years with more than 11 inches. In 1950, the monument received a paultry 3.38 inches, and 55% of that fell in July, while in 1984, 17.22 inches fell.

Precipitation increases at higher elevations in Arizona due to orographic effects. The higher land mass causes greater precipitation by physically forcing moist air masses upward as they pass over the mountains, and by providing updrafts that initiate thunderstorms during the monsoon season. This is significant in the Ajo Mountains, where annual precipitation approaches 15 inches and supports a relict oak-juniper plant community.

Temperatures since 1944 have ranged from a recorded summer high of 117° F to a winter low of 14° F at headquarters. Lower temperatures occur at the top of Mount Ajo, and higher temperatures are found on the low plains on the west side of the monument. Summers are hot, with daytime temperatures commonly exceeding 100° F and average nighttime lows near 70° F. Maximum temperatures during the four summer months of June through September average 100° F or greater. Warm winter days with temperatures from 65 ° F to 85° F are common, while night temperatures may drop to near freezing.

In this segment of the Sonoran Desert, evaporation rates commonly exceed 8 feet annually, due to the combination of high temperatures, low humidity, and clear skies with intense solar radiation. Evaporation peaks in the hottest and driest months of May, June, and July. Over the year, evaporation is nine times greater than precipitation. In order to survive, plants and animals must take advantage of both the brief periods when rainfall exceeds evaporation, and natural features that concentrate and store water.

Rainfall is recorded monthly at 17 locations throughout the monument by resource management staff. Seven of the locations are equipped with Forester rain gauges, whose data is summarized annually. Nine sites have automated Datapod weather stations with tipping buckets. Weather data, including precipitation, is recorded hourly on data storage modules (DSM). Each weather station is serviced monthly and the data on each DSM is downloaded into a computer and summarized. An annual report on automated weather station data is prepared. An additional rainfall record is made as part of the monument's involvement in the National Atmospheric Deposition Program (NADP), a nationwide program for monitoring precipitation chemistry. A precipitation gauge is serviced weekly, and pH and conductivity measurements are performed on precipitation samples. A portion of the sample is shipped to the National NADP laboratory where a more detailed analysis is conducted.

II.B.2. Topography and Geology

The monument lies within the Basin and Range Geologic Province which extends from northwest Mexico to southeast Oregon, and from the Colorado Plateau and Sierra Madre on the east to the Sierra Nevada on the west. The Basin and Range is named for the numerous elongated mountain ranges alternating with wide alluvial

valleys. Stretching of the earth's crust in the late tertiary period, 8-15 million years ago, caused numerous block faults to form where alternating blocks rose, fell or were tipped several thousand feet. As mountains rose and valleys fell, material eroded from the mountains partly filled the valleys, giving the region its distinctive topography. Throughout the province, the mountains and valleys trend roughly north and south.

The geology and topography here is typical of the Basin and Range. The variability from range to range is attributable to differences in the kinds of rock that were uplifted, the extent and timing of uplift, and the amount of erosion that has occurred.

The Ajo Mountains rise abruptly to 4,843 feet above sea level along the eastern boundary, and are the most prominent topographic feature of the area. They are made up of volcanic rock (tuff, andesite, basalt, and rhyolite) that was deposited on the land surface during the middle and late tertiary period, before the block faulting.

West of the Ajo Mountains, across the Sonoyta Valley and the Valley of the Ajo, lay the smaller Puerto Blanco Mountains and Sonoyta Mountains. The northern portion of these mountains is made up of tertiary volcanic rock similar to that found in the Ajo Mountains. Further to the south, older mesozoic andesite, rhyolite, gneiss, and schist are exposed. Most peaks of the Puerto Blanco and Sonoyta Mountains rise to about 2,500 feet, with Pinkley Peak reaching 3,145 feet.

Another series of low mountains rise near the western boundary. The Bates Mountains and Cipriano Hills contain thick layers of volcanic basalt and andesite, deposited during the late tertiary and early quaternary periods. Some altered sedimentary rock is exposed in the northernmost Bates Mountains. Here shales, sandstones, limestones, and conglomerates have been metamorphosed into phillite, quartzite, and nmarble. The southern member of this group of mountains, the Quitobaquito Hills, are low exposures of mesozoic igneous and metamorphic rock, including andesite, dikes and plugs, rhyolite, gneiss, and schist.

Structural valleys between the mountain ranges, including the Sonoyta and Growler Valleys, Valley of the Ajo, and La Abra Plain, are filled with alluvium eroded from the surrounding mountain ranges. Great quantities of gravel, sand, silt, and clay have been carried down the numerous ephemeral channels from the mountains to the valley floors. The accumulated alluvium may well exceed several thousand feet in depth. These deep valley deposits provide major reservoirs for groundwater in the Basin and Range Province. Valley floors in the monument are between 1,000 and 1,600 feet in elevation.

II.B3. Description of Watersheds

Though the flow of surface water is an uncommon event, a complex drainage pattern has developed that supports many ephemeral channels. Storm water that collects in the steep narrow drainages in the mountains, flows in numerous small channels down the long sloping bajadas away from the mountains, before flowing into the major drainages. There are two major drainage basins; the Rio Sonoyta to the south and San Cristobol Wash to the north. These are delineated on the drainage basin map (Figure 2).

Water from approximately 143,000 acres (43%) of the monument flows south to the Rio Sonoyta in Mexico. Drainage from the western Puerto Blanco Mountains flows into the Aguajita Wash before crossing the border, while the majority of surface flow on this watershed crosses the border in numerous small channels on the bajada.

The Rio Sonoyta drains a large area extending 80 or more miles to the east, including much of the Tohono O'odham Reservation. All of the

channels over this area are ephemeral, with flow only as groundwater or as brief floods following heavy rains. It is not known if the groundwater basin of the Rio Sonoyta corresponds with the surface watershed. The Rio Sonoyta flows parallel to, and within 1 to 3 miles of, the international boundary for almost the entire width of the monument. This is the only reach that supports a perennial stream. Downstream the Rio Sonoyta turns to the southwest and empties into the Sea of Cortez 50 miles away.

The remainder of the monument, approximately 188,000 acres, drains to the northeast toward San Cristobol Wash and eventually into the Gila River. The Valley of the Ajo, the largest valley in the monument, is drained by Cherioni Wash. It joins with Cuerda de Lena Wash to form Growler Wash, which flows out of the northwestern corner and on to San Cristobol Wash.

Surface water flows into the monument only along the northern and northeastern boundary. Kuakatch Wash enters the northeast corner after draining about 19,000 acres of the Tohono O'odham reservation. Cuerda de Lena Wash enters from the north and drains 70,000 acres of federal lands managed by the BLM, Tohono O'odham reservation lands, and a few acres of private lands at the community of Why. The mining developments at Ajo are not in the Cuerda de Lena Wash surface watershed, but the direction and magnitude of groundwater flow in this area are not known.

Hydrologic Unit Maps for each state are published by the U.S. Geological Survey. The northern portion of the monument, which drains into San Cristobol Wash, is in Hydrologic Unit #15070203, and has a total drainage area of 1570 square miles. The southern portion of the monument is in Hydrologic Unit #15080102, the Rio Sonoyta.

II.B.4. Flora

Approximately 550 species of vascular plants are found within the boundaries of Organ Pipe Cactus National Monument. This number includes both perennial and annual plant species, representing three distinct subdivisions of the Sonoran Desert and their associated vegetative communities. Approximately 11% (62 species) of the flora is composed of non-native plants (Felger, 1990).

The highly diverse Arizona Upland subdivision embraces the greater eastern portion of the monument. Included in this subdivision is the mixed cactus/palo verde community found on the bajadas or low-lying gravel slopes. Here cacti such as the giant saguaro *(Camegiea gigantea)* and organ pipe cactus *(Lemaireocereus thurberi)* dominate the landscape. The prevalent tree species is the foothill palo verde *(Cercidium microphyllum).* In the higher elevations of the Ajo Mountains, the jojoba/ evergreen scrubland community is found. Here, where rainfall is more abundant, plants such as jojoba *(Simmondsia chinensis),* agaves *(Agave sp.),* and one-seed juniper *(Juniperus monosperma)* are found.

The Colorado Lowland subdivision is best represented in the western portion of the monument. The creosote bush/bursage community best characterizes this subdivision. Creosote bush *(Larrea tridentata),* triangle-leaf bursage *(Ambrosia deltoidea),* and white bursage *(Ambrosia dumosa)* are well represented in the Valley of the Ajo and Growler Valley. Mixed shrub communities of brittlebush *(Encelia farinosa),* triangle-leaf bursage *(A. deltoidea),* and foothill palo verde (C. *microphyllum)* are found throughout the Bates, Puerto Blanco, Sonoyta and Diablo Mountains and Cipriano and Quitobaquito Hills. Along the south boundary, where the soil is highly alkaline, saltbush *(Atriplex sp.)* communities thrive.

A few species of plants, representative of a third subdivision - the Central Gulf Coast - are found in the vicinity of the Senita Basin. Here plant species exist that are rarely found elsewhere in the United States. Many of the plant species are at the northern extreme of their range and

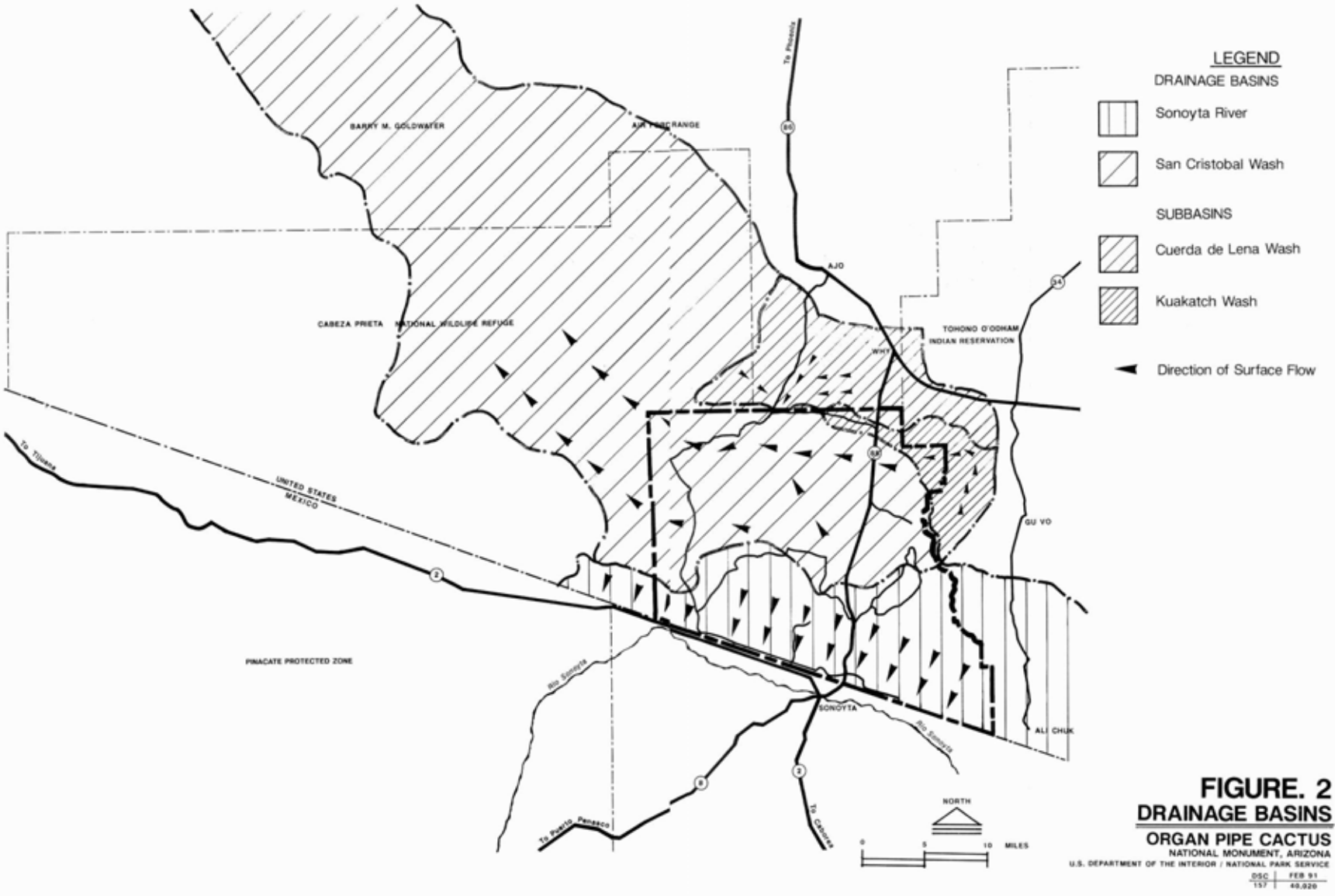


FIGURE. 2
DRAINAGE BASINS
ORGAN PIPE CACTUS
NATIONAL MONUMENT, ARIZONA
U.S. DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE

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are very sensitive to changes in climate. Included are the senita cactus *(Lophocereus schottii)* and ashy jatropha *(Jatropha cinerea).* The only known U.S. populations of both plants are found within the monument.

ILBS. Fauna

Like the flora, the fauna of Organ Pipe Cactus National Monument is highly diverse. There are approximately 53 species of mammals, four species of amphibians, 43 species of reptiles, and one species of fish. In addition, observations of over 278 bird species have been recorded. Of these, 63 are known to breed, and an additional five are suspected of breeding within the monument.

The monument exhibits one of the highest concentrations of avian species in the Sonoran Desert for an arid natural area. This great diversity is due to several factors, including the large number of habitat types available, the presence of open standing water, and the proximity to a major migratory route along the Sea of Cortez. Some of the most productive habitat types for birds are those associated with water. Marsh and riparian habitats are associated with Quitobaquito pond and the Rio Sonoyta. Dry riparian areas along ephemeral stream courses are widespread and support large and varied populations. Free water, as provided by tinajas and water troughs, is essential for some bird species. In addition, the dry riparian areas and surface water probably increase the diversity of surrounding habitat types (Johnson and Brown 1987).

Artificial water sources in the monument and Mexico have allowed populations of some species, particularly Gambel's quail *(Callipepla gambelii),* mourning dove *(Zenaida macroura),* white-winged dove *(Zenaida asiatica)* and house finch *(Carpodacus mexicanus),* to increase. There is a concern that birds and insects are ingesting pesticides in Mexico and introducing them into food chains in the monument. Water resources contribute to the diversity of mammal species in a similar manner. The range of some large mammals, such as the desert bighorn sheep *(Ovis canadensis mexicana),* mule deer *(Odocoileushemionus)* and white-tailed deer *(Odocoileus virginianus), is* limited by the availability of free water.

Of the herpetofauna, the sonoran mud turtle *(Kinosternon sonoriense)* and five frog and toad species are dependent on permanent or seasonal open water.

II.C. Water Resources

A map of the water resources of the monument (Figure 10.) is located inside the back cover, and Tables in Appendix B and C list the known ground and surface water resources.

II.C.1. Surface Water Sources

Sources of surface water at Organ Pipe Cactus National Monument are very limited, as is to be expected in such an arid land. No perennial streams or rivers exist within the monument. Ephemeral flow occurs for brief periods as a result of locally heavy summer rainstorms or rare regional storms.

Brown et al. (1983) present specific information on 84 water sources including 11 springs, 60 tinajas, 3 stock tanks, 7 watering troughs, and 3 sewage disposal ponds. The report maps all of these water sources and provides the following information on each source: location; elevation; classification (according to the system developed by Brown et. al (1983) for surface water resources in arid lands natural areas); naturalness; permanence; maximum capacity; brief history; remarks; and references. One of the reasons for this study was to assess the potential affects upon fauna and flora as water supplies from wells used for grazing were lost when the leases were terminated in about 1978, none were found. This study determined that the availability of monument surface water resources has changed during this century. Some water supplies have been lost, but the

overall change is an increase in water sources available to wildlife, due to human development of artificial water sources.

All springs within the monument are of extreme importance to the biota. Perennial springs provide the only year-round water source for animals.

II.C.la. Springs

Of the eleven 11 springs in the monument, three are perennial; Quitobaquito, Williams, and Dripping Springs. The remainder are intermittent.

Springs in the Quitobaquito Hills
- Quitobaquito Springs (2) (perennial)
- Williams Spring (perennial)
- Burro Spring
- Muddy Spring
- Aguajita Spring
- unnamed spring
- unnamed spring

Springs in the Ajo Mountains
- Bull Pasture Spring (existence is questionable)
- Bee Spring

Springs in the Puerto Blanco Mountains
- Dripping Springs (perennial)

Quitobaquito is the largest spring system, discharging a nearly constant flow of 30 to 35 gallons per minute (Figure 3). Discharge occurs predominantly at two points on the southern slope of the Quitobaquito Hills, referred to as the northeast (upper) and southwest (lower) springs. It is the only spring system with flow sufficient to create a large body of open water, resulting in one of the largest spring-fed oasis in the Sonoran Desert. It is surpassed in volume and size only by Quitovac, 30 miles to the south in Sonora, Mexico (Johnson 1984). Quitobaquito Springs support, among many other species, an endangered species of desert pupfish *(Cyprinodon macularius eremus).*

Monitoring of the flow of these springs was initiated on January 12, 1974. Water was piped from the northeast spring to the southwest spring where the combined flow was directed over a weir. Volumetric discharge measurements were collected by monument personnel on a monthly basis until October 26, 1981, when the monitoring became part of the USGS program, and a recorder was installed on the weir to obtain continuous data. Measurements taken during the initial seven year period provide a fair record of the flow. Inconsistencies in measurement methods could have occurred during this time, since numerous employees recorded measurements. Two other sources of error are known to have occurred during the sample period: 1) root buildup in the stilling well of the northeast spring caused an overflow of the small collection dam, and 2) plant buildup in the ditch upstream of the weir also caused some overflow.

In November 1989, a project entitled the Quitobaquito Habitat Project, developed in consultation with U.S. Fish and Wildlife Service, was initiated. The project was designed to provide a natural appearing shallow water habitat for the endangered Desert Pupfish, Sonoran Mud Turtle *(K sonoriense longifemorale)* young and associated crustaceans and microorganisms. It was also intended to prevent catastrophic events; such as occur twice in recent history, when riparian vegetation has clogged the earthen ditches, diverting water away from the pond and allowing the pond water level to drop significantly enough to threaten pupfish habitat.

The project consisted of constructing an open, concrete lined stream channel from the springs to the pond, with an underground pipeline backup. The channel is the primary means of water transport from the springs to the pond. The stream channel was designed to duplicate the approximate width and depth historically used when the area was farmed, and incorporates areas of both slower and faster moving water. The use of pools, overhangs and islands within the stream channel provide protection

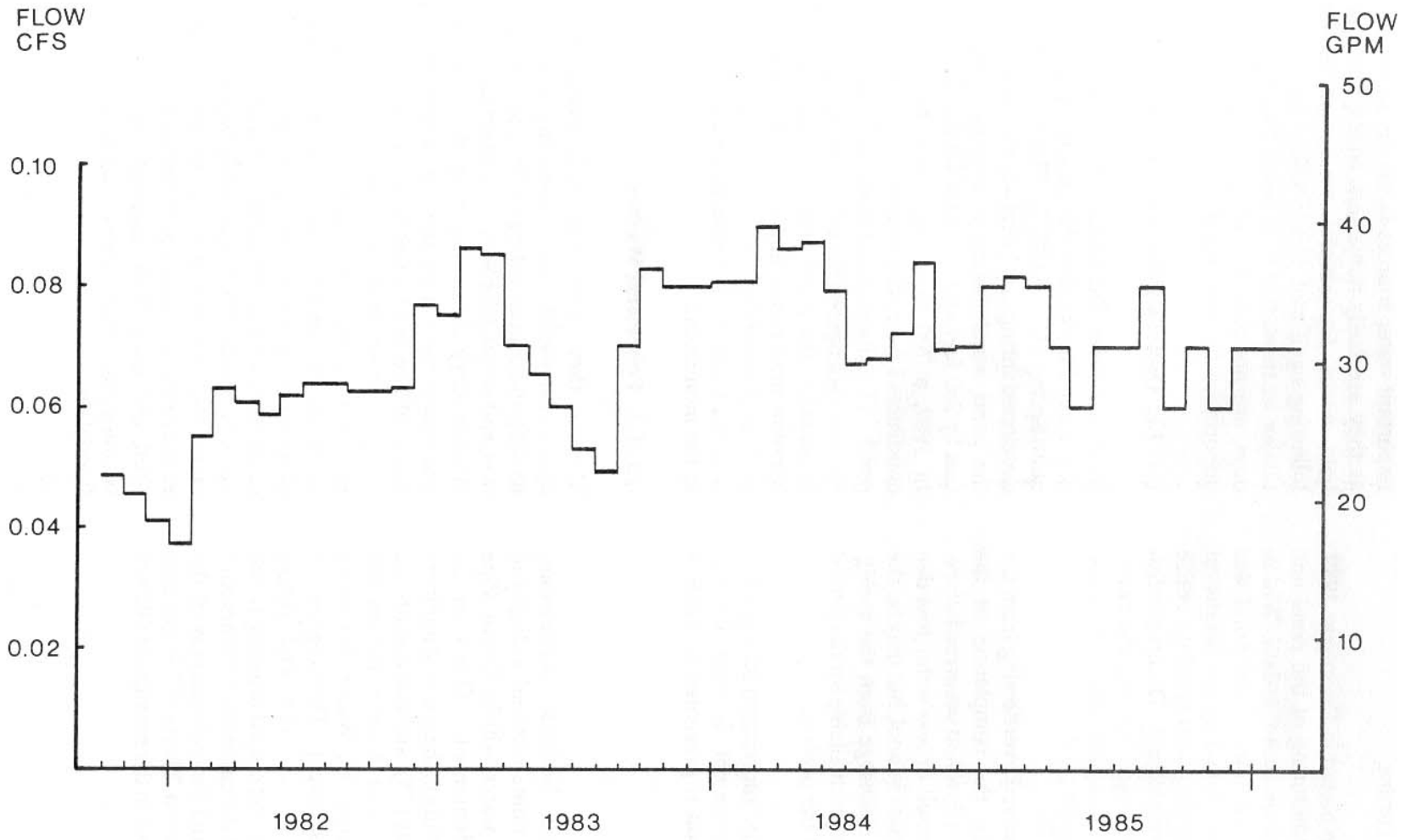

Figure 3. Mean Monthly Flow from Quitobaquito Springs, in cubic feet per second and gallons per minute. Data from US Geological Survey gauging station below the confluence of the northeast and southwest springs for the period October 1981 to February 1986.

and necessary habitat for both Desert Pupfish and Sonoran Mud Turtles.

The project was completed in December 1989. One full year of monitoring of the pond and channel has revealed encouraging data. Within one week after the channel to the pond was opened, pupfish were found at the southwest spring, indicating that they had moved the entire length of the 700 foot channel. Desert pupfish now fully occupy, in large numbers, the entire length of the new channel, and are found primarily in the shallow pools.

Water has been observed overflowing from the pond regularly since the completion of the project where no overflow had occurred before. This is probably a result of less water loss due to infiltration from the channel, but may be the result of increased discharge from the spring. Discharge data is not yet available for the period since completion of the project.

Flow and water quality information for the other springs in the monument is very limited. Available information is presented in Table 3 (Appendix C).

II.C.1.b. Tinajas

Tinajas, or natural bedrock depressions, constitute the most numerous and widespread sources of surface water within Organ Pipe Cactus National Monument. There are 58 known tinajas, occurring in the greatest numbers in the Ajo Mountains (35), and more scattered in the Bates (15), and Puerto Blanco (8) mountains (see Figure 10. Water Resources Map inside the back cover). The longevity of water is affected by the size and runoff characteristics of the watershed draining to the tinaja, the volume of the catchment, the amount of shade received, and the permeability of the bedrock. Spring Arroyo Tinaja #2 is the only perennial tinaja known in the monument (Brown et al. 1983).

Intermittent tinajas are probably the most important water sources in the dry mountains, as they are fairly numerous, widespread, and hold water for several weeks or months following significant precipitation. Ephemeral tinajas, or those that hold water for only a few days, are not reliable enough to be of much importance for most wildlife species.

ILC.1.c. Quitobaquito Pond and Stream

In 1860, Andrew Dorsey constructed a dam and dug a pond to capture the flow from Quitobaquito Spring. (Greene 1977). Flow from the two developed springs at Quitobaquito was piped to the pond, which measures approximately 200 feet by 260 feet and averages 4.8 feet in depth. In 1989, a 700 foot long open channel was constructed from the southwest spring to the pond. The channel and pond provide habitat for the endangered species of desert pupfish. In addition, the pond provides habitat for the Sonoran mud turtle, and numerous species of birds and invertebrates. The spring and pond together form the largest surface water resource in the monument.

II.C.1.d. Ephemeral Washes

Though they may flow only occasionally, ephemeral washes are of great importance in moving and concentrating the limited precipitation, and shaping the Sonoran Desert landscape. Washes carry water away from the mountains and concentrate it on the flatter terrain. On much of the land away from the mountains, drainage channels do not coalesce, but remain as numerous small, sinuous and roughly parallel channels. In fact, on alluvial fans and bajadas, every point on the land surface was at one time or another part of an active channel, and will again be touched by a channel as they meander across the land surface. Only the major washes in the centers of the large valleys are relatively fixed, and even these undergo quite a bit of braiding and channel movement within a broad floodplain.

Flow in ephemeral channels is entirely dependent on heavy rainfall. The precipitation intensity must exceed the infiltration capacity of the soil so that overland flow can collect in the channels. This is much more likely to occur in the mountains than the valleys due to greater frequency and intensity of rainfall and thinner soils. Washes may not flow for several consecutive years, then may flood several times in one year.

The additional water that is collected and transported by ephemeral channels supports much more productive and varied plant and animal life than in the more arid surroundings. The drainages can be identified by narrow ribbons of palo verde, ironwood and saguaro. In larger washes, riparian plants such as mesquite and desert tree caper are able to reach the groundwater table with deep tap roots. They form dense thickets, or bosques, that are very productive wildlife habitat. Riparian plant communities are found along the major drainages including Growler, San Cristobol, and Tejano Washes; and somewhat less developed along Aguajita, Kuakatch and Cherioni Washes. Lowering of the groundwater table is a threat to riparian ecosystems along the border at Tejano and Aguajita washes.

The USGS established a crest-stage gage station on a tributary of the Alamo Wash in 1963 as part of a state-wide program to assess floods. The level of the largest flood that occurs each year is recorded for a watershed of 0.90 square miles. Monitoring has continued to the present time at the request of the NPS as a supplement to the groundwater monitoring effort. Since installation, peak flows have been measured in 24 years. The maximum flow was 510 cfs in 1972, and there were three years when no flow was recorded. The mean peak discharge has been 173 cfs. All of the peak discharges for which a date is known occurred during the monsoon and tropical storm months of July through October. Peak flows occurred in August in 40% of the years.

II.C1.e. Sewage Disposal Lagoon

The sewage disposal lagoon contains water on a permanent basis and is located in the south-central portion of the monument, near the NPS headquarters. The lagoon services waste from the main visitor campground, the new campground duplex, and the three vault toilets (Alamo, Quitobaquito, and Bonita). The lagoons are accessible to wildlife and are frequently used.

II.C.I.f. Surface Waters Near Monument

In addition to water sources within the monument, wildlife are able to use water sources from the agricultural and residential developments on adjacent lands in Mexico provide ready sources of water along the southern boundary of the monument. Access to these sources is not without risk though, as wildlife can be subjected to hunting, motor vehicles, pets, and pesticides.

A perennial tinaja located on the Tohono O'odham Reservation provides reliable water in the Ajo Mountains. Little or no water is available in any other adjacent areas.

II.C.2. Groundwater

II.C.2.a. Groundwater Recharge

The source of groundwater in alluvial valleys in the Sonoran Desert results from the infiltration of rainfall from rare storm events. Even though evaporation greatly exceeds precipitation on average, there are periods when rainfall is sufficient to penetrate the soil surface and move beyond the rooting zone of plants. This water can remain in the ground indefinitely, until brought to the surface by wells, plant roots, or is discharged at a spring. Precipitation can reach the groundwater reservoir in several ways including direct infiltration, or surface or subsurface movement from other areas. How this occurs is discussed below and depicted in Figure 4.

Direct infiltration of rain water on the alluvial valleys. Groundwater recharge of the alluvial valleys can occur directly through either downward percolation of rainwater where it falls, or through sheet runoff into channels and subsequent infiltration. Due to the infrequency of rainstorms and the resultant normal, low soil moisture content, direct infiltration of rainfall is not a major contributor to groundwater recharge. The short duration of rains usually precludes full saturation of the soils below the rooting zone. In addition, intense evaporation of surface moisture usually follows storms, and desert vegetation quickly withdraws accessible soil moisture.

Rainfall in mountains that moves to the valley floor as stream flow. Stream flow from runoff from the mountains, is thought to provide the vast majority of groundwater recharge to alluvial basins. Mountain runoff is a large contributor for several reasons. First, rainfall amounts and intensity are greater there due to orographic lift. In addition, mountains are usually composed of consolidated geologic strata with steeper slopes which retard infiltration and increase runoff. Stream flow enters the margin of the valley on alluvial fans composed of coarse, unconsolidated material, which permits rapid percolation to begin, then flows in broad sandy channels across the valley floor where additional infiltration occurs.

Groundwater recharge through subsurface flow. Groundwater in the alluvial basins can be recharged by water moving from the mountains through fractures, fault planes, or permeable sediments. The same mechanisms can allow groundwater to move from one alluvial basin to another by passing through fractures, permeable strata and fault plains in an intervening mountain range. An important aspect of groundwater hydrology is that surface water drainages are of no importance in evaluating the area of groundwater influence. Groundwater moves in response to the subsurface hydraulic gradients and the presence of permeable materials and/or pathways, so the direction can be very different from surface runoff patterns. An understanding of the geology of the area is essential for understanding the direction and magnitude of groundwater flow. No appraisal of this factor has been made for the monument, but the magnitude of interbasin flow is thought to be relatively minor. The geologic factors conducive to large regional subsurface flows, such as extensive deep limestone formations and large fracture zones, are not known to be present.

Groundwater elevations are generally higher at the margin of the alluvial basins because recharge from mountain streams occurs there, as does recharge from fracture flow, though to a lesser degree. Groundwater moves toward the center of the basin and down gradient to the outflow from the basin. Outflow can occur at a well or spring, where riparian vegetation taps the groundwater, or where the water flows into another basin. Groundwater basins in the monument have been delineated using the known topography, geology, and groundwater quality. The basins, as they are understood at this time, are depicted in Figure 5. and described in section II.C.2.c. Groundwater Quality.

II.C.2.b. Groundwater Development

Wells were sought at numerous places to provide water for cattle before the monument was established, and after establishment while grazing was still allowed. Numerous water sources were desirable to obtain a more uniform distribution of livestock. Wells were constructed both by excavation and by drilling to depths of about 200 feet. Some attempts to reach water were unsuccessful. A review of unpublished data on file revealed that attempts to find water at sites where the alluvium was 50 feet or more in

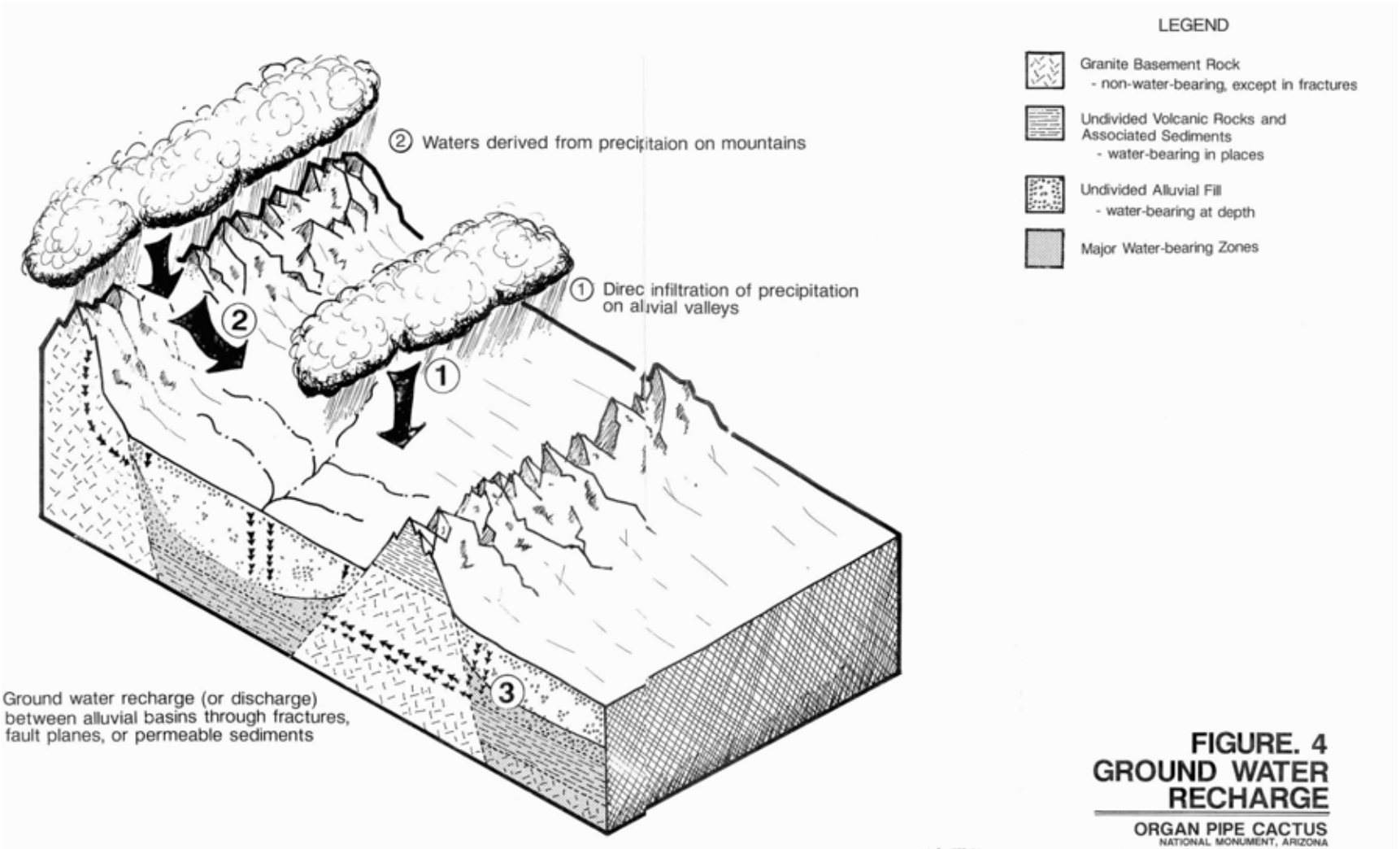

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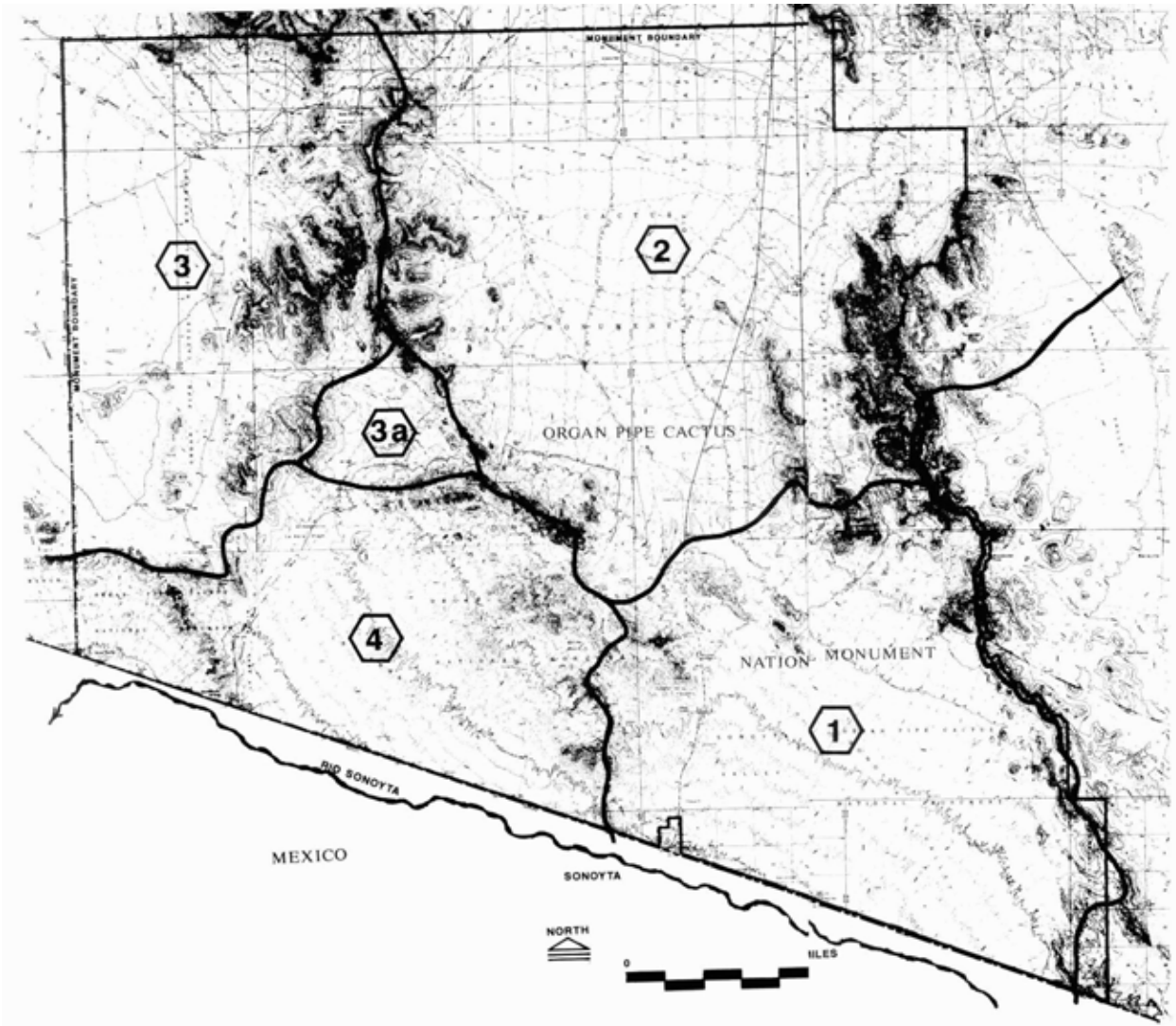
FIGURE. 4
GROUND WATER RECHARGE

ORGAN PIPE CACTUS
NATIONAL MONUMENT, ARIZONA
U.S. DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE



LEGEND

1. Sonoyta Valley
2. Valley of the Ajo
3. West of Bates Mountains
3a. Acuña Well Area
4. West of Sonoyta Valley

Boundary Between Groundwater Basins
Approximate boundaries based on geologic structure, topography and water quality

FIGURE. 5
GROUNDWATER
DRAINAGE BASINS

ORGAN PIPE CACTUS
NATIONAL MONUMENT, ARIZONA
U.S. DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE

thickness were generally successful, although relatively low yields were common (Werrell 1990, pers. comm.). The Valley of the Ajo is an exception. Numerous attempts, including three fairly deep wells, NPS test borings to 500 and 185 feet, and an excavated well 212 feet deep all failed to produce water. Other unsuccessful efforts included a deep, excavated well about one mile east of Bates Well and drilled and excavated wells at Cherioni. The concrete watering trough at Cherioni may indicate the availability of water seasonally. The dry conditions in the Valley of the Ajo are not well understood. Recharge to the basin from the east portion of the Bates Mountains and the western portion of the Ajo range should provide sufficient recharge to have established a water table at less than 200 feet deep.

All wells within the monument are apparently produced from alluvium, with the exception of:

- Mine shafts and exploratory drill borings for minerals which contain water, and the Alamo Well, which could be classed as a developed spring.

  The NPS headquarters wells which are reported to encounter volcanic bedrock. Based on recent borings, however, which reveal some porosities in the rock, water produced by the volcanic rocks at this shallow depth is believed to be hydrologically connected to the alluvium of the basin.

II.C.2.c. Groundwater Quality

In general terms, groundwater quality of alluvial basins is best along the margins, nearest the recharge points. Water running off of the mountains has had little time to dissolve minerals, thus the quality at the valley margin should be good, unless the mountains contain rocks with highly soluble minerals. As water moves away from its origin, it has a greater opportunity to dissolve minerals. Given the same mineralogy, a longer residence time results in greater levels of dissolved minerals and poorer water quality. The few samples that have been collected from wells indicate that this concept is applicable to the groundwater in Organ Pipe Cactus National Monument. The specific conductance of monument groundwater varies from 400 to 5500 micromhos/cm. While there are no state standards for specific conductance, generally waters with 0 - 500 micromhos/cm are considered of excellent quality; those with 500 - 1000 micromhos/cm are of good quality, and those over 1,000 micromhos/cm are of poor quality. For analysis of water quality, the monument has been divided into four areas, as follows:

Sonoyta Valley. Water in the Sonoyta Valley has a specific conductance of 700-720 micromhos/cm at the monument headquarters area, 800-930 micromhos/cm at Lukeville, and 900-910 micromhos/cm at the Dowling Ranch. Arsenic and fluoride concentrations above Public Health Service (PHS) standards in the water of the Lukeville area resulted in the US Customs and Immigration Station installing a reverse osmosis plant in the 1970's to remove these elements. Untreated water from the site has been used at the Lukeville Store and Motel since the 1910's. The deterioration of water quality from the headquarters area to the south is as expected, because the water further south has remained in the aquifer for a longer period.

Valley of the Ajo. Water quality in the Valley of the Ajo is not well known, due to the lack of successful wells. Specific conductance of Alamo Well water is 800 micromhos/cm, but this well is on the margin of the basin and may not be representative of the whole valley.

West of Bates Mountains. Two wells are located west of the Bates Mountains and Cipriano Hills. Water from Bates Well has a specific conductance of 400-530 micromhos/cm and Pozo Nuevo water is 1800

micromhos/cm, notwithstanding its location much nearer the head of the watershed. The reason for this is not known.

Acuna Well. Acuna Well has been separately delineated due to its anomalous water quality and the lack of understanding of the association of groundwater here with surrounding basins. The well is located in a pass, south of the Bates Mountains, north of the Puerto Blanco Mountains, and east of Cipriano Hills. The cause of the high specific conductance of 5500 micromhos/cm from water at this unpumped well is speculative, but may be associated with local mineral deposits.

West of Sonoyta Valley. In the southwest corner of the monument, south of the Puerto Blanco Mountains and west of the Sonoyta Valley, water from Hocker and Corner Wells, and Pozo Salado has a specific conductance of 2200 to 2500/cm micromhos. Anderson and Laney (1978) provide some chemical characteristics of water in this area as a portion of the Quitobaquito Springs study.

The only potable water supply available at this time is at the headquarters area.

II.C3. Groundwater Issues and Past Actions

Lowering of groundwater levels within the monument has been suspected along the international boundary. In the 1960's, the Government of Mexico began a program of developing irrigated agriculture adjacent to the border. Suspected impacts to monument resources from the groundwater pumping in Mexico, include: 1) disruption of the flow at Quitobaquito Springs, 2) the loss of water in Blankenship Well number two, 3) slowly lowering water levels in the Lukeville area, and 4) long term concern for the water supply at the headquarters area. Concern in the headquarters area stems from the original difficulty in finding a water supply for the monument (three test wells were drilled before this location was established), and the location of the wells on the margin of the Sonoyta Valley where they and are believed to be hydrologically connected to the alluvial aquifer pumped in Mexico. Impacts to the monument wells are probable even though they are located at a higher elevation and more than five miles from the pumpage area.

In response to these concerns, a well and spring inventory of the monument was conducted by the NPS Water Resources Division in the early 1970's to provide data and a basis for further study. This effort included repeated water level measurements at some wells to establish seasonal and long-term trends. A control structure was installed at Quitobaquito Springs, and monument personnel were trained to collect flow data which is kept on file at headquarters.

II.C. 3.a. Quitobaquito Springs

The possibility for disruption of the natural flow of Quitobaquito Springs due to disturbance of its supporting groundwater supply is a major concern. The groundwater system supporting Quitobaquito Springs was studied by Anderson and Laney (1978), who presented two possibilities for the groundwater supply for Quitobaquito Springs:

> The difference in the interpretation depends on the areal extent of the gneiss pediment in the northern part of La Abra Plain. The first hypothesis is that a continuous groundwater system exists between the alluvial deposits and the crystalline rocks throughout most of La Abra Plain and that Quitobaquito and other nearby springs are discharge points. If this is the case, impact from Mexico is possible. The second hypothesis is that the alluvial deposits in the southeast part and the crystalline rocks in the northwest part of La Abra Plain form two separate groundwater flow systems.

If the second interpretation is correct, pumping in Mexico would have little affect on spring flow. To determine which hypothesis is correct, a geophysical study of La Abra Plain was

recommended, with the drilling of several wells for geologic verification. This work has not yet been done. Other report recommendations (installation of rain gauges and continued monitoring of wells and Quitobaquito Springs) have been incorporated into the USGS monitoring program.

Flow from the northeast and southwest springs, which feed the pond, are gauged and monitored by the USGS. The gauging station is located near the southwest spring opening.

II.C3.b. Groundwater Monitoring

Anderson and White (1978) studied possible effects of groundwater withdrawals in Mexico on groundwater conditions in the Sonoyta Valley. This study included long term projections of water table conditions in the headquarters area and at Lukeville, as determined by a finite-difference model. The model simulated drawdowns which would result from up to 100 years of pumping. Wells along the border were not available for acquisition of groundwater data or groundwater coefficients, so the model was run with assumed hydraulic coefficients.

Predictions of drawdown in the headquarters area were:

10 years - range from 8 to 18 feet
20 years - range from 18 to 36 feet -
40 years - range from 36 to 72 feet
100 years - range from 85 to 185 feet

Predictions of drawdown in Lukeville were:

10 years - range from 12 to 24 feet -
20 years - range from 22 to 42 feet -
40 years - range from 40 to 80 feet
100 years - range from 90 to 190 feet

The conclusions of the final report stressed the need for additional wells along the border. These wells were needed to monitor groundwater levels over several years, providing refinement of the model to achieve more accurate predictions. Three wells were drilled in 1988, and after collection of monitoring well data for several years to establish trends, a rerun of the model is recommended.

A program of regular monitoring of groundwater elevation in wells and the flow of Quitobaquito Springs was initiated in 1981. Fourteen wells are monitored by the USGS, under contract to the NPS, and/or by park staff (six wells are monitored by both NPS and USGS).

USGS Monitoring. Groundwater levels are monitored at least every other month at 10 locations within the monument by the USGS. From east to west they are:

Salsola Well (Monitoring Well #3) Camino
Dos Republicas Well (Monitoring Well #1)
Lukeville Well (Monitoring Well #2)
Lukeville, East of Motel Well
Stack Well
Dowling Well
Pozo Salado Well
Bonita Well
Hocker Well
Corner Well

Organ Pipe Cactus National Monument Monitoring. Water levels are monitored in 10 wells on a quarterly basis by the resources management staff. From east to west they are:

Alamo Well
Lukeville, Kalil Well
Stack Well
Dowling Well
Pozo Salado Well
Bonita Well
Bates Well
Pozo Nuevo Well
Hocker Well
Corner Well

As recommended by Anderson and White (1978), three observation wells were drilled with USGS assistance in October 1988. The purpose

is to provide needed groundwater trend information for the Sonoyta Valley study. Water level measurements are collected continuously by recorders on the wells. Depth records for the three wells for the year 1989 are shown in Figures 6, 7, 8, and 9. The first three figures are for Camino dos Republicas (CDR) Well, Lukeville Well, and Salsola Well, respectively (Note the vertical scale in Figure 8 is different from Figures 6 and 7). Figure 9 compares level data for all three wells.

In reviewing the first year of data, the drawdown resulting from pumping in Mexico is clearly noticeable in the record from CDR and Lukeville Wells. Temporary groundwater declines of one to two feet occur repeatedly with each period of pumping. These fluctuations are more pronounced at the Lukeville Well, probably because it is closer to the border. Both wells show declines of six to eight feet during the summer followed by some recovery in the fall as pumping rates diminish. By December 1989 the water surface had not recovered to December 1988 levels in either well.

The Salsola Well is more remote from the area of maximum pumping and shows a pattern of greater stability. Short term fluctuations in water elevations were much less noticeable during 1989, and the general trend is flat or slightly rising. The differing response between Salsola Well and the other monitoring wells may be attributable to the distance from pumping, pumping patterns in the immediate vicinity of Salsola well, local recharge, and aquifer characteristics.

The pattern of declining groundwater has continued at a rate of about 0.2 feet per year though the data is, as yet, unpublished (Werrell 1990 pers. comm.). Several years of record will be required to provide a reliable analysis of trends and to determine aquifer characteristics.

A project was initiated in 1988 to gather data on Mexican agricultural development in the Sonoyta Valley as part of the Sensitive Ecosystems Program (Great Western Research 1988). Study objectives included identifying or determining:

Total acreage under production within 10 miles of the monument
Acreage and types of crops under cultivation
Volume of water withdrawn for irrigation
Past, present and projected land usage in the Valley
Factors that will influence future land use
Factors that have occurred in the recent past to promote agricultural development
The impact of light pollution on the night sky

Several photo points were established in the monument to record land use changes along the southern boundary. This research project was amended in 1989 to allow for continued data gathering through 1990. Additional data gathering and analysis were to include:

Further expanding the well database to incorporate additional years of data
Collecting electrical use data on a well-by-well basis
Compiling well data into an expanded database
Calculating the estimated pumpage over the available period of record for selected wells
Defining the boundaries of the Sonoyta Valley aquifer
Developing a system for adding annual data to the database

H.C.3.d. Impacts to Groundwater from External Sources

There are three sources of present and past actions outside the boundary which may be having adverse impacts on groundwater in the monument.

- **Irrigation practices in Mexico.** Large withdrawals of groundwater from irrigation

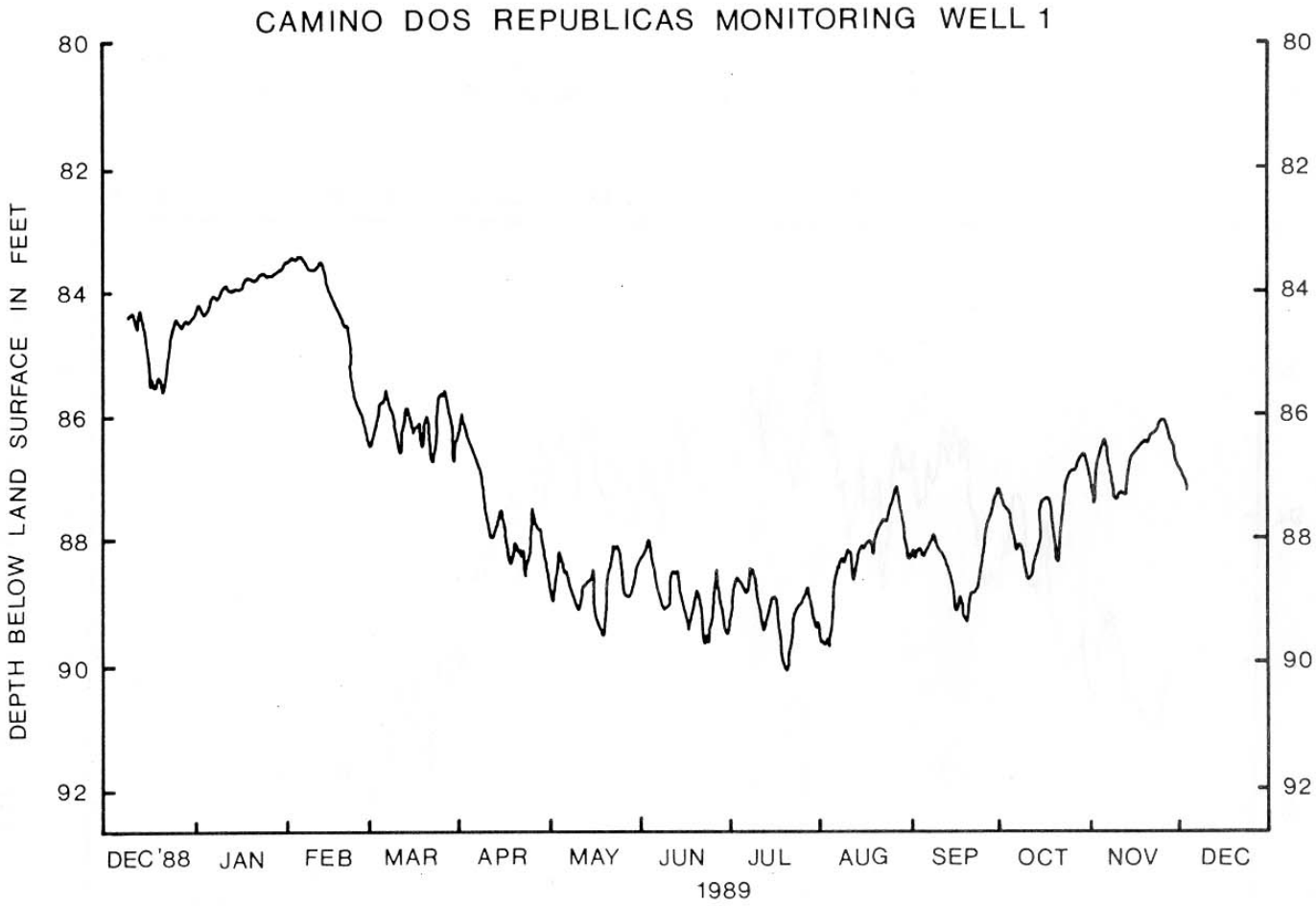


Figure 6. Depth to water in Camino Dos Republicas Well (Monitoring Well #1) during 1989. This well is located along Camino Dos Republicas one mile east of Lukeville and ½ mile north of the international boundary. It is monitored by US Geological Survey.

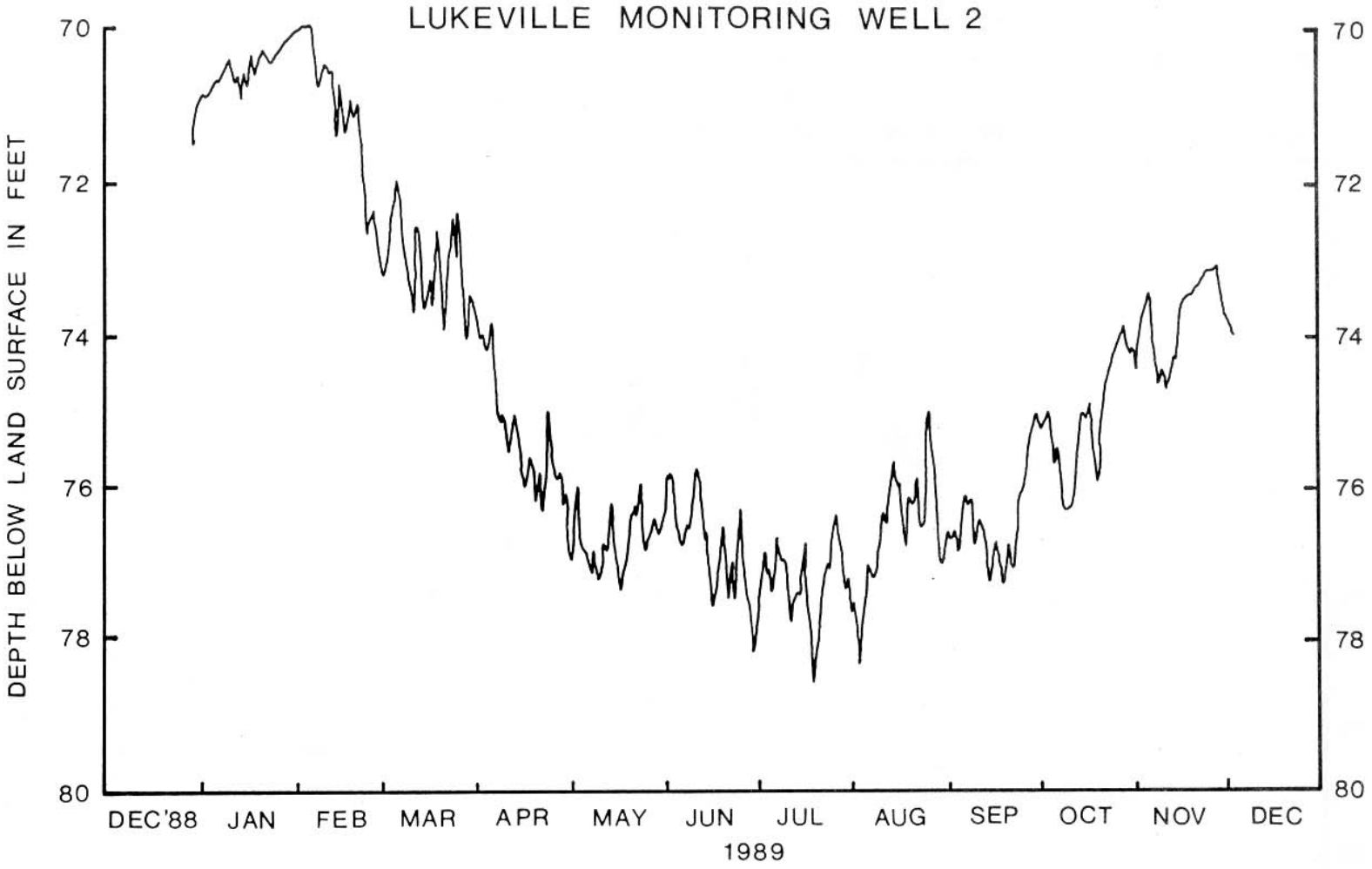


Figure 7. Depth to water in Lukeville Well (Monitoring Well #2) during 1989. This well is located along the international boundary one mile east of Lukeville. It is monitored by US Geological Survey.

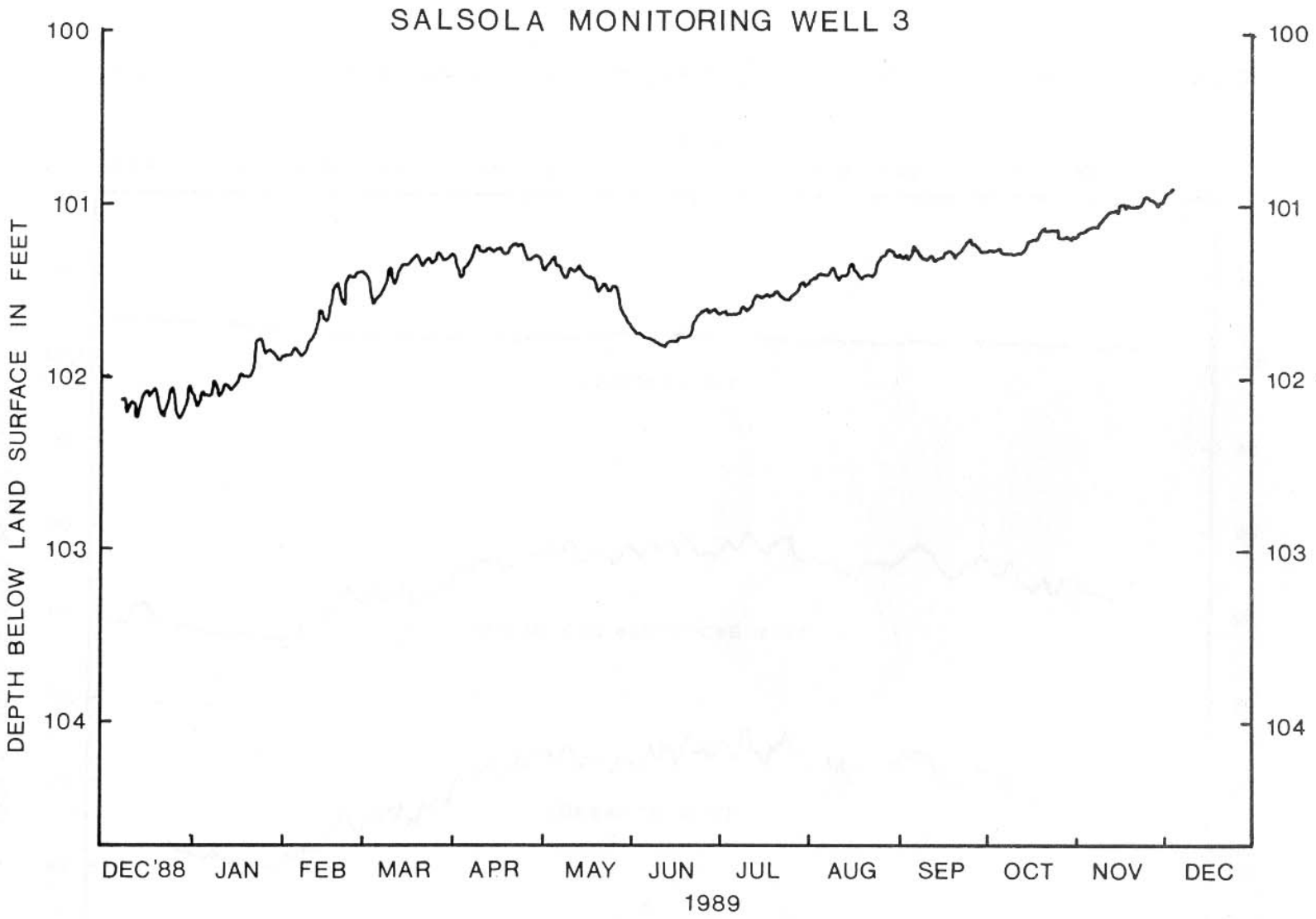


Figure 8. Depth to water in Salsola Well (Monitoring Well #3) during 1989. This well is located along the international boundary 6½ miles southeast of Lukeville. It is monitored by US Geological Survey.

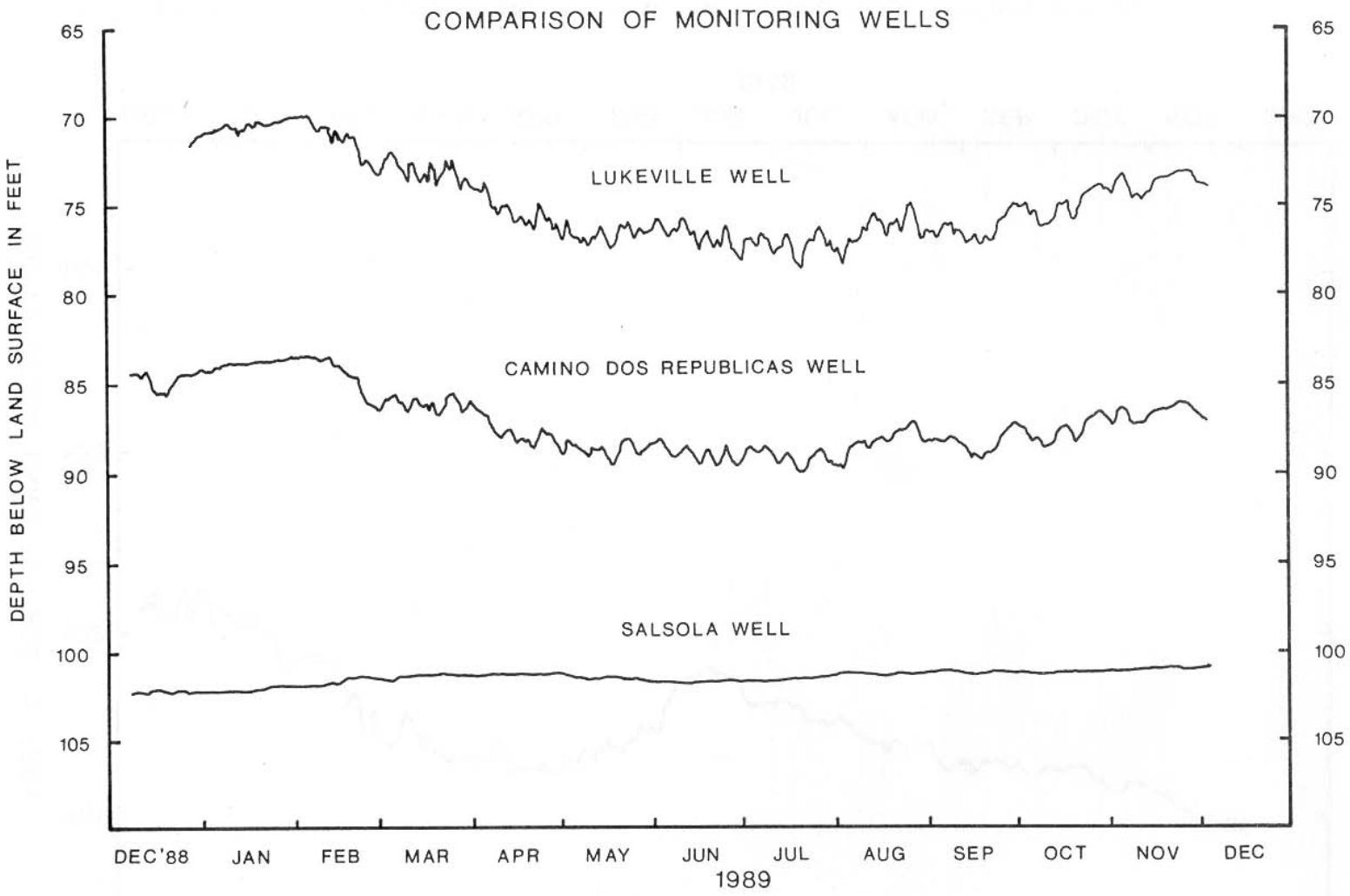


Figure 9. Comparison of depth to water during 1989 for the three wells in the monument that are continuously monitored.

practices south of the international boundary draws down the groundwater table around each well, forming a cone of depression. When a well is not being pumped, the cone of depression associated with the well will immediately begin to fill. If the well n riot pumped for a day or so, the Lone tails substantially disappear and water levels that existed before pumping will he essentially regained. Where several wells are pumping. as is the case in the Ric Sonoyta Vallee, the cones overlap. forming an area of general lowering of the groundwater table_ The lateral extent of this lowering, and whether it extends into the monument, is dependent on the amount of pumping, the amount of recharge and the hydraulic conductivity of the substrate. Monitoring wells #1 (CDR) and #2 (Lukeville i show that groundwater drawdewn does extend into the monument, at least on a daily and seasonal basis.

Of even greater concern is the potential tor long term lowering of the groundwater table over the entire aquifer. When the amount of water pumped exceeds recharge, even if the wells are not pumped continuously, the overall static groundwater table of the aquifer will decline. This condition has been termed "mining water" or "pumpage of water beyond the safe yield." Pumping in the Rio Sonoyta Valley is believed to exceed natural recharge by a factor of 2.5 to 1, leading to great concern that wells and springs in the monument, even those some distance from the border, may be adversely affected (Brown 1988).

Since Lukeville is closer to the site of the pumping, groundwater levels will decrease first in this area. The decline in groundwater levels will also be more pronounced than at the headquarters area, because of the proximity of the pumping. Since the thickness of the alluvium at Lukeville is much greater than at headquarters, however, the wells along the border can be deepened to prolong production. Augmenting production in the headquarters area will be much more difficult.

Additionally, water which ;nay presently recharge the Rio Sonora aqua *may he* diminished as water and irri anon increase°' on he ihon ' O'odham Reservation. Such effects could accentuate the lowering of the water table *in Mexico and increase* effects upon *the* monument. Only small portion of the drainage of the Rio Sonoyta extends into the reservation, however, so possible effects are considered relatively' minor.

Water use on the Tohono O'odham Reservation which could affect aquifers near Kuakatch Wash. Similar groundwater withdrawal effects could also occur at the northeast corner and along the northern boundary. At these locations two intermittent streams, Kuakatch and Cuerda de Lena Washes, enter the monument. The inultration of the flow of these streams and alluvial groundwater flow into the monument provides an unquantified amount of recharge to the alluvial groundwater regime. Presently tribal lands are used for a small amount of grazing, and the impacts from such activities if any, are unknown. If future uses, such as grazing, agriculture, or land development, occur in these areas, both quantity and quality of groundwater inflows to the monument may be affected.

Impacts to groundwater in the Valley of the Ajo and Cuerda de Lena Wash. The surface water drainage of Cuerda de Lena Wash outside the northern boundary of the monument is approximately 110 square miles. The town of Why is located in this area and the lack of water supplies here have historically restricted its development. Future activities in this area, particularly more aggressive water development, could impact the groundwater table in the northern portion of the monument and

reduce the water supply at Bates Well. Another concern in this area is the mine tailings at Ajo. While just outside the surface watershed for Cuerda de Lena Wash, groundwater could flow southward toward the monument carrying a plume of contaminants from the tailings. The status of groundwater in the vicinity of the tailings is not known. Fortunately, few natural water sources exist in this portion of the monument. The only potable water supply which could be affected by external inputs from the northeast and north is at Bates Well.

II.C3.e. Regional Groundwater Regimes

The potential for extensive groundwater flow between basins is not well understood in this area. Small flows are thought to be possible, however, the current state of knowledge is limited. Groundwater can move large distances, beneath several surface drainages and divides, if a gradient and pathway exist. The most conducive pathways, continuous expanses of porous or karst rock, are not known to exist in this area. A more likely pathway is flow through highly fractured rock. A possible origin of Quitobaquito Springs is the flow of groundwater through fractures in gneiss (Anderson and Laney 1978). Such fracture flow on a larger scale, from basin to basin, almost certainly exists due to complex and extensive faulting in the geologic past (Haxel, et al. 1984), but its significance relative to local flows is not known. Further basic geologic work is needed to identify interbasin flow in this portion of the Basin and Range Province.

ILC3.f. Land Subsidence

With continued withdrawal of groundwater in Mexico and a resulting lowering of the water table, land subsidence is possible. Such fand subsidence in Arizona is not uncommon and special studies have been made, such as of the Eloy agricultural area (between Phoenix and Tucson) where subsidence from 1965 to 1983 was 3.58 feet (Epstein 1987). Land subsidence is caused by groundwater withdrawal which increases vertical stress upon the sediments, resulting in compaction and a lowering of the surface elevation. As subsidence continues, earth cracks form along the margins of mountains where the thickness of alluvium changes abruptly. These cracks grow in both width and length as land subsidence in the basin continues. The drainage patterns of small arroyos is interrupted by the diversion of flow into and along the cracks. Land subsidence commonly begins only after the water table has been lowered about 50 feet. The rate of land subsidence thereafter accelerates with continued lowering of water tables. Based on unpublished data (available at monument headquarters), the water table along the international boundary is believed to have decreased some 10 to 15 feet (Werrell 1990 pers. comm.).

In order to provide a baseline against which future subsidence can be measured, it is recommended that a survey be conducted to accurately establish the elevation of the boundary monuments and benchmarks along the border. These would be resurveyed every 5 to 10 years thereafter to evaluate the degree of subsidence. With future groundwater declines of up to 300 feet predicted, it may be reasonable to anticipate some 15 feet of subsidence. It is recommended that this project be initiated within the next three years to insure that background data are collected before subsidence begins.

II.C.4. Riparian and Aquatic Resources and Habitats

Although no monument streams are perennial, plants make use of the additional water along ephemeral washes creating bands of riparian vegetation and, where the groundwater table is shallow enough, extensive thickets of riparian vegetation. Among the species of concern are mesquite *(Prosopis velutina)* and desert tree caper *(Atamisquea emarginata)* - which is a rare species with its northern range limit in Organ

Pipe. These species utilize deep tap roots extending to the groundwater table to supply their nutrient and moisture needs and may now be facing a significant threat from the excessive use of groundwater in areas adjacent to the monument. Possible damage to these riparian ecosystems from falling ground water tables is a concern, due to their importance to the integrity of the desert biome.

Active erosion is in two riparian areas, Armenta Ranch and Dos Lomitas. It is believed to stem from concentrated grazing around water sources from the 1880's to the 1970's, exacerbated live normal flood and drought events and soil characteristics. Over 170 acres are experiencing excessive sheet and gully erosion, Small scale attempt', in the 1960's to reduce active headcutting have met with minor success, but die scope of the project was to small to affect any improvement in vegetation and soil stability. Loss of mesquites and other riparian vegetation types due to water drawdown could exacerbate these problems.

The riparian and aquatic environment of the Quitobaquito Oasis is unique and is a significant monument resource. It is the largest open body of water in the monument, a popular rest stop for visitors along a four hour scenic loop drive, and a well known birding area. The area is the focus of an Intensive, multi-year, interdisciplinary research effort by the NPS Cooperative National Park Resources Studies Unit in Tucson, Arizona, which will result in site management recommendations. The Quitobaquito Oasis is the location of *an* endangered species of desert pupfish, a newi_ described butterfly, an endemic snail, a *side ,uh found* nowhere else in the United States, *in* iag g historic pomegranate cultivar and numerous natural history records for the monument. With such high significance, the protection of Quitobaquito is a concern, particularly in light of the unknown threats to its water supply from nearby groundwater pumping for crop production.

II.C.S. Flood Hazards

Floodplains delineations of the major flood hazard areas in the monument are underway at this writing. Field work was completed iii April 1991 for two drainages neat monument headquarters and the group campground. The results of these analyses are pending. If structures or visitor camping are found to be in the regulatory floodplain and subiect to flood hazards, the National Mark Service will take actions to mitigate the hazards.

The only other area of potential flood hazard is Bates Well. Bates well is a historic ranching site in the northeast corner of the monument that has been nominated to the National Register of Historic Places. The extent of flood hazards will influence the management of the historic structures, visitor use of the area, and whether more extensive developments are considered. The evaluation of two drainages, Growler Wash and the wash north of the site, are needed. Flooding to the floor of Henry Gray's house has been reported in the past. Establishing a ranger station at Bates Well has been proposed in the past but is not planned for the near future.

Executive Order 11988, Floodplain Management, was signed by the President on May 24, 1977. The Order tied "together the need to protect lives and property with the need to restore and preserve natural and beneficial floodplain values." Compliance with the Order by the NPS is mandatory. On February 10, 1978, the US Water Resources Council published Floodplain Management Guidelines in 43 FR 6030 as assistance to Government Agencies in implementation of the Executive Order and "to assist each agency which will develop its own individual procedures for compliance with the Order." The National Park Service responded by publishing its Floodplain Management and Wetland Protection Guidelines for implementing the Executive Order in 45 FR 35916 and published minor revisions in 47 FR 36718. The Executive Order speaks to floodplains within the

100- and 500-year floodplain only. In establishing NPS guidelines, it was recognized that greater protection of the lives of NPS personnel and visitors should be afforded in high hazard areas. Thus NPS guidelines direct that in areas where "flash floods" occur, protection from the Probable Maximum Flood will be provided by not placing buildings, campgrounds, parking lots, or other features which tend to congregate people within the floodplain. The Probable Maximum Flood is the largest flood believed reasonably possible as calculated by accepted methods.

II.C.6. Wastewater Management

The NPS maintains four small wastewater systems for the disposal of sewage from the campground, residences, maintenance shop, visitor center, and offices. The NPS also maintains three pit toilets and one (double) Clivus-Multrum composting toilet, which are dispersed along the scenic drives (dirt roads) for monument visitors.

All three pit toilets are of vault construction and require occasional pumping, but do not allow the waste to enter the groundwater. The Clivus--Multrum composting toilet is also self-contained and requires regular maintenance. The main campground, with 208 campsites (no hook-ups), a sewage dump station, six restroom buildings with sinks and flush toilets, and one duplex, is equipped with sewage lines leading about .62 miles south to four open evaporative lagoons. There is no effluent discharge from the lagoons. The lagoons cover about one acre and are regularly used as a water source by wildlife.

There are four sewage systems comprised of a septic tank and leach field which serve the following areas:

The group campground restroom.
The NPS residence area comprised of 10 single family residences, one duplex, the community building, resource center, ranger station and 11 site Volunteer in Parks campground.
The visitor center and administrative offices.
The maintenance shop.

All sewage systems are currently functioning adequately. Some future failure of any system or expanded demand could lead to updating and redesigning of the existing sewage systems. Such evaluation and design work falls into the realm of park planning and development, and will be addressed there as needed.

The community of Lukeville has several systems for the treatment of wastewater. An evaporation lagoon services the residents and facilities in the U.S Customs and Immigration compound. The remainder of Lukeville uses several (at least 4) separate septic tank/leach field systems.

Disposal of wastewater with little or no treatment in Mexico is probably causing contamination problems in the Rio Sonoyta. These waters do not cross the border on the surface or subsurface, or directly threaten monument resources.

II.D. History and Present Status of Water Resources

Water is a critical factor in the Sonoran Desert. The location of reliable sources has always been of vital importance to both humans and wildlife. Early explorers and travelers in the region usually noted the location of reliable sources. The first reference to the water resources of the monument was made by Eusebio Francisco Kino, a Jesuit priest, in 1698 (Bolton 1960). He briefly mentioned a visit to the Quitobaquito Springs, describing the area as "...a good place called San Serguio." The name "San Serguio" was not used for Quitobaquito after the Kino era (Hoy 1969). Quitobaquito later became an important frontier watering stop for travelers along the Camino del Diablo, or the Devil's Highway, which led from Caborca, Sonora, Mexico, to Yuma, Arizona, along the Arizona-

Sonora border (McGee 1901). On his expedition to explore the Pinacate region of northwestern Sonora, William Hornaday (1908) passed through what is now the monument and stopped at Quitobaquito. Carl Lumholtz (1912) also visited Quitobaquito Springs during his travels in the Papago country of Arizona and Sonora.

The presence of water sources has been vital to the occupation and settlement of this region from prehistoric times to the present (Greene 1977). Although Quitobaquito Springs was the only water source within the monument mentioned in the early literature, other sources were probably known to the cattlemen and miners who settled the area during the period between 1910 and 1920. Sources, which inevitably determined the location of every ranch _site, include springs, ponds, wells and tanks. Through time these water sources have been the requisite criterion for human occupancy of the Sonoran Desert. Without water, the development of the principal regional economies - cattle ranching and mining - could not have occurred.

With the publication of Kirk Bryan's Routes to Desert Watering Places in the Papago Country, Arizona (1922) and The Papago Country, Arizona:___ A Geographic, Geologic, and Hydrologic Reconnaissance with a Guide to Desert Watering Places (1925), a great deal of information on the monument water resources became available for the first time. Bryan located and described Aguajita, Bull Pasture, and Dripping Springs, and gave an analysis of the hydrology of Quitobaquito Springs. Several wells existing within the monument at that time were also mentioned, including Alamo, Bates, and Blankenship Wells. Important water sources identified on adjacent lands included; Barajita Well, Meneger's Dam, and the Rio Sonoyta.

With the establishment of Organ Pipe Cactus National Monument in 1937, the National Park Service initiated several groundwater studies. These were undertaken to identify ways of providing a dependable domestic water supply for the monument and to learn more about the local water resources. Gould (1938) and Maxwell (1940) gave locations for several springs and wells. McDougall (1939) and Peterson (1942) commented on the relationship between wildlife and water sources. Coates (1951) also made a brief survey of groundwater conditions and described known wells and springs.

Other investigations rapidly followed. Early biologists made note of water sources that were valuable to wildlife, including the first mention of- tinajas in the area (Huey 1942, Hensley 1954). The availability of groundwater in the Molenitus area of the Tohono O'odham Indian Reservation, adjacent to the monument, was examined by Heindl (1958). An ecological reconnaissance of Quitobaquito Springs (Cole and Whiteside 1965) described limnological and physicochemical features, as well as the flora and fauna of the pond. The Bureau of Land Management identified several artificial and natural water sources that were being used by cattle (Schultz 1966, Schultz et al. 1971). Steenbergh (1969) identified certain ecological problems at Quitobaquito Springs. An interim management plan, based on his report, was subsequently prepared for the area (USDI, National Park Service 1979). In the fall of 1981, the Western Regional Office funded a monitoring program to be carried out by the USGS to establish a continuously recording gauging station to measure flow at Quitobaquito Springs. The program also included monitoring water levels in existing wells along the international boundary, collecting stream runoff data on a drainage near the Quitobaquito Oasis and measuring precipitation with two recording rain gauges.

Concern regarding the withdrawal of groundwater along the international boundary for irrigation purposes in Mexico prompted monument officials to request assistance from the Water Resources Division of the National Park Service's Western Regional Office in 1971. In response, regional personnel began an

inventory of all springs and wells in 1972. Updating of this inventory has continued on a yearly basis. As a continuation of this assistance, the Western Regional Office, in cooperation with the USGS, studied the effects of groundwater pumping in Mexico on groundwater conditions in both the Quitobaquito area and the Sonoyta Valley (Anderson and Laney 1978, Anderson and White 1978).

Maps showing groundwater conditions in southern Arizona and providing data on a few springs and wells in the monument were published by the USGS (Leake and Clay 1979). As a portion of their study of the white-tailed deer in the Ajo Range, Henry and Sowls (1980) indicated the locations of important waterholes in that area. This included not only the traditional water sources such as stock tanks and wells, but most of the larger tinajas as well. The longevity of tinajas was also discussed. In addition, National Park Service personnel have gathered water resources information during three decades. From the mid-1960's through the present, the staff has compiled miscellaneous water observations. These observations have been incorporated into two unpublished handbooks, referred to herein as "ORPI files." These handbooks outline the occurrence of some artificial and natural water sources by location, and give some information on their history, flow rates, development, and seasonal water level fluctuations.

The aforementioned well and spring inventory efforts undertaken by the Western Regional Office, detail water resources on USGS well and spring site forms. These forms contain information on the following: location, water levels or flow rate, physical aspects of the source, field specific conductance, and photographs. Maps indicating the locations of sources were also prepared. The original data are on file with the NPS Water Resources Division and copies are on file at the monument.

Cattle were grazed in the area from about 1915 and continued after establishment of the monument in 1937. In 1978, the grazing permits terminated and all cattle were removed. During the period of grazing, ranchers increased the usefulness of the range to cattle by creating artificial watering sources. A number of wells were drilled and stock water troughs (supplied by pumped or hauled water) were developed or improved, both by stockmen and the National Park Service (Brown et al. 1983).

Irrigated agriculture, on a large scale, is relatively new to the Sonoyta Valley. Agricultural activities in the Sonoyta Valley consisted primarily of cattle ranching and subsistence farming as late as the early 1950's. The only lands actively farmed were located adjacent to the stream banks and were irrigated only from the sporadic flowing of the Rio Sonoyta. Lack of water storage facilities and distribution systems limited the irrigated area to about 250 acres. Crop production was primarily for subsistence of local residents, who also maintained small areas of pasture lands for livestock.

The first deep wells were installed in 1952, to the east of the town of Sonoyta. Development of groundwater resources progressed slowly throughout the 1950's and early 1960's, as local landowners had to rely upon their own resources to install irrigation and livestock wells. In 1966, the Mexican government began a limited-scale program to subsidize and encourage development of land and water resources throughout northern Sonora, including the Sonoyta Valley. Government support of agricultural development greatly increased in the early 1970's. From 1973 to 1983, the number of wells increased from 112 to 290, and the pumping capacity went up from 14,465 gpm to 213,203 gpm.

Today, agricultural land ownership in the Sonoyta Valley is divided between cooperative farms called ejidos (50%) and private ownership (50%). The Mexican government continues to subsidize the development of land and water resources throughout northern Sonora. The program is admihistered by the Secretaria de

Agricultura y Recursos Hidraulicos (SARH) which has an office located in Sonoyta. A moratorium is currently in effect to limit the land developed for irrigated agriculture to the present 32,000 acres (of which 60% to 70% is currently being farmed).

Groundwater withdrawals were approximately equal to the recharge rate in 1978 and began to exceed groundwater recharge in 1979. Although net depletion of the aquifer has steadily increased since 1979 to a maximum of 55,025 acre-feet in 1987, the cropped area has remained relatively constant since 1981. The Mexican government is fully aware of the overdraft situation of the aquifer and has placed a moratorium on the drilling of new wells. A considerable increase in groundwater withdrawals could occur, however, without the development of new water and land resources, due to the existing excess capacity in pumping and developed agricultural lands. Nevertheless, under existing conditions, annual groundwater withdrawals will still be approximately 2.5 times the annual rate of recharge and the depth to water will continue to increase in the near future (Brown 1988).

This has raised concerns about the possible effects on flora and fauna. Continued or increased pumping in Mexico may both lower the groundwater table and reduce hydrostatic pressure at certain locations within Organ Pipe Cactus National Monument, such as at Quitobaquito, Burro and Williams Springs.

In 1988 a National Park Service sponsored research project was awarded to Great Western Research to investigate agricultural and urban development in the Sonoyta Valley. Areas examined included acres of land in production, type and quantity of crops, number of wells and their capacity, and annual water drawdown in the Sonoyta Valley. The study was amended to continue through 1990.

II.E. Status of Water Rights

The United States National Park Service, presently holds Federal reserved water rights in Organ Pipe Cactus National Monument. With future acquisitions, the monument may also acquire State appropriative water rights. State water rights in Arizona are based on the Doctrine of Prior Appropriation. Under this Doctrine, the party who first utilizes water for a beneficial use has a prior right to use, against all other appropriators - i.e., "first in time, first in right." The water must be put to beneficial use as defined by the State, which in Arizona include irrigation, domestic, stock watering, municipal, commercial, industrial, mining, recreation, fish and wildlife, and other uses. An appropriative water right is a property right; under State law it can be bought or sold, and its place of use, purpose, and point of diversion may be changed without loss of priority, provided there is no injury to the water rights of others.

Federal reserved water rights arise from the purposes for the reservation of land by the Federal Government. When the Federal Government reserves land for a particular purpose, it also reserves, by implication, enough water unappropriated at the time of the reservation as is necessary to accomplish the purposes for which Congress or the President authorized the land to be reserved, without regard to the limitations of State law. The rights vest as of the date of the reservation, whether or not the water is actually put to use, and are superior to the rights of those who commence the use of water after the reservation date.

Quitobaquito Pond (Public Water Reserve No. 88) arises from a withdrawal "under and pursuant to the provisions of the act of Congress approved June 25, 1910 (36 Stat., 847), entitled 'An act to authorize the President of the United States to make withdrawals of public lands in certain cases', as amended by act of Congress approved August 24, 1912 (37 Stat., 497)." Public Water Reserve No. 88 stated that "all

lands within one-forth mile of an unnamed pond located in what will probably be when surveyed the SW1/4 of NE1/4, Sec. 17, Township 17 South, Range 7 West, of the Gila and Salt River Meridian" were "...withdrawn from settlement, location, sale, or entry, and reserved for public use in accordance with the provisions of Sec. 10 of the act of December 29, 1916 (39 Stat., 862)." Section 10 states "that lands containing water holes or other bodies of water needed or used by the public for watering purposes shall...be kept and held open to the public use for such purposes under such general rules and regulations as the Secretary of the Interior may prescribe."

Instructions published by the General Land Office, Department of the Interior (Circular No. 1066, May 25, 1926), state that public water reserves are "designed for general public use and benefit" and are "not therefore to be construed as applying to or reserving from homestead or other entry lands having small springs or water holes affording only enough water for the use of one family and its domestic animals. It withdraws those springs and water holes capable of providing enough water for general use for water purposes.

General basin-wide adjudications are the means by which the Federal Government claims its reserved water rights. The McCarran Amendment (66 Stat. 560, 43 U.S.C. 666, June 10, 1952) provides the mechanism by which the United States, when properly joined, consents to be a defendant in an adjudication.

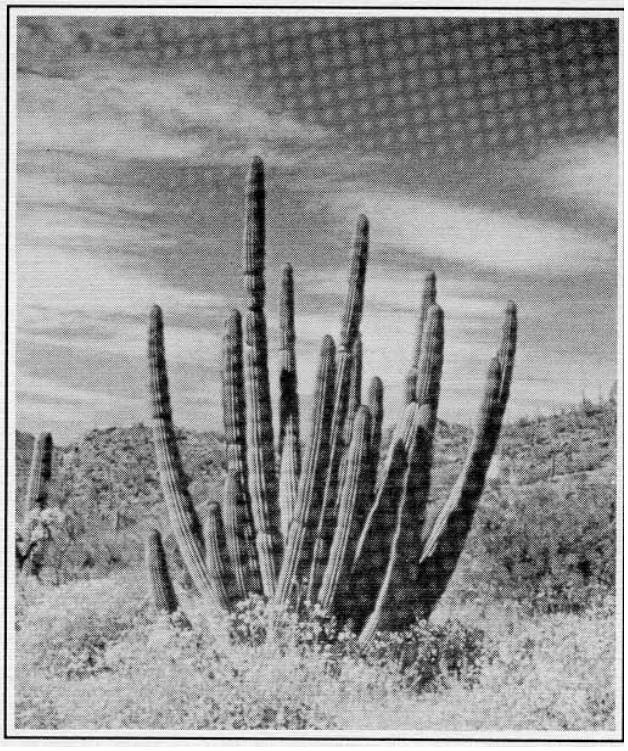
Once adjudicated by the State, the water rights of the United States, reserved and appropriated, fit into the State priority system along with those of all other appropriators. In general, when it is brought into a general adjudication, the Unites States is given its only opportunity to assert its claim to water rights. Unless legally absent from the proceedings, it is generally understood that failure to assert a claim to water rights in such a proceeding may result in forfeiture of these rights.

In 1987, in the adjudication of water rights in the Lower Gila River, the United States Department of Justice, on behalf of the National Park Service, submitted a claim for Federal reserved and State appropriative water rights for consumptive and non-consumptive uses for the northern portion of Organ Pipe Cactus National Monument. Federal reserved water rights were claimed in the Lower Gila River adjudication for water necessary to fulfill the purpose of the reservation. These Federal reserved water rights have not yet been quantified.

The southern portion of Organ Pipe Cactus National Monument, including Quitobaquito Springs and pond, drains south into Mexico. Though the Rio Sonoyta is an independent watershed, the State of Arizona includes it in the San Simon watershed for the purposes of water rights administration. To date, the state has not required the filing of water rights claims in the San Simon watershed.

In addition, to these claims, non-NPS (alien) claims for rights to water from sources within and near Organ Pipe Cactus National Monument occur. The status and validity of these claims, as well as their potential impacts on management of the monument resources, are unknown..

III. WATER RESOURCES MANAGEMENT PROGRAM



III. WATER RESOURCES MANAGEMENT PROGRAM

Specific actions to address water resource issues are presented in this section. Each issue is examined briefly, and actions to address the issues are proposed. In each case where an action is proposed that will require an additional commitment of staff or funding, a project statement is included in Section III.C. Water Resources Management Project Statements. A few issues that are important, but are not suitable for project statements in this plan, are also presented below.

Project statements are the basic unit used to propose resource management actions in the National Park System. Each presents one significant issue with recommended actions for dealing with that issue. Possible alternative actions are included where appropriate, as well as the need for environmental or cultural compliance prior to implementing the proposed action. These project statements are considered part of the more comprehensive Natural and Cultural Resources Management Plan, and will be incorporated there for funding and programming purposes. A table summarizing the issues and actions presented in the project statements in this plan in presented in Appendix D.

Management priorities and funding needs for projects are presented in Table 1. Water Resources Management Plan Programming Sheets. Projects are listed in the programming sheets in order of priority. They are discussed below roughly by priority, with some modification in order to group related topics.

This is a dynamic plan that will be updated as new information becomes available and priorities change. Programming sheets and project statements will be updated regularly.

III.A. Water Resources Issues and Proposed Actions

• Water Rights

Addressing water rights issues is the highest priority, because the monument will have to identify water resource attributes before it can participate effectively in state water rights adjudications. These adjudications offer a one-time opportunity to quantify Federal reserved and appropriated water rights. The monument must have the appropriate information and justifications prepared to submit to the state when the watersheds are adjudicated. The time table for adjudications is established by the State of Arizona. A project for addressing water rights issues is presented in **Identify and Inventory Water-Related Resource Attributes (ORPI-N-200).** This proposes using an interdisciplinary team to conduct literature and field research into the water-related resource attributes so that water rights claims can be quantified and supported.

Alteration of Natural Flow Regimes and Groundwater Levels

The most significant water resource threat by far is the pumpage of groundwater for agriculture and other uses in adjacent Mexico. The rate of water use greatly exceeds the rate of recharge, and this overdraft will increase if current trends continue. Lowering of the groundwater table in the Sonoyta Valley can have negative impacts on a number of monument resources. Flows could be reduced or eliminated at the unique springs in the Quitobaquito Hills; water levels in the wells that provide water to the headquarters could be lowered; and the earth's surface could subside in the Sonoyta Valley. Ten of the project statements included in this plan directly or indirectly address problems resulting from the pumping of groundwater along the Rio Sonoyta. Most of

Table 1. Water Resources Management Plan Programming Sheet

Costs in Thousands of Dollars

WRMP PROJECT NO.	PROJECT TITLE	RES. ISSUE CODE	WRMP PRI.	PARK PRI.	FUND SOURCE CODE [2]	ACT. TYPE CODE[3]	START YEAR $/FTE	OUT YEAR 1 $/FTE	OUT YEAR 2 $/FTE	OUT YEAR 3 $/FTE
ORPI-N-200	Identify and Inventory Water-Related Resource Attributes	N13	1		SNWR RNSR/RM	RES DOC	20.0 / .10	20.0 / .10		
ORPI-N-201	Determine the Geohydrology of Quitobaquito Springs	**NO2**	2		SNWR RNSR/RM	RES	**48.0** / .10			
ORPI-N-202	Monitor Land Subsidence	N12	3		SNWR RNSR/RM	RES MON	8.0 / .02			
ORPI-N-203a	Monitor Groundwater Resources in **the Rio Sonoyta Watershed**	N12	4		SNWR RNSR/RM	RES MON	**25.0** / .15	16.0 / .10	16.0 / 1.0	16.0 / 1.0
ORPI-N-203b	**Investigate Groundwater Use on Tohono O'odham Lands**	N12	5		SNWR PNR1	RES MON	**6.5** / .01	**.25** / .01	**.25** / .01	.25 / .01
ORPI-N-203c	**Surface Water Inventory of the Rio Sonoyta Watershed**	N12	6		SNWR RNSR/RM	RES	**26.0** / .10			
ORPI-N-203d	Land Use Inventory of the Rio So-**noyta Watershed**	N12	7		SNWR RNSR/RM	RES	**56.0** / .10			
ORPI-N-203e	Evaluate Trends in **Water Use** in **the Rio Sonoyta Watershed**	N12	8		SNWR RNSR/RM	RES	**25.0** / .00			
ORPI-N-204	**Control Accelerated Erosion**	N06	9		SNWR RNRM	MIT	81.0 / .10	.50 / .01	.50 / .01	.50 / .01
ORPI-N-205	Develop and Implement Water Con-**servation Program**	N24	10		SNWR RNRM	MIT	20.0 / .00	15.0 / .00		
ORPI-N-206	Define Characteristics of Regional Aquifers	N12	11		SNWR RNSR/RM	RES	18.0 / .00			

Table 1. Water Resources Management Plan Programming Sheet (Continued)

Costs in Thousands of Dollars

WRMP PROJECT NO.	PROJECT TITLE	RES. ISSUE CODE	WRMP PRI.	PARK PRI.	FUND SOURCE CODE [2]	ACT. TYPE CODE[S]	START YEAR $/FTE	OUT YEAR 1 $/FTE	OUT YEAR 2 $/FTE	OUT YEAR 3 $/FTE
ORPI-N-207	Update Water Resources Inventory and Monitoring	N12	12		SNWR RNSR/RM	RES MON	**32.0** / .10	**50.0** / .10	14.0 / .10	14.0 / .10
ORPI-N-208	**Develop a Geographic Information System Component for Water Resources**	N12	13		SNGS RNSR/RM	DOC	**25.0** / .50	15.0 / .40	10.0 / .30	
ORPI-N-209	Monitor Riparian Ecosystems	N12	14		SNWR RNSR/RM	RES MON	27.0 / .02	6.0 / .01	**6.0** / .01	6.0 / .01
ORPI-N-210	**Identify Pollution Threats from Kuakatch and Cuerda de Lena Washes**	N11	15		SNWR RNSR/RM	RES	6.0 / .01	6.0 / .01	**6.0** / .01	6.0 / .01
ORPI-N-211	**Evaluate Flood Hazards at Bates Well**	N20	16		SNWR RNRM	RES	6.0 / .40			
ORPI-N-212	Evaluate Abandoned Mine Tailings	N10	17		SNEM SNWR RNRM	RES MON	**6.5** / .01			
ORPI-N-213	**Monitor Precipitation Chemistry**	N20	18		PNR1	RES MON	**.25** / .01	**.25** / .01	**.25** / .01	**.25** / .01
ORPI-N-214	**Monitor Wastewater Systems**	**N24**	19		ROTH	MIT	4.0 / 0.0			

1 Resource Issue Codes: **NO2** = Impacts on **Threatened, Endangered,** and other Sensitive Animals; N06 = Disruption of Native Plant Communities and **Accelerated** Erosion Due to Past Land Management Practices; N10 = Disruption of Park Resources Due to Mineral Extraction & Geothermal Activities; N11 = **Degradation** of Park Water Quality Due to External Activities; N12 = Alteration of Natwal Flow Regimes; N13 = Lack of Secure Water Rights; N20 = Lack of Basic Data; N24 = Other Issues.

2 Fund Source Codes: PNR1 = Park Recurring (Permanent) Operating Base - Natural Resources; RNRM = Regional Natural Resource **Management;** RNSR/RM = Regional Science Research and **Resource Management;** ROTH = Regional Other; SNEM = **Servicewide** Energy, Mining and Minerals; SNGS'= **Servicewide Geographic** Information Systems; SNWR = Servicewide Water Resources.

3 Action Type Codes: RES = Research; DOC = **Documentation;** MON = Monitoring; MIT = Mitigation.

the projects seek to fill gaps in the understanding of the extent of groundwater overdraft and its impacts. Actions are also included to document the extent of the problem to strengthen the monument's position in encouraging the Mexican government to reduce groundwater overdraft.

Geohydrology of Quitobaquito Springs

As well as providing critical habitat for the endangered desert pupfish, the riparian and aquatic environment of Quitobaquito Oasis is quite unique and is a significant monument resource. As such, maintaining present water quality is a significant management concern. The pond is the largest open body of water in the monument and is a popular stopping place for visitors along a scenic loop drive. The area is also habitat for a newly described butterfly, an endemic snail, a shrub found nowhere else in the United States, a living historic pomegranate cultivar, and numerous events in the natural history of the monument. The nature of the aquifer that supplies Quitobaquito Springs is not well understood. The productivity of these springs presents an apparent anomaly in such an arid region. The aquifer for Quitobaquito Springs is adjacent to, if not an integral part of, an aquifer that is being pumped extensively just across the border in Mexico. In order to achieve a level of understanding that will allow the monument to assess the threat posed by pumping, it is proposed to **Determine the Geohydrology of Quitobaquito Springs (ORPI-N-201).** Elements of this study include: assembling and interpreting existing data on spring flow, pumping, precipitation and groundwater levels; mapping the geology of Quitobaquito Hills, completing a geophysical survey of La Abra Plain, and producing a final report that includes the design for a permanent monitoring network.

Land Subsidence

As the groundwater table in the Sonoyta Valley continues to fall as a result of pumping in Mexico, land subsidence will also occur. This is likely to result in earth cracks that disrupt natural drainages, trap wildlife, and damage facilities; and in a permanent loss of capacity in the affected aquifer. Effects will be most pronounced in Sonoyta Valley, where deep alluvium occurs. At this time, there is no way of knowing if subsidence is occurring, since no baseline survey has been made. An accurate survey is proposed in **Monitor Land Subsidence (ORPI-N-202).** This will establish a baseline survey along the Mexican border for comparison with later surveys, in order to document land subsidence.

Groundwater Depletion From Water Use on the Rio Sonoyta Watershed

Much of the occurrence and use of water in the Rio Sonoyta basin is not well understood. Five project statements propose to inventory and evaluate water and land use in the basin and their trends. These project statements are grouped under ORPI-N-203 because of their similarities, but are separated so that the numerous actions can be more easily understood, and evaluated individually for sequencing and priority setting. All of the projects under ORPI-N-203 involve coordination and cooperative data gathering with land management officials in Mexico and the Tohono O'odham tribe. Similar projects have been undertaken successfully in the past. In fact, the mutual knowledge gained and the shared awareness of sound land management is considered a major benefit of these projects.

Groundwater levels have been monitored for 12 years in the monument. In- **Monitor Groundwater Resources in the Rio Sonoyta Watershed (ORPI-N-203a)** the continuation of this program is proposed. This will include continuous monitoring at three wells along the border, quarterly monitoring at six wells along the border and at four wells away from the border, and continuous monitoring of the flow of Quitobaquito Springs.

The Tohono O'odham have an area of irrigated agriculture and extensive ranching on the Rio Sonoyta watershed. The amount of groundwater used and its contribution to lowering the water table in the monument is not known. An inventory of wells, depth to water, and, pumpage is proposed in **Investigate Groundwater Use on Tohono O'odham Lands (ORPI-N-203b).** Protocols for a continued monitoring program would also be established.

The extent of surface waters in the Rio Sonoyta watershed and their contribution to the groundwater system is not known. This deficiency is addressed in **Surface Water Inventory of the Rio Sonoyta Watershed (ORPI-**N-203c). This proposal includes an inventory of surface waters, collection of historic flow information, and a hydrologic analysis to estimate runoff and recharge.

Little is known of the type and extent of land uses on the Rio Sonoyta watershed. Most land uses, such as agriculture, ranching, and urbanization are supported by groundwater pumping and contribute to the overdraft of the aquifer. In the absence of accurate pumping records, an examination of land uses is the most effective method for estimating water consumption over a large area. An investigation of the extent of existing and potential land uses proposed in **Land Use Inventory of the Rio Sonoyta Watershed (ORPI-N-203d).** This will include the delineation of the watershed boundary, identification and delineation of land uses and land capability, and where possible, the collection of land ownership information.

Although it is known that groundwater is being withdrawn at a rate greater than recharge, the existing data are limited in duration, scope, and accuracy. At the current level of inventory and monitoring, it is not possible to accurately document or predict trends. In **Evaluate Trends in Water Use in the Rio Sonoyta Watershed (ORPI-N-203e),** it is proposed to quantify historic uses to the extent possible, compile present uses as identified in the other four 202 projects, and to predict future uses of the watershed in the 20 to 25 year time frame.

■ **Lack of Basic Information Necessary to Understand Monument Resources and Related Threats.**

Characteristics of Regional Aquifers

Aquifers that supply groundwater to the Rio Sonoyta Valley are not well understood outside of the monument. In order to fully understand the water balance of the aquifer, there is a need for a project to **Define Characteristics of Regional Aquifers (ORPI-N-206).** This proposes a relatively simple analysis of existing literature to characterize the regional aquifer system of the Rio Sonoyta.

Water Resources Inventory and Monitoring

The current water resources inventory for the monument includes little information on water quality and provides no indication of trends. Project Statement **Update Water Resources Inventory and Monitoring (ORPI-N-207)** proposes an improved inventory as well as a schedule for long term monitoring. The proposed action will include three phases; 1) a study design during the first year of funding, 2) an intensive inventory/monitoring program during the second year and repeated at 5-year intervals, and 3) low intensity monitoring of selected sites during the interim years.

Pollution Threats from Kuakatch and Cuerda de Lena Washes

Cuerda de Lena and Kuakatch Washes enter the monument as major surface drainages from public and private lands north and east of the monument and from the Tohono O'odham Reservation. Both could be transporting surface and groundwater pollution. Land uses of concern include ranching, a small community, and most importantly, a huge copper mine at Ajo. In order to detect pollution that may be entering the monument, this plan includes a

proposal to **Identify Pollution Threats from Kuakatch and Cuerda de Lena Washes (ORPI-**N-210). Since surface water flow in these washes is rare, wells inside and outside of the monument on these watersheds will be monitored to detect changes in water quality.

. **Degradation of Monument Water Quality and Resources**

Accelerated Erosion

Anthropogenic erosion is evident in the vicinity of historic ranch sites where soils are fine in texture and cattle grazing pressure was the strongest. Broad scale loss of soil from wind and water has occurred in these areas, resulting in changes in the vegetation communities. There are approximately 170 acres of heavily eroded soil at Armenta Ranch and Dos Lomitas. Since these sites are not recovering naturally, a project statement is included for **Control Accelerated Erosion (ORPI-N-204).** The two areas will be treated as prescribed in a 1989 study of the problem. Treatments will include construction of earthen dikes at 83 locations in incised channels, as well as construction of rock and brush structures. Establishment of native vegetation will be encouraged.

Abandoned Mine Tailings

The monument has had a history of hard rock mining. Some of the techniques of mineral extraction may have used cyanide solution or mercury to extract gold. Other metals may have been released into the environment through processing of the ore. If significant cyanide leaching was used, it may have adversely affected the quality of the groundwater in and near the monument. Even though an inventory of abandoned mine sites was conducted in 1984, it did not include any assessment of the presence of potential sources of contamination. A program to assess the extent of contamination at these sites is presented in **Evaluate Abandoned Mine Tailings (ORPI-N-212).** This will involve literature and field searches to determine if cyanide, mercury or other metals are potential problems at each abandoned mine site, followed by chemical analysis of mine tailings from problem sites.

Floodplain Management and Wetlands Protection

Protection of Riparian Ecosystems

Dry desert washes and arroyos experience flash floods when rains are sufficient to saturate the soil and water runs off the surface. This moisture creates strips of desert riparian vegetation along the arroyos that are some of the most diverse and productive ecosystems in the monument. Some of the plants which are major components of this community are known to have deep tap roots, and are dependent on relatively shallow water tables below these washes. A significant and/or rapid lowering of the water table could eliminate these riparian ecosystems. A project is proposed to **Monitor Riparian Ecosystems (ORPI-N-209).** This will include field surveys and aerial mapping of selected riparian areas in order to both determine their present status and establish long term trends.

Floodplain Hazards

Historic structures and visitors at Bates Well are potentially threatened by flooding of Growler Wash. Flood waters have been observed at the level of the floor of Henry Gray's House. In addition, Bates well is occasionally proposed for the development of visitor facilities or employee housing. The need for flood hazard analyses is assessed in **Evaluate Flood Hazards at Bates** Well (ORPI-N-211). A flood hazard analysis is needed in order to determine if mitigation is needed to protect, document or salvage the historic structures, or if plans for more extensive use of the area are resurrected.

. **Related Resource Issues**

Water Conservation in Monument Operations

Although water consumption is relatively small, Organ Pipe should set a good example if they are to ask other water users to conserve. The monument's water supply wells are threatened by a lowering groundwater table, so water conservation may eventually become a necessity. The proposal in **Develop and Implement Water Conservation Program (ORPI-N-205) includes** encouraging voluntary conservation by providing information to residents and visitors, installing meters to track use and identify leaks, retrofitting with water conserving fixtures, conducting a leak detection survey, and phasing to native landscaping and drip irrigation. This approach to water use is consistent with the monument's location in a desert environment.

Geographic Information System

The current data handling system for water resources is cumbersome and inefficient. A Geographic Information System (GIS) is currently being developed, and water resources will be a major component of this system. In **Develop a Geographic Information System Component for Water Resources (ORPI-N-208),** it is proposed to digitize water inventory and monitoring data, to digitize and analyze available water resource data from Mexico and the Tohono O'odham lands, to depict impacts to resources, and to digitize in detail the Quitobaquito sensitive habitat area.

Chemistry of Monument Precipitation

The monument has participated in the National Atmospheric Deposition Program for precipitation monitoring since 1980 to identify pollutants entering the monument through precipitation. This is a valuable monitoring program, as contaminated precipitation could have adverse effects on the water quality. In addition, the monument provides a significant data point at the edge of the US. Continued participation in this program is proposed in **Monitor Precipitation Chemistry (ORPI-N-213).**

Wastewater Management

Wastewater management is handled by several small independent systems. The main monument campground, with 208 campsites (no hook-ups), a sewage dump station, six restroom buildings with sinks and flush toilets, and one duplex, is served by sewage lines leading about .62 miles south to four open evaporative lagoons. There are four septic tank leach field systems serving: the group campground restroom, the NPS residential area (consisting of 10 single family residences, one duplex, the community house, the resource center, ranger station and an 11 site volunteer campground), the visitor center and administrative offices, and the maintenance shop.

All sewage systems are currently functioning adequately. It is proposed in **Monitor Wastewater Systems (ORPI-N-214)** that the systems continue to be operated in compliance with state regulations and be routinely examined for leaks.

III.B. Actions Which Are Not Included in Project Statements in this Plan

Biosphere Reserve

As a MAB unit since 1976, the monument joins an international network of biosphere reserves in emphasizing some of the basic NPS ideas, such as preserving genetic diversity, protecting a sample of one of the world's major ecosystems - the Sonoran Desert, and being devoted to the conservation of nature. In addition, biosphere reserve status encourages managers to stress outreach programs and attitudes, thus placing the monument in more of a regional setting, as the core zone of preservation within a much larger area of varying use. Scientific research is also stressed more in a biosphere reserve than in traditional park units. Research is promoted which emphasizes baseline investigations and long-term monitoring. This is done to fulfill the

program's appeal to provide a standard against which the effects of human impact on the environment can be measured.

In relation to water resources management, this means taking a broad view approach, considering resources and outside use patterns as part of the greater monument ecosystem, and emphasizing baseline data gathering followed by monitoring. Finally, this nonbinding international program is an effective avenue for significant increases in communication and cooperation with other agencies, including Mexican agencies.

Domestic Water Supply

The monument depends on two wells, situated closely together, for the potable water supply for thevisitor center, administrative offices, maintenance shops, residence area, and campground. The quality of this groundwater is tested regularly. It is within Arizona State Department of Environmental Quality standards, but it is rather high in fluoride. Two or three of the monument residences have been equipped with resin filter systems to provide fluoride free drinking water. The town of Lukeville has a private potable water system using well water which is rather high in both fluoride and arsenic. The Lukeville wells are about five miles south down-gradient from the two headquarters wells.

Quitobaquito Management Area

The management area that includes Quitobaquito Springs and Pond is the subject of a multi-year program of studies by the National Park Service, Cooperative Park Studies Unit at the University of Arizona. This program includes a broad spectrum of investigations into the flora, fauna, and history of the area. On completion, recommendations will be made for the management of the area. When actions are proposed, they will be incorporated into this plan or the Natural and Cultural Resources Management Plan.

Coordination with Mexico

Many of the present day threats to the water resources come from adjacent lands, especially from the urban and agricultural areas to the south. The town of Sonoyta, Sonora, has grown to a regional agricultural center with a population of 15,000. It is centered 1.85 miles south of the border crossing at Lukeville. Irrigated agriculture has also spread east and west of Sonoyta, along the course of the Rio Sonoyta.

The governmental office for the Secretaria de Agricultural y Recursos Hidraulicos (SARH) in Sonoyta deals with water allocation, flow monitoring, crop production, and agricultural credit. Contacts have been developed and water resource data has been shared between the NPS and these offices. It is advantageous for the NPS to continue to work with these offices in order to better understand the regulatory systems and the water use patterns which may be affecting the monument. In addition, information about the geohydrology would probably be of use to planners in Mexico.

Coordination with Mexico will be accomplished on major trans-boundary issues through information exchanges under the Memorandum of Understanding of November 30, 1988 along with other treaties and agreements. This memorandum provides for regular meetings and information exchange between the Director of the National Park Service and the director of the equivalent agency in Mexico. The monument will work through the Office of International Affairs for the National Park Service and, when appropriate, with local contacts in Mexico.

Most treaties and efforts to resolve disputes along the international boundary involve linkages between similar or dissimilar issues. As a result, any agreement to resolve trans-boundary issues in the vicinity of the monument will likely be part of a larger compromise.

III.C. Water Resources Projects Statements
Complete project statements follow

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-200

2. Identify and Inventory Water-Related Resource Attributes

3. Systemwide Issue: N13

4. Problem Statement: The water-related resource attributes of the monument have not been fully assessed. Identification and inventory are needed to both document the possibility of impact, and to measure its magnitude in the event impact does occur. This information will be required in water rights litigation or in any other similar arena in which the NPS seeks relief from such impact to protect the monument and the purposes for which it was created.

At present there exists an incomplete, and perhaps inadequate, understanding of the relationship of water to the natural resources. The first step in developing this understanding is to identify and inventory the nature and magnitude of resource attributes that are affected by or are dependent on both surface and subsurface water.

The possibility of future impact to water-related resource attributes exists because of agricultural expansion and development along the Mexican border. Water withdrawals from aquifers underlying the monument or alterations in surface water flow regimes are likely to affect water-related resource attributes. Without identification and inventory, actions to arrest and reverse effects will be delayed, resulting in additional or longer-lasting effects.

5. Alternative Actions/Solutions and Their Probable Impacts: No action. This action would leave the monument without an adequate database to protect its water rights or to understand the relationships between water and water-related resource attributes of the monument. Opportunities to quantify and fully protect Federal reserved and appropriated water rights could be jeopardized under such stewardship.

6. Description of the Recommended Project or Activity: Conduct a Thorough Inventory of all Water-related Resource Attributes. Such a study will give the Superintendent an adequate database from which to make informed management decisions and to protect water rights. Such results will also be of use to all other resource related inventories conducted at the monument.
The identification and inventory of water-related resource attributes will require a technical assessment of natural resources and scientific literature. This project will be best undertaken by an interdisciplinary team working as a unit. Field and office assessments will result in summary reports, maps and atlases. When completed, additional projects and/or studies may be required to evaluate the nature and magnitude of the relationship between water and water-related resource attributes.

Personnel: This project will be accomplished and/or contracted by the Water Resources Division, National Park Service.

Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, I.J.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 1 other project in this plan. -

   ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-200 Identity and Inventory Water-Related Resource Attributes	YEAR	IN PROGRAM SEQUENCE		
	1st	2nd	3rd	4th
Personal Services	20,000	20,000		
Other	0	0		
TOTAL	20,000	20,000		
Funds Available in Park Base	0	0		
Additional Funds Needed	20,000	20,000		

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-201

2. Determine the Geohydrology of Quitobaquito Springs

3. Systemwide Issue: NO2

4. Problem Statement: The possibility that the natural flow of Quitobaquito Springs could be affected by groundwater pumping in adjacent Sonora, Mexico, is of critical concern to the monument. Flow from the spring currently fluctuates around 32 gallons per minute. The unique fauna occupying the pond and surrounding area includes designated critical habitat for the endangered desert pupfish *(Cyprinodon macularius eremus).* It is imperative that the NPS know whether this spring and its habitat are imminently threatened by activities in Mexico. The ability a direct threat will strengthen the monument's position in negotiations with the Mexican government.

Large areas of agriculture are supported by groundwater pumping in the Rio Sonoyta Valley, immediately to the south. The irrigated lands extend from 30 miles east to five miles west of Quitobaquito Spring, and occur within 'h mile south of the spring. The amount of water being withdrawn is not accurately known, but groundwater overdraft is estimated to be 2.5 times the rate of recharge (Brown 1988). The Mexican Government has placed a moratorium on new wells in the area, but pumping can increase significantly before the current capacity is reached.

A study by Anderson and Laney (1978) suggested that a dike system in the highly fractured granitic gneiss of the Quitobaquito Hills may be responsible for the blockage of underground water coming into the system from the La Abra Plain, and thus for the subsequent surfacing of water at Quitobaquito, Williams and Burro Springs. The study also showed that the quality of the water from all of the springs was similar, indicating they are supplied by the same groundwater system, but the water differed from wells in the area. The groundwater flow system that supplies the springs could not be defined because of the small amount of information that was available.

Several recommendations were made as a result of this study, including monitoring spring flow, rainfall and water levels in several wells in the area. The monitoring program was initiated in 1981.

5. Alternative Actions/Solutions and their Probable Impacts: No Action. This alternative will leave unanswered the question of possible impact to the spring flow from pumpage in Mexico. Negotiations with Mexico will be hampered by the lack of documentation and understanding of impacts to monument resources. The cause of future declines in spring flow will be speculative.

6. Description of the Recommended Project or Activity: Study the Geohydrology of Quitobaquito Springs. In order to define the aquifer feeding Quitobaquito and other nearby springs, a study is recommended to build on the existing information base. The objectives of this study are; (1) to define the source of spring flow at Quitobaquito, (2) to determine if groundwater withdrawals in Mexico have the potential to affect natural spring flow and, if so, (3) to design a permanent monitoring network that can provide a warning of impending declines in spring flow, as well as document any effects to spring flow that occur. The network will also evaluate the possibility for developing a

supplemental water supply for the pupfish habitat. The program to accomplish these objectives will include the following five components.

Assemble and interpret data acquired in the current monitoring program and evaluate the precipitation/spring flow relationship, spring flow duration statistics, changes in groundwater levels, and water quality relations between springs and wells.

Complete a detailed geologic map of the Quitobaquito Hills with an emphasis on the fracture system in crystalline rocks that provides the conduit through which water is discharged at the springs.

Complete detailed geophysical surveys required to define the Hydrology of the area. They will be conducted in two phases. Phase 1 will include a reconnaissance electromagnetic and gravity survey along the main road across the La Abra Plain and north along the loop road through Cipriano Pass. The survey will be analyzed to determine if an alluvial aquifer overlies the bedrock and if so, the approximate thickness of the aquifer. Phase two will be implemented if a significant thickness of alluvial material is found. It will include a gravity survey throughout La Abra Plain in the United States to determine the geometry and continuity of the alluvial material with the aquifer underlying the agricultural area in Mexico. The survey will be conducted using a helicopter and Global Positioning Satellite System to allow for the establishment of each gravity station in areas of designated wilderness.

Maps will be prepared showing the hydrogeology of the flow system contributing water to the springs and its connection, if any, to the alluvial aquifer that supplies water in Mexico.

Preparation of a final report that will include all data and conclusions, a prediction of future spring flow and a design for a permanent monitoring network. If it is determined that withdrawals in Mexico may affect springs in the monument, the project report will also include recommendations for establishing a backup or supplemental water supply.

Personnel: This project will be accomplished by the USGS with assistance from monument staff.

7. Compliance: This project can be accomplished with no additional ground disturbance by using existing roads and helicopter transportation. The impacts of helicopter use will have to be evaluated. Once this is done, the project will probably be categorically excluded from further NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is not required for this project.

8. Relationships: This project is related to at least 8 other projects listed in this plan. These are as follows:

ORPI-N-202 Monitor Land Subsidence
ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed
ORPI-N-203b Investigate Groundwater Use on Tohono O'odham Lands ORPI-N-203c Surface Water Inventory of the Rio Sonoyta Watershed ORPI-N-203d Land Use Inventory of the Rio Sonoyta Watershed ORPI-N-203e Evaluate Trends in Water Use in the Rio Sonoyta Watershed

ORPI-N-206 Define Characteristics of Regional Aquifers ORPI-N-208
Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-201 Determine the Geohydrology of Quftobaquito springs	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	37,000			
Other	11,000			
TOTAL	48.000			
Funds Available in Park Base	0			
Additional Funds Needed	48,000			

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-202

2. Monitor Land Subsidence

3. Systemwide Issue: N12

4. Problem Statement: Further lowering of the groundwater table along the southern boundary will probably result in land subsidence. Monitoring needs to be initiated now so that future substance can be identified and documented.

Agricultural pumping and irrigation in Mexico was initiated in proximity to the monument about 20 years ago. Increased withdrawals of groundwater from the alluvial aquifer have caused a lowering in the groundwater table within the monument by about ten feet. Subsidence can generally be expected when the lowering of the groundwater exceeds about 50 feet. The amount of land subsidence increases as the water table continues to decline. Once subsidence has occurred, it cannot be fully corrected.

Subsidence resulting from groundwater withdrawal is an increasing problem in alluvial basins in the southwestern US. The two major types of impacts from subsidence are changes in the land surface and drainage patterns, and permanent changes in the aquifer. Surface impacts occur when the centers of alluvial basins subside, and the surrounding mountains do not. Earth cracks, some hundreds of feet long and several of feet deep, form at the point of flexure around the margins of the basin. The cracks can capture and divert small drainages, disrupting drainage patterns across the bajadas and causing significant erosion and sedimentation. Vegetative changes occur when water supporting vegetation along one channel is diverted away to another channel. Earth cracks can also damage roads, pipelines and other structures.

Damage to the aquifer occurs when alluvium, which is no longer supported by the full depth of groundwater, compacts. This permanently reduces the hydraulic conductivity of the substrate, as well as the water holding capacity of the aquifer.

At this time it is not believed that land subsidence along the international boundary has taken place. The purpose of this project is to provide a quantitative baseline against which future data can be compared. A baseline can be established with an accurate survey of existing benchmarks and boundary monuments along the border. The ability to identify when and if subsidence occurs, and its magnitude, will strengthen the monument's ability to negotiate for pumping rates that do not exceed groundwater recharge. In addition, documentation of observed changes will provide a basis for predicting future changes.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. The no action alternative would result in a weakened NPS position for demonstrating impacts from groundwater pumping. The first evidence of land subsidence will be the observation of earth cracks after substantial subsidence has occurred.

Expanding the number of surveyed points to include the entire Sonoyta Valley is an alternative that would provide a greater understanding of the extent and depth of alluvium that fills the valley. The

additional warning of subsidence provided by these additional sites is minimal, however, as subsidence is expected to appear first at the southern boundary.

6. Description of the Recommended Project or Activity: Conduct a Survey of Existing Bench Marks and Boundary Markers Along the International Boundary. A first order survey of existing bench marks and boundary monuments along the international boundary will be made from the Ajo Range (IBM # 163) west to the Sonoyta Mountains (IBM # 168). It is expected that almost all of these markers are within the 60 foot wide strip of land adjacent to the international boundary reserved by Presidential Proclamation. Survey work in this area will be coordinated with the US Customs and Immigration Service.

Photographs will be taken to document surface conditions and to aid in relocating the survey markers. The area should be resurveyed at five year intervals unless changes in the rate of water table decline indicate the need for more or less frequent observations. The Mexican government should be notified of the NPS concern over subsidence, as well as its intention to monitor the condition.

7. Compliance: As this is a minor non-destructive data collection activity, it is Categorically Excluded from further compliance under NEPA (516 DM 2.3A(2) § 1.6). Minor ground disturbance that may be associated with this project will occur in previously disturbed areas. An archeological clearance, under NHPA, Section 106, will be required.

8. Relationships: This project is related to at least 6 other projects listed in this plan. These are as follows:

> ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed ORPI-N-203b Investigate Groundwater Use on Tohono O'odham Lands ORPI-N-203c Surface Water Inventory of the Rio Sonoyta Watershed ORPI-N-203d Land Use Inventory of the Rio Sonoyta Watershed ORPI-N-203e Evaluate Trends in Water Use in the Rio Sonoyta Watershed ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-202 Monitor Land Subsidence	Year in program sequence			
	1st	2nd	3rd	4th
Personal Services	7000			
Other	1000			
TOTAL	8000			
Funds Available in Park Base	500			
Additional Funds Needed	7500			

Additional funding for repeating the survey will be required at 5 to 10 year intervals.

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-203a

2. Monitor Groundwater Resources in the Rio Sonoyta Watershed

3. Servicewide Issue: N12

4. Problem Statement: The primary threat to the natural resources of Organ Pipe Cactus National Monument is the continued urbanization and agricultural development near its southern boundary, in the neighboring state of Sonora, Mexico. The primary concern is that continued or increased pumping of groundwater in Mexico is lowering the groundwater table which may impact monument resources, specifically Quitobaquito Oasis, where the endangered desert pupfish *(Cyprinodon macularius)* occurs. As of 1988, there were approximately 22,455 irrigated acres in production in the Sonoyta Valley, supported by 165 wells. Annual groundwater pumpage is approximately 83,160 acre feet, which is 2.5 times the aquifer recharge rate. Although there now exists a moratorium on the drilling of new wells, current wells are pumping at less than ~fz their potential capacity of 191,000 acre feet.

Water level data has been collected from 14 wells within the monument and at Lukeville since 1981. This includes bimonthly measurements by USGS at 10 wells, and quarterly measurements by monument staff at 10 wells (6 wells are measured by both). USGS personnel, under NPS contract, installed a gauge height recorder at one well in Lukeville. After an initial report by USGS in 1978 estimated future drawdown near the international boundary and stressed the need for additional data to improve the accuracy of the model, three additional monitoring wells were drilled in 1988 and equipped with continuous recording devices. Several years of data will be necessary to establish trends and provide an improved base for rerunning the model.

Volumetric flow measurements were taken regularly at Quitobaquito Springs between 1974 and 1981 when a continuous recording gauge was installed. The quality of the measurements was improved in 1989 with modifications to the channel to minimize interference from vegetation and seepage. The recording gauge is maintained and the data collected by the USGS under contract to the NPS. Continued measurements are essential for identifying trends in spring flow and possible impacts from pumping.

Over the past three years, National Park Service efforts through the Sensitive Ecosystems Program, a baseline research program, have made significant progress in researching this problem, and in working with Mexican resource personnel. Efforts have included researching past, present and future land usage in the Sonoyta Valley, developing an eight year database of depth-to-water measurements for 165 wells adjacent to the monument, gathering electrical use data for wells, calculating pumpage by point and attempting to define boundaries of the aquifer.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This alternative will leave the monument with no means of knowing the status of groundwater resources.

6. Description of Recommended Project or Activity: Establish a Formal Groundwater Monitoring Program. This program will continue the collection of groundwater data both within the monument and on adjacent Mexican lands, and will include both existing monitoring activities and the development of new ones. The program will encompass the following:

Organ Pipe Cactus National Monument

Monitor groundwater continuously at 3 locations on the southern boundary of the monument. Monitoring wells drilled in 1988 along the monument's southern boundary will continue to be monitored on a continuous basis. USGS will be contracted to maintain and provide data summaries for these wells. Continuous recording of water levels will allow trends to be determined.

Monitor groundwater quarterly in 6 locations on the southern boundary of the monument. Depth-to-water data will be collected quarterly at the following designated wells: Kalil Well, Stack Well, Dowling Well, Pozo Salado Well, Hocker Well, and Corner Well. Data will be incorporated into an analytical spreadsheet to monitor trends and to assist in modeling and evaluating impacts.

Monitor groundwater quarterly at 4 locations within the monument not located on the southern boundary. Depth-to-water data will be collected quarterly at the following designated wells: Pozo Nuevo Well, Bonita Well, Alamo Well, and Bates Well. These sites, removed from the impacts of agricultural development, will serve as control sites.

Monitor spring flow at Quitobaquito. Flow monitoring of Quitobaquito Springs will continue. USGS will be contracted to maintain and provide data summaries on spring flow. Data analysis will indicate any trends and will provide information indicating possible impacts from groundwater depletion in the area.

Sonoyta, Sonora, Mexico

Collect annual depth-to-water and electrical data for 165 agricultural wells located in the Sonoyta Valley in Mexico. Annual depth-to-water and electrical data will continue to be collected from Secretaria de Agricultura y Recursos Hidraulicos (SARH) Mexican agricultural officials in Sonoyta, Sonora, Mexico. All data collected will be input into databases maintained at the monument.

Increase the number of data checks on selected wells. Currently all agricultural wells in the Sonoyta Valley are shut down for approximately one week each November, while SARH staff measure and record data related to the static water levels. These annual measurements have been conducted by SARH since the early 1980's. In addition, measurements will be made at several selected wells during the remainder of the year in order to develop a more complete understanding of the aquifer.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 8 other projects listed in this plan. These are as follows:

ORPI-N-201	Determine the Geohydrology of Quitobaquito Springs
ORPI-N-202	Monitor Land Subsidence
ORPI-N-203b	Investigate Groundwater Use on Tohono O'odham Lands
ORPI-N-203c	Surface Water Inventory of the Rio Sonoyta Watershed
ORPI-N-203d	Land Use Inventory of the Rio Sonoyta Watershed
ORPI-N-203e	Evaluate Trends in Water Use in the Rio Sonoyta Watershed
ORPI-N-206	Define Characteristics of Regional Aquifers
ORPI-N-208	Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	2,000	3,000	1 3,000	3,000
Other	23,000	13,000	13,000	13,000
TOTAL	25,000	16,000	16,000	16,000
Funds Available in Park Base	2,000	2,000	2,000	2,000
Additional Funds Needed	23,000	14,000	14,000	14,000

Long-term funding will be required as this monitoring should continue for many years.

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-203b

2. Investigate Groundwater Use on Tohono O'odham Lands

3. Servicewide Issue: N12

4. Problem Statement: Land and water use on Tohono O'odham Reservation lands east and adjacent to Organ Pipe Cactus National Monument may pose future threats to natural resources. Land within the immediate vicinity of the boundary is not intensively used and is predominantly grazed by livestock. Approximately 20 miles to the east of the boundary, however, near the Mexican border, is Papago Farms, an agricultural area. Papago Farms is significant because of its location in the headwaters of the Rio Sonoyta watershed. Although no data is presently available, it is believed that the major portion of the water supply for the farms comes from groundwater. Surface water runoff may also contribute to the supply. Water consumed on the Tohono O'odham Reservation contributes to the collective overdraft of water in the Rio Sonoyta watershed.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This alternative will leave unanswered questions on groundwater usage on the Tohono O'odham Reservation lands, which may impact the natural resources of Organ Pipe.

6. Description of the Recommended Project or Activity: Conduct an Inventory of Wells in the Vicinity of Papago Farms for Location, Water Depth, and Pumped Volumes. Information will also be collected concerning the area under irrigation and recent cropping patterns. Well data and other information will be organized into a database and preliminary analysis will be made.

Data collection procedures will be established to periodically update information received from Papago Farms. Contacts from whom staff can obtain periodic data related to water volume and depth, and cropping patterns, will be identified in cooperation with the farm manager and the Gu Vo District of the Reservation.

Personnel: The work for this project will be contracted. Resource management staff will assist with the data gathering and will implement long-term monitoring protocols, including obtaining annual data and updating the database.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 8 other projects listed in this plan. These are as follows:

ORPI-N-201 Determine the Geohydrology of Quitobaquito Springs
ORPI-N-202 Monitor Land Subsidence
ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed
ORPI-N-203c Surface Water Inventory of the Rio Sonoyta Watershed ORPI-N-203d Land Use Inventory of the Rio Sonoyta Watershed ORPI-N-203e Evaluate Trends in Water Use in the Rio Sonoyta Watershed ORPI-N-206 Define Characteristics of Regional Aquifers
ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-203b Investigate Groundwater Use on Tohono O'odham Lands	YEAR IN PROGRAM SEQUENCE			
	1St	2nd	3rd	4th
Personal Services	500	250	250	250
Other	6,000	0	0	0
TOTAL	6,500	250	250	250
Funds Available in Park Base	500	250	250	250
Additional Funds Needed	6,000	0	0	0

Long-term funding may be required to the continue the monitoring aspects of this project.

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-203c

2. Surface Water Inventory of the Rio Sonoyta Watershed

3. Servicewide Issue: N12

4. Problem Statement: Insufficient information exists on surface water use in the Rio Sonoyta watershed, of which Organ Pipe Cactus National Monument is a part. On-going monitoring along the southern boundary has shown that continued urbanization and agricultural development in Sonora, Mexico, annually deplete the groundwater aquifer at 2.5 times the recharge rate. Very little data on surface water use in the Rio Sonoyta watershed is currently available. While data collection has begun on groundwater usage outside of the monument, little research has been done on surface water availability, locations, uses and trends that may impact the resources.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This alternative will leave unanswered questions on surface water use within the Rio Sonoyta watershed which may impact the natural resources or ORPI.

6. Description of the Recommended Project or Activity: Conduct a Thorough Inventory of Surface Water in the Rio Sonoyta Watershed. The recommended action includes three primary components, including an inventory of surface water use, historic flow information and performing an analysis of watershed hydrology.

> **Inventory of Surface Water Use.** An inventory of surface water use in the Rio Sonoyta watershed will be made. This will include surface water use by the Tohono O'odham Reservation and Mexico. The primary user of surface water is the Tohono O'odham Tribal farm. At the present time, little is known concerning surface water use from the Rio Sonoyta in Mexico.
>
> **Collect Historic Flow Information.** Available historic flow information will be collected for the Rio Sonoyta and its major tributaries within the watershed.
>
> **Watershed Hydrology.** A preliminary hydrological analysis of the Rio Sonoyta Basin will be conducted based upon available historic information related to climate, watershed size, soils, flows, and uses. Estimates will be made for runoff, flows, and groundwater recharge.

Personnel: The work for this project will be contracted. Resource management staff will assist with the data gathering.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 8 other projects listed in this plan. These are as follows:

ORPI-N-201 Determine the Geohydrology of Quitobaquito Springs
ORPI-N-202 Monitor Land Subsidence
ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed
ORPI-N-203b Investigate Groundwater Use on Tohono O'odham Lands ORPI-N-2034 Land Use Inventory of the Rio Sonoyta Watershed
ORPI-N-203e Evaluate Trends in Water Use in the Rio Sonoyta Watershed
ORPI-N-206 Define Characteristics of Regional Aquifers
ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-203c Surface Water Inventory of the Rio Sonoyta Watershed	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	1,000			
Other	25,000			
TOTAL	26,000			
Funds Available in Park Base	500			
Additional Funds Needed	25,500			

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-203d

2. Land Use Inventory of the Rio Sonoyta Watershed

3. Servicewide Issue: N12

4. Problem Statement: Insufficient information exists on land use in the Rio Sonoyta watershed, of which Organ Pipe Cactus National Monument is a part. The region is exposed to a multitude of threats and issues, impacting water and other natural resources. Land is managed by an array of governmental, private, and tribal organizations. The types and extent of land uses are not well known, particularly on the Tohono O'odham Reservation and in Mexico. Land management practices in one area could affect water availability throughout the watershed. A more thorough understanding of land uses within the watershed will provide for more effective management of the resources, and assist in mitigation of current and potential problems resulting from such land use.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This alternative will leave unanswered questions on land use within the Rio Sonoyta watershed, which may impact the natural resources of Organ Pipe Cactus National Monument.

6. Description of the Recommended Project or Activity: Conduct a Thorough Land Use Inventory of the Rio Sonoyta Watershed. This recommended action includes four primary components, including defining the watershed, collecting land use data, collecting ownership data, and conducting a land capability survey.

Define Watershed. The objective of this component is to define the boundaries of the watershed on available maps. At present, no single map of the complete watershed area exists, and therefore, two sets of maps will be used: one for the US lands; and one for the Mexican lands. The area of the watershed will be computed along with appropriate subareas. The resulting map will serve as a "base map" for the other components described below.

Identify and Delineate Land Uses. Land use data will be collected for the watershed area. Appropriate land use categories will be developed to encompass current activities present in the watershed area. Examples of these categories are: agriculture, grazing/range, riparian, streambeds, reserves, urban, etc. Visits will be made to various parts of the watershed to ascertain existing uses. The results will be delineated upon a copy of the base map of the watershed to be named: "Land Use Map."

Collect Land Ownership Data. Land ownership data of the watershed will be collected in concert with land use data. Ownership in the US pertains to Organ Pipe, the Tohono O'odham Reservation, and the Cabeza Prieta National Wildlife Refuge. In Mexico, however, ownership is divided between public and private entities. As far as possible, both private and public lands will be identified. The results will be delineated on a copy of the base map to be named: "Land Ownership Map."

Conduct Land Capability Survey. A land capability survey will be made of the watershed. Land capability will be based primarily upon soils, elevation and climate. The general soil associations found in the watershed will be identified. This information will be used in conjunction with elevation and climatic data to determine land capability. The results will be useful to identify different land characteristics such as productivity, erosion risk and drainage. Land will be classified according to its highest capability, taking into consideration applicable limitations. Land capability classes will be mapped along with appropriate symbols and legends.

Personnel: The work for this project will be contracted. Monument Resource Management staff will assist with the data gathering.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 8 other projects listed in this plan. These are as follows:

ORPI-N-201 Determine the Geohydrology of Quitobaquito Springs
ORPI-N-202 Monitor Land Subsidence
ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed
ORPI-N-203b Investigate Groundwater Use on Tohono O'odham Lands ORPI-N-203c Surface Water Inventory of the Rio Sonoyta Watershed ORPI-N-203e Evaluate Trends in Water Use in the Rio Sonoyta Watershed ORPI-N-205 Define Characteristics of Regional Aquifers
ORPI-N-207 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-203d Land Use Inventory of the Rio Sonoyta Watershed	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	1,000			
Other	55,000			
TOTAL	56,000			
Funds Available in Park Base	500			
Additional Funds Needed	55,500			

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-203e

2. Evaluate Trends in Water Use in the Rio Sonoyta Watershed

3. Servicewide Issue: N12

4. Problem Statement: Insufficient information exists on trends in ground and surface water use in the Rio Sonoyta watershed, of which Organ Pipe Cactus National Monument is a part. On-going monitoring along the monument's southern boundary has shown that continued urbanization and agricultural development in Sonoyta, Sonora, Mexico, on lands adjacent to the monument, annually depletes the groundwater aquifer at 2.5 times the recharge rate. Information on past, present and projected water uses in the watershed is needed to provide an understanding of development in the region and its associated impacts on the natural resources of the monument.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This alternative will leave unanswered questions on trends in ground and surface water use in the Rio Sonoyta watershed, which may impact the natural resources of Organ Pipe.

6. Description of the Recommended Project or Activity: Conduct an Evaluation of Trends in Water Use in the Rio Sonoyta Watershed. This recommended action includes three primary components, including evaluating historic, present, and future potential water use in the Rio Sonoyta watershed.

> **Historic Uses**. Historic water use data in the watershed will be compiled. Users and quantities will be identified, along with a descriptive history of water use. Documentation of formal claims will be included where possible.
>
> **Present Uses.** Present water use data for the watershed will be compiled. This will include the use of both surface and groundwater. Types of uses and respective quantities will be determined where adequate information is available and estimated where it is not. Historic data collected in previous studies of the watershed will form the database for the analysis of present water use in the basin.
>
> **Future Potential Uses.** Projections will be made of future water use in the Rio Sonoyta Basin. Separate projections will be made for the Tohono O'odham Nation, Organ Pipe and Mexico. An appropriate time horizon will be selected for the analysis (20 to 25 years). Future uses will be compared to projected available resources. Conclusions concerning water and land policies will be developed from comparisons.

Personnel: The work for this project will be contracted. Monument Resource Management staff will assist with the data gathering.

7. Compliance: This *project* is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 8 other projects listed in this plan. These are as follows:

ORPI-N-201 Determine the Geohydrology of Quitobaquito Springs
ORPI-N-202 Monitor Land Subsidence
ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed
ORPI-N-203b Investigate Groundwater Use on Tohono O°odham Lands ORPI-N-203c Surface Water Inventory of the Rio Sonoyta Watershed ORPI-N-203d Land Use Inventory of the Rio Sonoyta Watershed ORPI-N-206 Define Characteristics of Regional Aquifers
ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-203e Evaluate Trends In Water Use In the Rio Sonoyta Watershed	YEAR IN PROGRAM SEQUENCE			
	1St	2nd	3rd	4th
Personal Services	0			
Other	25,000			
TOTAL	25,000			
Funds Available in Park Base	0			
Additional Funds Needed	25,000			

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-204

2. Control Accelerated Erosion

3. Servicewide Issues: N06

4. Problem Statement: Anthropogenic erosion is evident in the vicinity of historic ranch sites where soils are of fine texture and where cattle trampling and grazing pressure was the strongest. Erosion problems are most severe at Dos Lomitas and Armenta Ranches, where 170 acres are affected. Widespread and persistent erosion from wind and water has occurred in these areas and resulted in permanent loss of soil fertility and infiltration capacity, and changes in vegetation communities.

In the thirteen or more years since cattle have been removed from the monument, erosion in these areas has shown no trend toward stability. Gullies that appear to stabilize after several dry years, are reactivated by one season of heavy rains, increasing in depth and extent. Heavy summer rains in 1991 initiated new headcutting in many channels.

Perennial grasses and forbs, except for unpalatable species not used by cattle, horses, and burros, are almost completely absent from problem areas. The lack of vegetative ground cover, either from grazing, roads, and attempts at farming has permitted large areas of critical gully erosion to develop unchecked. As the soil level drops, the landscape changes and erosion channel headcutting expands. Road maintenance is difficult as they are cut by gullies or experience severe erosion of the roadbed itself.

Small scale attempts at reducing active headcutting, by placing brush and rock in the cuts, have been tried on an experimental basis. Seven hundred acres of contoured water spreading dikes have been constructed in the vicinity of Blankenship Ranch and the Growler Valley. In 1968, badly eroded sites were inspected by representatives of the Soil Conservation Service and recommendations were made for a recovery plan in 1968. In the 1970's, 80's and 90's, monitoring studies have been conducted under the direction of Terrance Marsh (North Central College, Naperville, Illinois) to assess further headcutting and width increases in existing gullies at the north and south boundary areas. Indications that some stability had been attained and plant establishment was occurring in certain gully sections was encouraging. However, recent rains have reactivated all of the eroding channels.

In 1989, the NPS contracted with Great Western Research to study methods of controlling erosion on two sites. The result of this contract was a study entitled, "Erosion Control Studies at Armenta Ranch and Dos Lomitas", which recommended measures required to mitigate the eroded soils at both sites. At Armenta Ranch, near the north central boundary, the watershed was estimated to be 49 square miles in size and 20 miles in length. The affected area encompasses about 66 acres, and soil losses were estimated to range from 25 to 50 tons/acre/year. At Dos Lomitas, along the southeastern boundary, the watershed was estimated to be 13 square miles in size and 11.5 miles in length. This affected area is larger, totalling about 110 acres in size, and soil losses were estimated to range between 17 and 34 tons/acre/year.

Field observations identified two distinct and different erosion conditions: main channel erosion And side channel erosion. Mitigation measures were recommended for both erosion conditions, and .. nsisted of using small earthen dikes, larger brush and rock structures and limited channelization work The purpose of this project is to implement the recommendations of the contract study.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. Erosion of fine soils and the incision of small channels will continue and possibly accelerate.

6. Description of the Recommended Project or Activity: Implement the Study Recommendations. Follow the 1989 Study "Erosion Control Studies at Armenta Ranch and Dos Lomitas."

Armenta Ranch- Highest priority will be given to erosion problems in the side channels rather than in the main channel, and the following actions will be accomplished:

Side Channels. Initiate pilot program of installing small earthen dikes at the mouth of selected side channels from a total potential of 34 locations. Monitor effectiveness and compare with data from Marsh's project.

Main Channels. 1) Stabilize gabion structure at road and place additional rock downstream. 2) Install rock and brush structures just west of road. 3) Investigate the feasibility and practicality of diverting the north channel into the next adjacent channel. 4) Recreate the channel crossing the boundary road.

Dos Lomitas- Highest priority will be given to erosion problems in the side channels rather than in the main channel, and the following actions will be accomplished:

Side Channels. Initiate pilot program of installing small earthen dams at the mouth of selected side channels from a total potential of 49 locations. Monitor effectiveness and compare with data from Marsh's project.

Main Channel. This work will be the lowest priority and will include construction of additional rock and brush structures spaced in the main channels to slow water during smaller flows. The structure will be designed so that larger flows will overtop, leaving the materials in place.

Once eroding soils and channels are stabilized, long-term recovery should be possible. The impacts that initiated erosion, extensive overgrazing, have been eliminated from the monument.

Several additional areas exhibiting severely eroded conditions have been mapped and photographed as part of Mr. Marsh's study. Monument staff will be involved in the monitoring efforts to assess potential problems before (or as) they arise. Mitigation may be necessary in some areas, and may involve revegetation or other appropriate stabilization measures. Areas with fine soil texture prone to compaction and erosion (at both the north and south boundaries) need to be more intensively surveyed for problems. The full extent of the damage has not been quantified in recent years.

Personnel: The work for this project will be contracted. Resource management and maintenance staff will provide assistance.

7. Compliance: Environmental Assessment and Archeological Clearance will be required before the initiation of work.

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

9. Funding:

ORPI-N-204 Control Accelerated Erosion	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	1,000	500	500	500
Other	80,000	0	0	0
TOTAL	81,000	500	500	500
Funds Available in Park Base	0	0	0	0
Additional Funds Needed	81,000	500	500	500

Some long-term funding may be required for continued monitoring.

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-205

2. Develop and Implement Water Conservation Program

3. Servicewide Issue: N24

4. Problem Statement: Although the amount of water used by monument operations has been described as "a grain of sand among sand dunes", the actual amount used is not closely monitored. Even though the use is relatively small in comparison to Mexican agricultural demands, NPS credibility will be greatly enhanced if management makes an effort to most efficiently use the water necessary for our own operations.

Inholdings include the GSA owned Port of Entry Facilities and the privately owned Gringo Pass enterprise, both at Lukeville, Arizona. Both have active wells and sewage systems. Wells are not monitored for pumpage rates. Owners and operators of these inholdings may be encouraged to initiate water conservation efforts.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. Continue monument operations without a well developed plan of water conservation.

6. Description of the Recommended Project or Activity: Develop and Implement a Water Conservation Plan. During August, 1990, a drought contingency plan was developed for Big Bend National Park by Mark Flora of the NPS Water Resources Division. That plan defined alternative management actions that could be undertaken to reduce water consumption. The Big Bend plan provides a good starting point for water conservation efforts at Organ Pipe. The project will utilize existing expertise by working with consultants from the NPS Water Resources Division and outside specialists, such as the Phoenix and Tucson City Water Conservation Departments, to modify and implement the plan to suit Organ Pipe's specific needs.

Water Conservation Plan

Encourage a voluntary water conservation program and provide monument residents with an information fact-sheet on residential water conservation.

Install/calibrate water meters at key locations that would allow for the routine tracking of water use and identification of possible water line leakage. A minimum program would include metering water at the visitor center, visitor and volunteer campgrounds, at the dump station, and at individual residences or groups of residences.

Install/retrofit devices so that consumption is reduced to 1.5 gallons/flush for toilets, 2 gallons/minute (gpm) for showers and 1.5 gpm for personal use spigots. Install automatic shut-off faucets in all public restroom facilities.

Evaluate the need for contracting a leak detection survey. This activity is especially recommended for sections of distribution systems that are old, suspected of leaking, or are located in areas of potential water supply shortages.

Phase-out lawn areas, promote the use of native vegetation for landscaping activities, and require the use of drip irrigation systems where watering is essential.

Personnel: This work will be accomplished by monument staff with supplemental funding for equipment and supplies.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

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

9. Funding:

ORPI-N-205 Develop and Implement Water Conservation Program	YEAR IN PROGRAM SEQUENCE			
	1 st	2nd	3rd	4th
Personal Services	10,000	5,000		
Other	10,000	10,000		
TOTAL	20,000	15,000		
Funds Available in Park Base	0	0		
Additional Funds Needed	20,000	15,000		

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

NATURAL RESOURCE PROJECT STATEMENT

ORPI-N-206

2. Define Characteristics of Regional Aquifers

3. Systemwide Issue: N12

4. Problem Statement: It is not known whether the movement of groundwater through large regional aquifers affects the local groundwater basins in and around the monument. Some inter-basin flow is likely, but the existence of large regional flows has not been investigated.

Groundwater can move large distances, beneath several surface drainages and divides, if a gradient and pathway exist. The most conducive pathways, continuous expanses of porous or karst rock, are not known to exist in this area. A more likely pathway is flow through highly fractured rock. A possible origin of Quitobaquito Springs is the flow of groundwater through fractures in gneiss (Anderson and Laney 1978). Such fracture flow on a larger scale, from basin to basin, almost certainly exists due to complex and extensive faulting in the geologic past (Haxel, et al. 1984); but may not extend over large areas, or facilitate the movement of large quantities of water.

Further geologic work is needed to identify the existence of a regional aquifer and its influence on groundwater resources in the monument. A limited investigation is proposed because geologic conditions do not appear conducive to large regional groundwater movement. The knowledge provided would supplement the understanding of local aquifers and depletion of groundwater.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. Knowledge concerning the regional groundwater movements would remain very limited. Possible threats and impacts occurring to the regional aquifer, and its influence on local aquifers would remain unknown.

6. Descri • Lion of the Recommended Pro'ect or Activi : Characterize the Regional Aquifer. Examine existing geologic and groundwater data to determine if a deep regional aquifer system exists. This will involve a review of literature available in the US and Mexico. Once assembled, the information will be analyzed in an effort to determine the lateral and vertical extent of the aquifer, recharge and groundwater yields, major directions and pathways of flow, groundwater consumption and trends in the condition of the aquifer. A report would be prepared presenting this information.

Personnel: This project will be accomplished through an agreement with the USGS or through a private contractor.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 6 other projects listed in this plan. These are as follows:

ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed ORPI-N-203b Investigate Groundwater Use on Tohono O'odham Lands ORPI-N-203c Surface Water Inventory of the Rio Sonoyta Watershed ORPI-N-203d Land Use Inventory of the Rio Sonoyta Watershed ORPI-N-203e Evaluate Trends in Water Use in the Rio Sonoyta Watershed ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-206 Define Characteristics of Regional Aquifers	Year in program sequence			
	1 st	**2nd**	**3rd**	**4th**
Personal Services	15,000			
Other	3,000			
TOTAL	18,000			
Funds Available in Park Base	500			
Additional Funds Needed	17,500			

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-207

2. Update Water Resources Inventory and Monitoring

3. Servicewide Issue: N12

4. Problem Statement: The current inventory of surface water resources provides little information about water quality or trends. A long term monitoring program needs to be initiated, based on the existing inventory, that will include water quantity and quality.

The existing inventory (Brown et al. 1983) identified 84 surface water sources including 11 springs, 60 tinajas, 3 stock tanks, 7 watering troughs, and 3 sewage disposal ponds. The report maps all water sources and provides the following information on each source: location; elevation; classification (following Brown, et. al, 1983); naturalness; permanence; maximum capacity; brief history; remarks; and references. One of the reasons for this study was to assess the effects upon fauna and flora as pumpage from wells used for grazing leases terminated in about 1978. This study determined that the availability of surface water resources in the monument has changed during this century. Some water supplies have been lost, but the overall change is an increase in water sources available to wildlife, due to human development of artificial water sources.

The existence of many of the sources is tenuous and may be affected by relatively small climate changes. The availability of water varies substantially with season, and probably from year to year as well. These sources are critical to the existence of monument wildlife. Water is a fundamental component in understanding the natural processes occurring in the monument.

Little or nothing is known of the water quality of all but a few sources. Tinajas might be particularly vulnerable to airborne contaminants. These may be transported in regional air flow or from agricultural activities in adjacent Mexico.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. The monument will have no knowledge water quality for most sources and know way to identify or document trends in the availability or quality of monument waters. Opportunities to correct or avoid impacts to monument resources may be lost.

6. Description of the Recommended Project or Activity: Initiate a Cyclic Program of Water Resources Inventory and Monitoring. The purposes of the proposed action are to document long term and seasonal trends in water quality and quantity and to expand the existing water resources inventory to include water quality. Three components are proposed.

> The first year of the project will focus on study design. The design will identify sample sites, sampling protocols and schedules, and parameters for analysis. Some sampling will be conducted in order to identify existing conditions and to evaluate logistical constraints to facilitate the study design and produce accurate cost estimates. It is envisioned that the long term project will include the two components presented below. Funding requests may have to be revised once the design is completed.

Intensive flow measurements and sampling will be conducted every fifth year. This will include several flow measurements collected throughout the year from most, if not all, water sources in the monument. Water quality analysis will be consistent with the design developed during the first year of the project and will probably include basic constituents, metals, radionuclides and pesticides. Species and density of macro invertebrates might also be included.

A limited monitoring program will be conducted every year. This will include several volume measurements of selected sources and a few water quality analyses of key water sources. This program will provide current information on water availability and quality, and is much more likely to produce data for particularly wet or dry years than are the more intensive sampling cycles described above.

Personnel: This work will be conducted by the CPSU/UA in Tucson, AZ, in cooperation with the NPS Water Resources Division. Assistance will be provided by resource management staff.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project. An Environmental Assessment may be necessary for the collection of aquatic invertebrates.

8. Relationships: This project is related to at least 1 other project listed in this plan. These are as follows:

ORPI-N-200 Identify and Inventory Water-Related Resource Attributes ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-207 Update Water Resources Inventory and Monitoring	YEAR	IN PROGRAM SEQUENCE		
	1 st	2nd	3rd	4th
Personal Services	2,000	10,000	2,000	2,000
Other	30,000	40,000	12,000	12,000
TOTAL	32,000	50,000	14,000	14,000
Funds Available in Park Base	1,000	1,000	1,000	1,000
Additional Funds Needed	31,000	49,000	13,000	13,000

Long-term funding will be required for regular monitoring and periodic intensive analysis.

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-208

2. Develop a Geographic Information System Component for Water Resources

3. Servicewide Issue: N12

4. Problem Statement: An efficient and effective method for managing water resources data is needed. Existing information on ground and surface water resources is extensive. This includes locations of water sources such as springs, tinajas, and wells; twelve years of depth-to-water data for wells; the locations of and data from 17 sites where precipitation is measured; and the locations and depth-to-water data for 165 wells in the Sonoyta Valley adjacent to the monument. Implementation of other projects within the Water Resources Management Plan will yield more data, including, but not limited, to regional aquifer sizes, surface and groundwater use, and land subsidence.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This alternative would result in inefficient database management of water resources. The lack of a GIS component would also prevent production of high quality usable digital maps. The overall effectiveness of the WRMP would be diminished by a "No Action" alternative.

6. Description of the Recommended Project or Activity: Input Water Resources Data into a Geographic Information System and Compatible Databases. This will include digitizing all available water resources data so that it is compatible with other GIS data. Applications will be developed to utilize and model the data and to assist with management of resources. Specific water resources GIS activities include:

Digitize and analyze all ground and surface water resource data - springs, tinajas, wells, and Quitobaquito pond.

Digitize and analyze ground and surface water data in Sonoyta, Sonora, Mexico, adjacent to the south boundary.

Digitize and analyze ground and surface water data on the Tohono O'odham Reservation lands adjacent to the boundary.

Evaluate impacts of groundwater depletion on monument resources due to agricultural development on adjacent lands in Mexico.
Evaluate impacts to natural resources due to surface water use in the Rio Sonoyta watershed.

Digitize, evaluate, and analyze the Quitobaquito sensitive habitat area. Water quality and quantity monitoring is essential to the preservation and management of the endangered Quitobaquito pupfish and its habitat.

Incorporate information from other water resource projects as they are implemented.

Personnel: This work will be conducted by the CPSU/UA, the University of Arizona/Art Lab and Resource Management staff at the monument.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 13 other projects listed in this plan. These are as follows:

ORPI-N-200 Identify and Inventory Water-Related Resource Attributes
ORPI-N-201 Determine the Geohydrology of Quitobaquito Springs
ORPI-N-202 Monitor Land Subsidence
ORPI-N-203a Monitor Groundwater Resources in the Rio Sonoyta Watershed
ORPI-N-203b Investigate Groundwater Use on Tohono O'odham Lands ORPI-N-203c Surface Water Inventory of the Rio Sonoyta Watershed
ORPI-N-203d Land Use Inventory of the Rio Sonoyta Watershed
ORPI-N-203e Evaluate Trends in Water Use in the Rio Sonoyta Watershed
ORPI-N-206 Define Characteristics of Regional Aquifers
ORPI-N-207 Update Water Resources Inventory and Monitoring
ORPI-N-209 Monitor Riparian Ecosystems
ORPI-N-210 Identify Pollution Threats from Kuakatch and Cuerda de Lena Washes
ORPI-N-213 Monitor Precipitation Chemistry

9. Funding:

ORPI-N-208 Develop a Geographic Information System Component for Water Resources	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	15,000	10,000	5,000	
Other	10,000	5,000	5,000	
TOTAL	25,000	15,000	10,000	
Funds Available in Park Base	0	0	0	
Additional Funds Needed	25,000	15,000	10,000	

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-209

2. Monitor Riparian Ecosystems

3. Servicewide Issue: N12

4. Problem Statement: Valuable riparian vegetation and associated ecosystems are threatened by continued depletion of groundwater in the southern portion of the monument, due to agricultural development on adjacent lands in Sonora, Mexico. When the water table falls below the rooting zone of the plants they will lose productivity and possibly die. A monitoring program is needed to identify and document any loss of riparian vegetation.

Although no monument streams are perennial, plants make use of the additional water along ephemeral washes creating bands of riparian vegetation and, where the groundwater table is shallow enough, extensive thickets of riparian vegetation. Among the species of concern are mesquite *(Prosopis velutina)* and desert tree caper *(Atamisquea emarginata)* - which is a rare species with its northern range limit in Organ Pipe. These species utilize deep tap roots extending to the groundwater table to supply their nutrient and moisture needs and may now be facing a significant threat from the excessive use of groundwater in areas adjacent to the monument. On-going monitoring indicates that the groundwater aquifer in the Sonoyta Valley is being depleted at 2.5 times the recharge rate. There are several documented cases in Arizona where large stands of mesquite have died following the excessive withdrawal of groundwater. If such a drop in the water table were to occur these riparian ecosystems could be diminished or lost.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This alternative could result in the loss of riparian vegetation going undetected and undocumented.

6. Description of the Recommended Project or Activity: Implement Monitoring Program for Riparian Ecosystems. Study plots will be established riparian vegetation communities thought to fall into the following groups.

Groundwater supported, likely to experience declining water table
Groundwater supported, not likely to experience declining water table
Not groundwater supported.

Plants will be monitored for vigor, growth rate, water stress, species composition and density. The extent and composition of the vegetation will be mapped using aerial photography. Techniques will be developed and employed to accurately measure species composition and densities and the general vigor of the flora and fauna of all study plots. Techniques developed will be standardized for use in other desert park areas. These plots will be located in proximity to existing well and climate monitoring stations to utilize data collected from these sources.

Five riparian study plots and two non-riparian controls will be established to evaluate the effects of water drawdown from agricultural uses. Riparian control plots will also be established with permanent and visible corner markers for aiding remote sensing studies. Aerial photography will

be conducted at elevations necessary to map vegetation composition. Techniques will be developed and employed to accurately measure species composition and densities and the general vigor of the flora and fauna of all study plots. Techniques developed will be standardized for use in other desert park areas. These plots will be located in proximity to existing monitoring wells and meteorological stations to utilize data collected from these sources.

After establishment, the plots will be monitored annually. New aerial photography and mapping efforts are planned at five-year intervals, but this schedule may be revised based on monitoring of the water table and vegetation.

Personnel: The work for this project will be contracted through the Cooperative National Park Studies Unit at the University of Arizona. Resource management staff will assist with the data gathering.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 1 other projects listed in this plan. These are as follows:

- ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-209 Monitor Riparian Ecosystems	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	2,000	1,000	1,000	1,000
Other	25,000	5,000	5,000	5,000
TOTAL	27,000	6,000	6,000	6,000
Funds Available in Park Base	0	0	0	0
Additional Funds Needed	27,000	6,000	6,000	6,000

Long-term funding will be needed for continued monitoring.

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-210

2. Identify Pollution Threats from Kuakatch and Cuerda de Lena Washes

3. Servicewide Issue: N11

4. Problem Statement: Two intermittent streams, Kuakatch and Cuerda de Lena Washes, enter the monument at the northeast corner and along the northern boundary. There is concern that pollutants in surface or groundwaters could follow these drainages into the monument. A monitoring program is needed to determine if this is occurring.

The infiltration of flow from both these streams and alluvial groundwater into the monument provides an unquantified amount of recharge to the alluvial groundwater regime. Presently the lands in this vicinity are used for a small amount of grazing, and the impacts from such activities, if any, are unknown. If future uses such as grazing, agriculture, or land development occur in these areas, both quantity and quality of these water inflows are likely tp change. In the northeast corner shallow groundwater conditions probably exist near the boundary since an abandoned, shallow, dug well is located in this area. Kuakatch Wash and associated washes within the Tohono O'odham Reservation drain approximately 30 square miles to the east.

The surface water drainage of Cuerda de Lena Wash outside the northern boundary is approximately 110 square miles. The town of Why, AZ, is located in this area and the lack of water supplies here have historically restricted both town and area development. In addition, a plume of groundwater contamination may reach into the northern portion of the monument from the extremely large tailings pile located at the inactive copper mine near the town of Ajo. Any future activities in this area, particularly water or mineral development, could have effects upon the monument. Fortunately, few natural water sources exist here, and the only potable water supplies which could be affected by external inputs from the northeast and north are at Bates Well.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. The effect of current and any future external activities occurring within these drainages on the quantity and quality of monument water supplies will remain unknown.

6. Description of the Recommended Project or Activity: Establish Monitoring Program. This program will involve data collection on the quantity and quality of groundwater, using existing wells, and surface water entering the monument from the north and east. Data will be collected by an independent government agency at important hydrologic times during each year. Efforts will be made to obtain water level and quality measurements at neighboring wells on the Tohono O'odham Reservation and on other lands along the northern boundary.

Personnel: This project will involve personnel from both the USGS and the monument.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationship: This project is related to at least 1 other projects listed in this plan. These are as follows:

ORPI-N-208 Develop a GIS system component for water resources

Funding

OP^i-i 2 U identify Pollution Threats from kuakatch and Cuerda de Lena Washes	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Persona Services	1,000	1,000	1,000	1,000
Other	5,000	5,000	5,000	5,000
,I TOTAL	6,000	6,000	6,000	6,000
Funds Available in Park Base	0	0	0	0
Additional Funds Needed	6,000	6,000	6,000	6,000

Long-term funding will be required for continued monitoring.

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-211

2. Evaluate Flood Hazards at Bates Well

3. Systemwide Issue: N20

4. Problem Statement: The normally dry channels in the monument are subject to flooding and occasional flash floods, when flood waters can arrive with little or no warning. This hazard is recognized and drainages in the vicinity of headquarters and campground have been evaluated.

Historic structures at Bates well are threatened by flooding. Flooding to the floor of Henry Gray's house at Bates Well has been observed in the past. The establishment of a ranger station, including an employee residence, has been proposed in the past but is not planned for the near future. In spite of being somewhat remote, Bates Well is a popular area for primitive camping. People at Bates Well may be unaware of large storms on the Growler Wash watershed because it is large, approximately 300,000 acres, and extends several miles to the north, east and south. Flows Cherioni, Cuerda de Lena, and Kuakatch combine to form Growler Wash two miles above Bates Well. The active channel of Growler Wash, if it is like most large washes in the area, can be expected to move laterally or and periodically adopt a new course.

Flood hazard analyses is needed in order to assure compliance with Executive Order 11988 and to guide the management of the area. The evaluation of two drainages at Bates Well, Growler Wash and the wash north of the site, will be required if facilities there are to be occupied on a seasonal or full time basis by monument personnel.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This alternative is not acceptable, as it will result in the NPS not meeting the mandated requirements of E.O. 11988, thus placing the safety of staff and property in jeopardy.

6. Description of the Recommended Project or Activity: Conduct a Flood Hazard Analysis of the Bates Well Area. This action is needed in order to guide the management of historic zone and visitor and official use of the area. The flood hazard analysis of the Bates Well area should be conducted as prescribed in NPS Floodplain Management Guidelines.

Personnel: This project can be conducted by the NPS Water Resources Division for a one time cost of $6,000.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

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

9. Funding:

ORPI-N-211 Evaluate Flood Hazards at Bates Well	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	4,500			
Other	1,500			
TOTAL	6,000			
Funds Available in Park Base	0			
Additional Funds Needed	6,000			

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-212

2. Evaluate Abandoned Mine Tailings

3. Systemwide Issue: N10

4. Problem Statement: The extent of cyanide and metals contamination from some of the numerous mines has not been investigated. Residuals of cyanide may exist, and the leaching of high levels of metals may be occurring at some abandoned mine sites, particularly where the ore was milled or otherwise beneficiated.

Cyanide has been used for the extraction of gold since the turn of the century. For many years cyanide extraction was used after the ore was finely crushed. More recently, heap leaching has been used to extract gold from large volumes of piled ore. The waste from both of these processes has been shown to retain cyanide for many years in arid climates. Additionally, the crushing and processing of ore and waste rock releases metals that can reach toxic levels in soils and water.

The adverse effects of cyanide residuals and metals contamination include direct and indirect effects of chronic and acute toxicity. These are manifested as loss of vigor and reproductive potential among plants and animals, and neurologic and physiologic disorders in animals. Differential tolerance to these compounds can result in changes in species composition.

The monument has an inventory of 12 abandoned mine sites. Many of the over 160 dangerous openings have been closed with fencing or steel grates. No assessment has been conducted of the use of cyanide in the monument, including residuals that might be present or metals contamination.

5. Alternative Actions/Solutions and Their Probable Imp'tcts: No Action. This alternative will result in the continued lack of knowledge concerning this problem and continued possible impacts.

6. Description of the Recommended Project or Activity: Determine Threat Posed by Abandoned Mine Tailings. The past use of cyanide processing in the monument should be determined through an examination of historic records and an on-site examination of each abandoned mine site. Where cyanide process waste or other fine waste are found, soil samples should be collected and analyzed for cyanide and metals. The metals analysis should include iron, arsenic, selenium, manganese, copper, boron and zinc.

The project will identify remedial actions which may include; establishing vegetation on the material to reduce erosion, removing and disposing of the offending material, excluding visitors and wildlife from the site, and continued monitoring.

It is estimated that this project can be accomplished in one fiscal year for $6,500. $2,500 will fund monument staff who will perform records research, field inventory and sampling, and development of remedial action plans. The remaining $4,000 is necessary for analyzing an estimated 36 tailings samples.

Personnel: This project will be accomplished by resources management staff.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

Further actions to reclaim or stabilize polluting mine waste may require environmental assessments and historic compliance at the time a specific plan is developed.

8. Relationships: This project is not directly related to others in this plan.

9. Funding:

ORPI-N-212 Evaluate Abandoned Mine Tailings	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	2,500			
Other	4,000			
TOTAL	6,500			
Funds Available in Park Base	1,500			
Additional Funds Needed	5,000			

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-213

2. Monitor Precipitation Chemistry

3. Servicewide Issue: N20

4. Problem Statement: Data on precipitation chemistry is needed to provide an indicator of potential contamination of the inputs into the region's ground and surface water sources. This data will provide information on the spatial distribution and temporal trends in concentration and deposition of the major cations and anions in precipitation to support monument research on terrestrial and aquatic effects.

Since 1980 the monument has participated in the National Atmospheric Deposition Program (NADP) by establishing a monitoring site to evaluate precipitation. Rainfall is continuously monitored and weekly samples are evaluated at the monument for pH and conductivity when sufficient precipitation has occurred. Chemical variables measured at the NADP laboratory (Central Analytical Laboratory) in Champaign, Illinois include the following ions: calcium, magnesium, potassium, sodium, ammonium, nitrate, chloride, sulfate, and orthophosphate. A ten year database now exists on precipitation chemistry.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. This valuable information will not be available to assist in monitoring impacts to ecosystems.

6. Description of the Recommended Project or Activity: Continue to Monitor Precipitation Chemistry. An Aerochem Metrics precipitation collector and Belfort rain gauge are set-up near the headquarters. Precipitation is recorded on a rain gauge chart and will continue to be collected. The site will be serviced weekly according to NADP protocols. Products will include semiannual data reports and annual data summaries.

Personnel: This project will involve personnel from both the Central Analytical Lab and the monument.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is related to at least 1 other project in this plan. This is as follows:

ORPI-N-208 Develop a GIS System Component for Water Resources

9. Funding:

ORPI-N-213 Monitor Precipitation Chemistry	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	250	250	250	250
Other	0	0	0	0
TOTAL	250	250	250	250
Funds Available in Park Base	250	250	250	250
Additional Funds Needed	0	0	0	0

Long-term funding will be required for continued monitoring.

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

NATURAL RESOURCE PROJECT STATEMENT

1. ORPI-N-214

2. Monitor Wastewater Systems

3. Systemwide Issue: N24

4. Problem Statement: The wastewater management system consists of several small independent systems. Waste from the main monument campground, with 208 campsites (no hook-ups), a dump station and six restrooms, is disposed of in four open evaporative lagoons. There are five septic tank leach field systems serving the following:

Campground duplex residence
Group campground restroom
NPS residential area with 10 single family residences, a duplex, the community house, the resource center, and a 12 site Volunteer in Parks Campground
Visitor center and administrative offices
Maintenance shop

All sewage systems are currently functioning adequately. Regular inspections are necessary, however, to ensure that problems do not develop and go undetected.

5. Alternative Actions/Solutions and Their Probable Impacts: No Action. The monument could risk being out of compliance with state regulations or permitting a sewage leak to go unchecked.

6. Description of the Recommended Project or Activity: Monitor Wastewater Systems. The systems will continue to be operated in compliance with state regulations. The systems will be examined periodically for leaks and deteriorated conditions.
Personnel: This project will be accomplished by maintenance and resources management staff.

7. Compliance: This project is categorically excluded from NEPA compliance, Departmental Categorical Exclusions, 516 DM, Chapter 2, Appendices 1 and 7, U.S. Department of Interior. NHPA compliance under Section 106 is likewise not required for this project.

8. Relationships: This project is not directly related to others in this plan.

9. Funding:

ORPI-N-214 Monitor Wastewater Systems	YEAR IN PROGRAM SEQUENCE			
	1st	2nd	3rd	4th
Personal Services	4,000			
Other	0			
TOTAL	4,000			
Funds Available in Park Base	0			
Additional Funds Needed	4,000			

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

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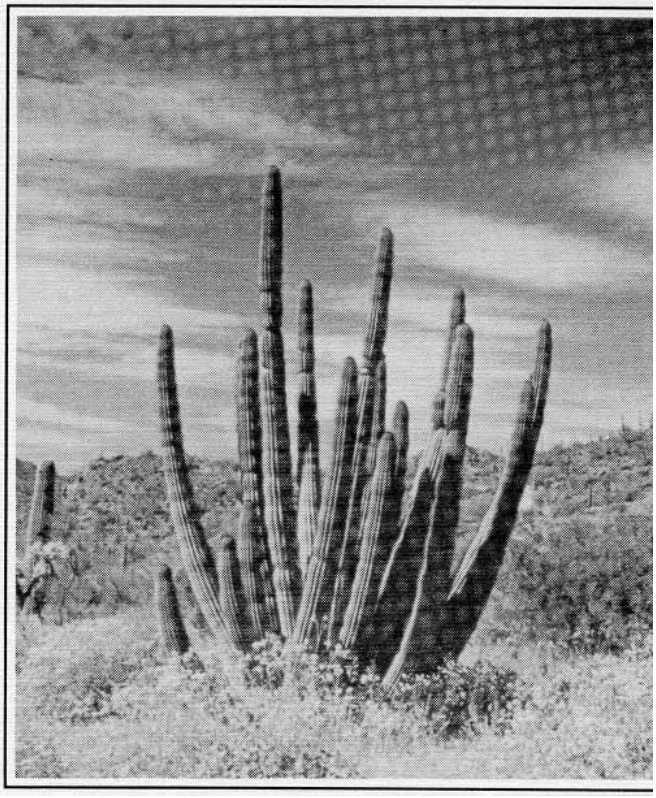
V. CONSULTATION AND COORDINATION

VI. APPENDICES



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VI. APPENDICES

APPENDIX A. List of Preparers

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APPENDIX B. Table 2. Groundwater Sources in Organ Pipe Cactus National Monument Includes Wells and Mine Workings that Contain Water

NUMBER (As on Water Res. Map)	LOCATION	SOURCE NAME	OWNERSHIP	DATE DRILLED	TOTAL DEPTH (FEET)	WATER LEVEL (FEET), DATE	SPECIFIC CONDUCTANCE, DATE	REMARKS
1	(C-15-7) 4 cc	No Name Well	NPS	?	131	Dry		Dry
2	(C-14-7) 35 aac	Daniell's Replacement	NPS	7/53	100	28.79 07/16/91	**530** 7/13/73	
3	(C-14-7) 35 aad	Unnamed Well	NPS	**1942**	80	**39.3** 4/12/50	400 7/13/73	
4	(C-14-7) **36** bbb	Henry Gray Well	State	**1976**	**?**	40.4 **3/29/81**		
5	(C-14-7) **35** adc	Daniell's Well	NPS	**1915**	**43**	37 9/30/17		Destroyed
6	(C-14-7) **36** bbc	**Bates** Well	State	1880?	82	40.0 9/30/17	470 7/13/73	Dug Well
7	(C-14-6) 31 dbd	Unnamed Well	NPS	1915?	200+	Dry 1915?		Dug Well, Dry
8	(C-14-6) 24 acb	Leo Rich Well/ Armenta Well #3	NPS	1930's	40	?		Dug Well, **Destroyed**
9	**(C-14-6) 24 dda**	Armenta Well #1	NPS	**7/15/35**	212	Dry 7/13/73		Dug Well, Dry
10	(C-14-5) **34 aaa**	NPS Test #1	NPS	**1940**	500	Dry **1940**		Dry Boring, De-**stroyed**
11	(C-15-4) 5 dab	NPS test #2	NPS	**1940**	**185**	Dry **1940**		Dry Boring, Dry

Table 2. Groundwater Sources in Organ Pipe Cactus National Monument (Continued)

NUMBER (As an Water Res. Map)	LOCATION	SOURCE NAME	OWNERSHIP	DATE DRILLED	TOTAL DEPTH (FEET)	WATER LEVEL (FEET), DATE	SPECIFIC CONDUC-TANCE. DATE	REMARKS
12	(C-15-4) 10 bca	Unnamed Well	NPS	1920's	7	7		Dug Well, Caved-in
13	(C-15-7) 20 bda	Powers Well	NPS	**1916**	**135**	Dry **1916**		Dug Well, Dry
19	(C-15-6) 15 bca 1	Cherioni Well #1	NPS	**1916**	72	Dry 10/1/17		Dug Well, Caved-in
20	(C-15-6) 15 bca 2	Cherioni Well #2	NPS	**1930**	150	Dry 7/14/73		Dry
25	(C-16-4) 6 abd	Alamo Well	NPS	19057	21	**8.78** 7/31 /91	800 **8/8/74**	Dug Well
28	(C-16-7) 1 cda	Acuna Well	NPS	**1929**	41	**35.5** 7/14/73	**5500** 7/14/73	Dug Well
31	**(C-16-8)** 24 **daa** 1	Jose Juan Orosco Well	NPS	**1908**	**29.6**	Dry 2/1 1174		Dug Well, Dry
32	**(C-16-8)** 24 **daa 2**	**Pozo Nuevo**	NPS	**7/53**	170	**42.37** 7/25/91	1800 2/1 1174	
33	(C-16-7) 30 cad	Cipriano Well	NPS	19007	57	**55.6** 9/30/17		**Dug Well, Caved-in**
34	(C-16-7) 27 **bad**	**Bonita Well**	NPS	**1937**	**36**	**26.34** 7/30/91	**620 2/9174**	Dug Well
39	(C-17-6) 1 **bab**	Red Tanks Well	NPS	**1939**	78	Dry **1939**		Dug Well, Dry

Table 2. Groundwater Sources in Organ Pipe Cactus National Monument (Continued)

NUMBER (As on Water Res. Map)	LOCATION	SOURCE NAME	OWNERSHIP	DATE DRILLED	TOTAL DEPTH (FEET)	WATER LEVEL (FEET), DATE	SPECIFIC CONDUC-TANCE, DATE	REMARKS
51	(C-17-8) **9** add	Corner Well	US-DOD	**8/49**	**97.8**	60.10 7/29/91	**2400** **2/6/74**	
52	(C-17-8) 11 dcd	Hocker Well	NPS	1924	18.7	Dry 7/29/91	2200 2/9/74	Dug Well, Dry
55	(C-17-7) 17 baa	Montgomery Well	NPS		20?	18 12/14177		Dry at Times
58	(C-17-7) 17 bdb	Jenkins Well	NPS	1930's	25	7		Dug Well, Caved-in
62	(C-17-7) 24 cdd	Pozo Salado	NPS	1 1 /40	1 1 1	Dry 7/29/91	2500 7/1 1 /73	Dug Well
63	(C-17-6) 24 cad	Victoria Mine Shaft	NPS		7	7		**Water Reported Several Hundred Feet** Down Shaft
64	(C-17-5) 18 dad	NPS HQS Well #2	NPS	6/54	305	Dry 6/54		Dry Boring
65(a) **65(b)**	(C-17-5) 17 abc 1 (C-17-5) 17 abc 2	NPS HQS Well #1 NPS HQS Well #5	NPS NPS	7/41 8/6/74	348 **420**	306, 7/41 325, 4/1 /90	714, **3/26/65** **700, 8/6/74**	Pump Replaced 3/90
66	(C-17-5) 17 acb	NPS HOS Well #4	NPS	11/1/57	**430**	320 **8/9/90**	720 **3/26/65**	Pump Replaced 3/90
67	(C-17-5) 17 dbc	NPS HQS Well #3	NPS	5/54	291	279 **5/54**		

Table 2. Groundwater Sources in Organ Pipe Cactus National Monument (Continued)

NUMBER (As on Water Ras. Map)	LOCATION	SOURCE NAME	OWNERSHIP	DATE DRILLED	TOTAL DEPTH (FEET)	WATER LEVEL (FEET). DATE	SPECIFIC CONDUC-TANCE, DATE	REMARKS
68	(C-17-4) **8** ddc	Unnamed Well	NPS	19207	80	Dry 19207		Dug Well, Dry
72	(C-18-6) 1 dbb 2	Bobby Gray Well	Private	7	7	**78.6 8/7/74**	900 **8/7/74**	
73	(C-18-6) 1 dbb 1	Dowling Well	Private	19157	129	**84.61** 7/29/91	910 7/1 1 /73	Dug Well, Improved in 1991
74	(C-18-5) 6 dbb	Stack Well	NPS	7	7	102.77 7/29/91	**930** 4/1 /81	
75	(C-18-5) 6 dca	Kalil Well	NPS	1 1 /66	**205**	**84.43 7/29/91**	800 7/10/73	
76	(C•18-5) 6 dcd	Lukeville Stores	Private	**1968**	160	**62 1968**	**850** 7/1 1 /73	
77	(C-18-5) 6 ddc 1	Lukeville Motel	Private	1964	120	60 **1964**	**850** 7/1 1 /73	
78	(C-18-5) 6 ddc 2	U.S. Customs and Immigration #3	US Customs & Imm.	1974	150	**68.84 5/5/76**	**825 5/5/76**	Desalinization Plant **Present**
79	(C-18-5) 7 aaa 1	Unnamed Well	Private	?	90	50		
80	IC-18-5) 7 aaa 2	Unnamed Well	Private	7	**84**	70.2 9/17/81		
81	(C-18-5) 7 aba 1	Blankenship Well #1	NPS	1917	**65**	**54.4** 10/3/17		Dug Well, Destroyed

Table 2. Groundwater Sources in Organ Pipe Cactus National Monument (Continued)

NUMBER (As on Wets Res. Map)	LOCATION	SOURCE NAME	OWNERSHIP	DATE DRILLED	TOTAL DEPTH (FEET)	WATER LEVEL (FEET). DATE	SPECIFIC CONDUC-TANCE, DATE	REMARKS
82	(C-18-5) 7 aba 2	U.S. Customs and Immigration #1	US Customs & Imm.	**1928**	90	60 **1928**		Dug Well, Destroyed
83	(C-18-5) 7 aba 3	U.S. Customs and Immigration #2	US Customs & Imm.	2/51	131	**61.5** 7/10/73	**830** 7/10/73	Destroyed
84	(C-18-5) 5 ddc	Camino dos Republicas Monitoring Well	NPS	11/16/88	250	**86.2** 11/18/88		Observation Well
85 4s.	**(C-18-5) 8 aca**	Lukeville Monitor-ing Well	NPS	11/17/88	250	71.7 11/18/88		Observation Well
86	**(C-18-5) 9 cad**	Gachado Well	NPS	19207	80	**60.6** 6/1 1 /52		Dug Well
87	(C-18-5) 11 cca	Unnamed Well	NPS	7	7	7		**Dug Well, Destroyed**
88	(C-18-5) 13 cba	Blankenship Well #2, or Dos Lomitas	NPS	**1918**	100	75.0 6/1 1 /52		Dug Well
89	(C-18-4) 19 aac	Salsola Monitoring Well	NPS	11/18/88	300	102.1 1217/88		Observation Well

APPENDIX C. Table 3. Surface Water Sources (Springs) of Organ Pipe Cactus National Monument

NUMBER (As on Water Resource Map)	LOCATION	SOURCE NAME	FLOW, DATE	SPECIFIC CONDUCTANCE, DATE	REMARKS
35	(C-16-6) 21 bac	Dripping Springs	2 gpm, 6/12/58	320 ppm, 4/1/81	Row **Estimated**
48	(C-16-4) 21 cbc	Bull Pasture Spring	2 gpm, 2/14/74	290 ppm, 2/14/74	Row Estimated
53	(C-17-7) 8 dbc	Williams Spring	2.8 gpm, 2/14/74	1250 ppm, **2/14/74**	Volumetric Row **Measurement**
54	(C-17-7) 18 **aab**	Burro Spring	2 gpm, 2/14/74		Row **Estimated**
56	(C-17-7) 18 aca	Muddy Spring	1 gpm, 12/14/76		Row Estimated
57	(C-17-7) 18 adc	Unnamed Spring	2 gpm, **3/30/81**	1750 ppm, **3/30/81**	Row Estimated
59	(C-17-7) 18 dba	Unnamed Spring	Dry, 4/1/81		
60	(C-17-7) 18 dac	**Quitobaquito** Springs	**33.5** gpm, 1/12/74	1100 ppm, **8/7/74**	Volumetric Row **Measurement,** New System
61	(C-17-7) 17 cdc	Aguajita Spring	1 gpm, 6/12/52	1300 ppm, 2/14/74	Row Estimated, Dry at Times

APPENDIX D. Table 4. Summary of Project Statements

PROJECT #	NAME	ISSUES[1]	PROBLEM	ACTIONS
ORPI-N-200	**Identify and Inventory of Water-Related Resource Attributes**	■ Water Rights	**Water resource attributes have not been identified.** This **information will be needed** when Arizona adjudicates water rights in the area.	Identify water-related resource attributes through literature and field research by an interdisciplinary team.
ORPI-N-201	**Determine the Geo-hydrology of Quitobaquito Springs**	■ Lack of Basic Understanding of Resources and Threats	The nature of the aquifer that supplies Quitobaquito Springs is not well understood. The aquifer is adjacent to, if not an integral part of, an aquifer that is being extensively pumped in Mexico.	**1. Assemble and interpret existing data on** flow, pumpage, precip. and groundwater levels. 2. Geologic map of Quitobaquito Hills. 3. Geophysical Survey of La Abra Plain. 4. Prepare Maps. 5. **Prepare** final report and design permanent monitoring network.
ORPI-N-202	**Monitor Land Subsidence**	■ Alteration of Natural Flow Regimes and Groundwater Levels	Land subsidence is expected to occur if groundwater table continues to drop. Current surveys are not sufficiently accurate to document subsidence.	A first order survey along the international boundary.
ORPI-N-203a	**Monitor Groundwater Resources in the Rio Sonoyta Watershed**	■ Alteration of Natural Flow Regimes and Groundwater Levels	Groundwater overdraft is occurring in adjacent Mexico. Groundwater level data has been collected for 12 years, this data collection needs to be continued.	1. Continuous monitoring at 3 wells along boundary. 2. Quarterly monitoring at 6 wells along boundary. 3. Quarterly monitoring of 4 wells away from boundary. 4. Monitor Flow of Quitobaquito.
ORPI-N-203b	**Investigate Groundwater Use on Tohono O'odham Lands**	**.** Alteration of Natural Flow Regimes and Groundwater Levels . Lack of Basic Understanding of Resources and Threats	Groundwater is used for agriculture and ranching on the Tohono O'odham Reservation. The amounts and impacts to ORPI are not known.	Inventory wells, depth to water and pumpage on the reservation. Establish protocols for continued data collection.

[1] As identified in Section I.E. Identification of Water Resources Issues.

Table 4. Summary of Project Statements (Continued)

PROJECT #	NAME	ISSUES	PROBLEM	ACTIONS
ORPI-N-203c	Surface Water Inventory of the Rio Sonoyta Watershed	■ Alteration of Natural Flow Regimes and Groundwater Levels ■ Lack of Basic Understanding of Resources and Threats	The extent of surface waters and their use on the Rio Sonoyta watershed are not known.	1. Inventory surface water use. 2. Collect historic flow information 3. Conduct hydrologic analysis of watershed to estimate runoff and recharge.
ORPI-N-203d	Land Use Inventory of the Rio Sonoyta Watershed	■ Alteration of Natural Flow Regimes and Groundwater Levels . Lack of Basic Understanding of Resources and Threats	Little is known of the type and extent of land uses on the Rio Sonoyta watershed. Most land use involve groundwater pumping that contributes to overdraft of the aquifer.	1. Define watershed boundary 2. Identify and delineate land uses. 3. Collect land ownership data. 4. Conduct land capability survey.
ORPI-N-203e	Evaluate Trends In Water Use In the Rio Sonoyta Watershed	■ Alteration of Natural Flow Regimes and Groundwater Levels ■ Lack of Basic Understanding of Resources and Threats	Although it is known that groundwater is being withdrawn at greater than the recharge rate, the data is limited in duration, scope and accuracy. Trends in water use cannot be accurately documented or predicted.	1. Quantify historic uses to the extent possible. 2. Compile present uses as identifies in other 202 projects. 3. Project future uses on the watershed in the 20-25 year time frame.
ORPI-N-204	Control Accelerated Erosion	■ Degradation of Water Quality and Resources	Past grazing in the monument has left 176 acres of the monument with greatly accelerated erosion. This occurred in two areas, Dos Lomitas and Armenta Ranch, and is not recovering naturally.	Both areas will be treated as recommended in a 1989 contracted study; including earthen dikes in channels at 83 locations and rock and brush structures. Natural seeding will be encouraged.
ORPI-N-205	**Develop and Implement Water Conservation Program**	■ Alteration of Natural Flow Regimes and Groundwater Levels	Although water use in the monument is relatively small, ORPI should set a good example if they ask other water users to conserve. The monuments water supply wells are threatened by lowering groundwater table.	1. Encourage voluntary conservation by providing information to residents and vis. 2. Install meters to track use and find leaks. 3. Retrofit with water conserving fixtures. 4. conduct leak detection survey if needed. 5. Phase to native landscaping and drip irrigation.

Table 4. Summary of Project Statements (Continued)

PROJECT #	NAME	ISSUES[1]	PROBLEM	ACTIONS
ORPI-N-206	Define Characteristics of Regional Aquifers	■ Lack of Basic Understanding of Resources and Threats	The potential for regional groundwater flow into or out of the monument are not well understood. Regional flows could augment of subtract from the local alluvial aquifers.	Analyze available literature to identify if regional aquifers exist and their implications for modeling the local aquifer systems.
ORPI-N-207	Update Water Resources Inventory and Monitoring	■ Lack of Basic Understanding of Resources and Threats	Current inventory includes little information on WQ and provides no indication of trends.	1. Study Design (first year) 2. Selected monitoring (every Year) 3. Intensive monitoring (every 5th *year)*
ORPI-N-208	Develop a GIS System Component for Water Resources	■ Lack of Basic Understanding of Resources and Threats	Current data handling for water resources is not efficient. A GIS system is being developed for the monument, water resources should be a major component.	1. Digitize ground and surface water inventory and monitoring data. 2. Digitize and analyze available water data from Mexico and Tohono O'odham Res. 3. Depict impacts to groundwater & other resources. 4. Digitize in detail the Quitobaquito Oasis.
ORPI-N-209	Monitor Riparian Ecosystems	■ Floodplain Management and Wetlands Protection	Riparian ecosystems along ephemeral washes are threatened by a lowering of the groundwater table. These are some of the most productive ecosystems.	Aerial photography and field mapping techniques will be used to establish study plots to monitor the status of riparian zones.
ORPI-N-210	Identify Pollution Threats from Kuakatch and Cuerda de Lena Washes	■ Degradation of Water Quality and Resources	Kuakatch Wash could be transporting surface and groundwater pollution from the Tohono O'odham Res. Cuerda de Lena wash could be doing the same from lands north of the monument.	Wells inside and outside of the monument on these watersheds will be monitored for water quality.
ORPI-N-211	Evaluate Flood Hazards at Bates Well	■ Floodplain Management and Wetlands Protection	Channels in the vicinity of Bates Well may be prone to flash flooding. Historic structures and visitors may be threatened.	A flood hazard analysis will be done at Bates Well in order to guide management of the area.

[1] As identified in Section I.E. Identification of Water Resources Issues.

Table 4. Summary of Project Statements (Continued)

PROJECT #	NAME	ISSUES'	PROBLEM	ACTIONS
ORPI-N-212	**Evaluate Abandoned Mine Tailings**	**.** Degradation of Water Quality and Resources	Cyanide, mercury and other metals contamination may exist at some of the several abandoned mine sites in the monument.	Determine mining methods used at each AML site. Where use of CN-, Hg, or extensive milling is suspected, conduct a chemical analysis of the mine tailings.
ORPI-N-213	**Monitor Precipitation Chemistry**	**.** Other Water Resources Issues	The monument has participated in the NADP program for precip. monitoring since 1980 to identify pollutants entering the monument through precip.	Continue participation in the NADP program.
ORPI-N-214	**Monitor Wastewater Systerns**	■ Other Water Resources Issues	There is a potential for contamination of groundwater through leaks in the wastewater treatment system.	Examine the system for leaks. Continue operation in compliance with state regs.

' As identified in Section I.E. Identification of Water Resources Issues.

APPENDIX E. Arizona Surface Water Quality Standards

Excerpts from Arizona Administrative Rules and Regulations, Title 18

R18-11-207. Explanation of Protected Uses

A. "Domestic water source" is the use of a surface water for a potable water source. Treatment by coagulation, sedimentation, filtration, disinfection, and other treatments may be required to yield a finished water suitable for human consumption.

B. "Full body contact" is the use of a surface water for an activity which normally causes the human body to come in direct contact with the water to the point of complete body submergence. Full body contact includes swimming, water skiing, skin diving, and other similar activities during which the water may be ingested accidentally and certain sensitive body organs, such as the eyes, ears, nose, etc. may be exposed to the water.

C. "Incidental human contact" is the use of surface water for an activity which may cause the human body to come in direct contact with the water, but normally not to the point of complete submergence. Incidental human contact includes fishing, hunting, trapping, boating, wading, and other similar activities, during which it is very unlikely that this water will be ingested, nor will critical organs such as eyes, ears, and nose normally be exposed to the water.

D. "Aquatic and wildlife" is the use of a surface water for the growth and propagation of fish, waterfowl, fur-bearers, other aquatic life, semiaquatic life, or wildlife. This water may be used for a cold water fishery, warm water fishery, wildlife habitat or other similar uses. Subcategories of uses under the general category of aquatic and wildlife may be recognized.

E. "Agricultural irrigation" is the use of a surface water for irrigation farming.

F. "Agricultural livestock watering" is the use of a surface water supply for livestock, including but not limited to beef cattle, dairy cattle, sheep, swine, horses, and poultry.

Allowable Limits for Protected Uses

PARAMETER	PROTECTED USES					
	DWS	**FBC**	**INC A&W**		**Agl**	**AgL**
FECAL COLIFORM MAXIMUM ALLOWABLE LIMITS [Colony-Forming Units (CFU/100ml)]						
1. GEOMETRIC MEAN (5 Sample Minimum)	1000	200	1000	1000	1000	1000
2. 10% OF SAMPLES FOR 30 DAY PERIOD	2000	400	2000	2000	2000	2000
3. SINGLE SAMPLE	4000	800	4000	4000	4000	4000
pH. ALLOWABLE LIMITS (Standard Units)						
1. MAXIMUM	NS	9.0	9.0	9.0	9.0	9.0
2. MINIMUM	NS	6.5	6.5	6.5	4.5	6.5
3. MAXIMUM CHANGE DUE TO THE ACTIVITIES OF MAN	NS	0.5	0.5	0.5	NS	NS
TRACE SUBSTANCES (Maximum Allowable Limits). (mg/1)						
ARSENIC (as As)	0.05D	0.05D	a	0.05D	2.0T	0.20 T
BARIUM (as Ba)	1.00D	1.00D	a	NS	NS	NS
BORON (as B)	NS	NS	a	NS	1.00T	NS
CADMIUM (as Cd)	0.O1T	0.O1T	a	0.01D[b]	0.05T	0.05T
CHROMIUM (as Cr Hexavalent Plus Trivalent)	0.05D	0.05D	a	0.05D	1.00T	1.00T
COPPER (as Cu)	1.00D	NS	a	0.05D	5.00 T	0.50T
LEAD (as Pb)	0.05D	0.05D	a	0.05D[d]	10.00 T	0.10T
MANGANESE (as Mn)	NS	NS	a	NS	10.00T	NS
MERCURY (as Hg)	0.0020T	0.0020T	a	0.0002T'	a	0.0100T
SELENIUM (as Se)	0.O10D	0.O10D	a	0.050T	0.02T	0.050T
SILVER (as Ag)	0.050D	0.050D	a	0.050D	NS	NS
ZINC (as Zn)	5.000D	NS	a	0.500D	10.00T	25.00T
AMMONIA (as Un-Ionized NH_3)	NS	NS	NS	0.02	NS	NS
CYANIDES (as Cyanideon & Complexes)	0.20	0.20	a	0.02 [d]	NS	0.20
PHENOLICS	0.005	0.005	a	0.005	NS	0.005
SULFIDES (Total)	NS	NS	NS	0.10 [d]	NS	NS

PARAMETER	PROTECTED USE				
	DWS	FBC and IHC	A&W	A&Wc	Ag1 and Ag L
TEMPERATURE ALTERATION (MAXIMUM ALLOWABLE LIMIT). NO PERSON SHALL RAISE THE NATURAL AMBIENT WATER TEMPERATURE MORE THAN DEGREES CELSIUS	NS	3.0	3.0	1.0	NS
TURBIDITY (MAXIMUM ALLOWABLE LIMIT) NO PERSON SHALL CAUSE THE TURBIDITY TO EXCEED NEPHELOMETRIC TURBIDITY UMTS (NTU)IN:					
STREAMS	NS	50	50	10	NS
LAKES	NS	25	25	10	NS
DISSOLVED OXYGEN NO PERSON SHALL LOWER THE DISSOLVED OXYGEN CONCENTRATION TO LESS THAN mg/1	NS	6.0	6.0	6.0	NS

NOTES:

a. Too little is known about adverse health effects for this use to adequately select a number.

b. For cold water fishery protected use the maximum allowable cadmium concentration is 0.001 mg/1.

c. Abbreviations used in this table: NS-NO STANDARD. T-TOTAL RECOVERABLE. D-DISSOLVED.

d. The allowable limit for this use is set at less than the current minimum level of detection. The limit necessary to adequately protect this use is lower. Until appropriate analytical procedures with lower detection limits are available, this particular limit is considered to be violated only when the number herein listed is reached or exceeded. Compliance requires concentrations be less than but not equal to the number listed.

APPENDIX F.

MEMORANDUM OF UNDERSTANDING
between

NATIONAL PARK SERVICE OF THE DEPARTMENT OF THE INTERIOR
OF THE UNITED STATES OF AMERICA
and

SECRETARIAT OF URBAN DEVELOPMENT AND ECOLOGY,
UNITED MEXICAN STATES
on

Cooperation in Management and Protection of National Parks
and Other Protected Natural and Cultural Heritage Sites

Memorandum of Understanding between the National Park Service of the Department of the Interior of the United States of America and the Directorate General for Ecological Conservation of the Natural Resources of the Secretariat of Urban Development and Ecology of the United Mexican States for Collaboration in the Conservation and Management of Protected Natural Areas and Cultural Heritage Resources; the National Park Service of the Department of the Interior of the United States of America, hereinafter referred to as "USNPS", and the Directorate General for Ecological Conservation of Natural Resources of the Secretariat of Urban Development and Ecology of the United Mexican States, hereinafter referred to as "D.G.C.E.R.N.":

Recognizing the advanced cooperation that exists between USNPS and D.G.C.E.R.N., hereinafter referred to as the "parties", in the rational use and management of natural resources and the establishment and conservation of protected natural areas that are their natural and cultural heritage;

Noting the mutual interest in the establishment and management of national parks and protected areas, that may be close or contiguous with the border, with the purpose of conserving ecosystems and promoting natural and cultural tourism;

Recognizing the advantages of facilitating, coordinating and amplifying efforts in conservation, management, development and research of natural and cultural resources in protected areas of mutual interest to both countries;

Recognizing the mutual interest in strengthening cooperation between the parties in the exchange of information and informal education activities for the management and operation of parks;

Noting the mutual objectives and interests of the parties declared in the conservation on nature protection and wildlife preservation in the Western Hemisphere of October 12, 1940; the Agreement of Scientific and Technical Cooperation between the United States of America and the United States of Mexico of June 15, 1972; the Convention Concerning the Protection of World Cultural and Natural Heritage of November 16, 1972; the convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region of March 24, 1983; and, the Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area of August 14, 1983;

Recognizing that the conservation policy in force in Mexico contemplates working in coordination and consultation with rural communities to conserve and rationally use and sustain natural areas and their resources, in a fashion that guarantees the preservation of biological diversity and the equilibrium of ecosystems, while at the same time allowing for integrated rural development;

Recognizing that the park policy in force in the U.S. is to conserve the scenery and natural resources and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations while, at the same time expand the role and involvement of citizens and groups in achieving the mission of USNPS and ensuring relationships with those whose lives and traditional practices are affected are considered in planning and management;

Recognizing that the biological diversity found in the two countries and the demographic pressure on natural areas and resources the implementation of conservation strategies and techniques unique to each country, seek, nonetheless, the joint development of appropriate strategies that support the maintenance and restoration of biodiversity in both countries, including those regarding the reintroduction of shared indigenous species extirpated in the respective national parks of the United States and Mexico;

The parties hereby agree to cooperate as set forth in this memorandum:

ARTICLE 1

This memorandum has as its objective the creation of a framework for the cooperation between the parties concerning: the conservation of protected natural areas and their biodiversity, the preservation of cultural heritage and natural resources, and when possible recognition of sustainable development alternatives for rural mexican communities located in those areas, the exploration of strategies for related cooperation with rural communities, citizens groups and scientific and other organizations acceptable to both countries within the legal framework of each country.

ARTICLE 2

1. The parties will establish a committee to formulate, orient and update cooperative activities to accomplish the objectives outlined in this memorandum. The committee will be chaired by the Director of the National Park Service for the United States of America and the Director General for Ecological Conservation of Natural Resources of the United Mexican States.

2. The committee will meet normally on an annual basis and alternating between the two countries, to review proposed and ongoing projects. Documentation for the projects will be reviewed, as well as a list of participants, will be exchanged two months prior to each meeting. The chairmen will decide by mutual consent whether to approve proposed projects and to continue ongoing projects.

3. Administrative procedures for the organization and work of the committee are set forth in the annex to this memorandum and may be amended by the mutual consent of the chairmen.

4. U.S. and Mexican coordinators and co-leaders, established within the annex, will meet as often as necessary.

ARTICLE 3

1. The forms of cooperative activities under this memorandum may consist of exchanges in information in natural and cultural heritage management and use; equal exchange of information regarding planning, management, and operations of parks and protected heritage sites and planning and conduct of courses, conferences, and symposia pertaining to the same; research in protected areas; personnel exchanges in fields of mutual interest within the scope of ongoing programs of both countries; and other forms of cooperative activities as mutually agreed upon.

2. The specific areas of mutually beneficial interest for cooperative activities may include, but are not limited to:

A. Establishment of natural and cultural heritage areas consistent with the policies and regulations of each country and their conservation, administration and development, and monitoring of protected natural and cultural areas, especially those contiguous to the international boundary.

B. Collaboration between specialized personnel from the parties in the management, development and administration of protected natural areas; in the research and management of natural and cultural heritage; and, in the planning and design of visitor programs and facilities.
C. Specialized projects related to the management of protected natural areas, including, but not limited to, arid and semi-arid environments and marine costal zones.

D. Exchange of information regarding the goals of this memorandum and in other areas mutually identified and accepted by the parties.

E. Development of educational and public information focusing on the environment and in understanding of protected natural areas and cultural heritage.

F. Completion of studies that will support, among others, the definition and formulation of strategies for the rational and sustainable use of natural resources.

G. Technical cooperation to protect, conserve, and maintain the flora and fauna within shared ecosystems protected by one or both countries.

3. For involvement requested by D.G.C.E.R.N. that extends into subjects outside the scope of the USNPS, the USNPS may, with the consent of D.G.C.E.R.N., and to the extent compatible with existing laws, regulations and policies of the United States of America, endeavor to enlist the participation of other organizations or agencies of the United States of America in the development and implementation of activities within the scope of this memorandum. For involvement requested by the USNPS that extends into subjects outside the scope of the D.G.C.E.R.N., the D.G.C.E.R.N. may, with the consent of the USNPS, and to the extent compatible with existing laws, regulations and policies of the United Mexican States, endeavor to enlist the participation of other organizations agencies of the United Mexican States, in the development and implementation of activities within the scope of this memorandum.

ARTICLE 4

Cooperation under this memorandum will be subject to the availability of funds and personnel of each party, and to the laws and regulations of each country. The nature and extent of funding of each project will be agreed upon by the parties before its commencement.

ARTICLE 5

Information transmitted by one party to the other party under this memorandum will be accurate to the best knowledge and belief of the transmitting party. The transmitting party does not warrant the suitability of the information transmitted for any particular use of or application by the receiving party.

ARTICLE 6

Nothing in this memorandum will be construed to prejudice other existing or future agreements concluded between the governments of the United States of America and United Mexican States, nor will it affect the rights and obligations of the two governments under international agreements to which they are a party. In particular, nothing will affect the objectives of the Water Treaty of 1944 and other boundary and water treaties and agreements in force between the two governments, nor shall it be understood to prejudice or otherwise affect the functions entrusted to the International Boundary and Water Commission.

ARTICLE 7

This memorandum will enter into force upon signature, and will remain in force for five years. It may be extended or amended by written agreement of the parties.

This memorandum may be terminated at any time by either party, upon written notification through diplomatic channels ninety days in advance of such termination. The termination of the memorandum will not affect the validity or duration of projects under this memorandum which are initiated prior to such termination.

Done at Mexico City, on this 30th. day of November, 1988 in duplicate in english and spanish, both texts being equally authentic.

SIGNED
For the National Park Service of the U.S. Department of the Interior; Mr. William Penn Mott, Jr., Director of the U.S. National Park Service

For the General Directorate for Ecological Conservation of Natural Resources of the Secretariat of Urban Development and Ecology; Dra. Graciela de la Garza, Director General

WITNESSED
Mr. Charles J. Pillroid, Jr., Ambassador of the United States of America to Mexico City

Fis. Sergio Reyes Lujan, SubSecretary of Urban Development and Ecology

ANNEX

Annex to the Memorandum of Understanding between the National Park Service and Directorate General for Ecological Conservation of Natural Resources

The National Park Service of the Department of the Interior of the United States of America and the Directorate General for the Ecological conservation of Natural Resources of the Secretariat of Urban Development and Ecology of the United Mexican States hereby agree to the administrative procedures for the organization and work of the committee as set forth in this annex.

ARTICLE 1

The program of cooperative activities between the parties will consist of projects and sub-projects. Documentation on all proposed and ongoing projects and sub-projects will be exchanged two months prior to each meeting and will be presented at the meetings of the committee for review and approval by mutual consent of the chairmen. Documentation, in support of proposed projects, may be submitted by either party and will be comprised of the following information:

Description of the project and sub-projects
Objectives
Methodology to be used in joint development
Calendar of events and date of conclusion
Equipment and personnel required
Estimated costs, itemized budget and methods of financing

All projects will consider and include, when possible, information workshops detailing the actions developed during the project for the personnel of both countries, as part of their structure.

ARTICLE 2

Each party will designate a coordinator to monitor the progress of ongoing projects and sub-projects between the meetings of the committee and to prepare the meetings of the committee.

ARTICLE 3

Each project and sub-project will be under the supervision of a U.S. and Mexican co-leader, who will be selected respectively by each of the parties. The co-leaders will be responsible for jointly developing and submitting, to their respective coordinators, documentation in anticipation of upcoming committee meetings. Such documentation will comprise a final report or report on the status, finances and objectives achieved within each ongoing project and sub-project.

ARTICLE 4

All joint projects and sub-projects must be approved by the chairman of the committee before they can be financed or changed by the coordinators of co-leaders.

ARTICLE 5

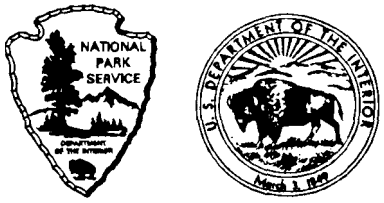
Those projects and sub-projects that, in the view of the chairmen, require special or urgent consideration, can be reviewed and approved by them at any time by mutual consent.

ARTICLE 6

Minutes of the meeting will be drafted in duplicate to be signed by the chairmen. The minutes will contain the proposed program of activities, including the approved cooperative activities, to be carried out between the meetings of the committee, as well as any other matters that have been discussed.

ARTICLE 7

The minutes of the committee will be transmitted to the mixed commission on scientific and technical cooperation between the United States of America and Mexico.



As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental an cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-77 June 1992