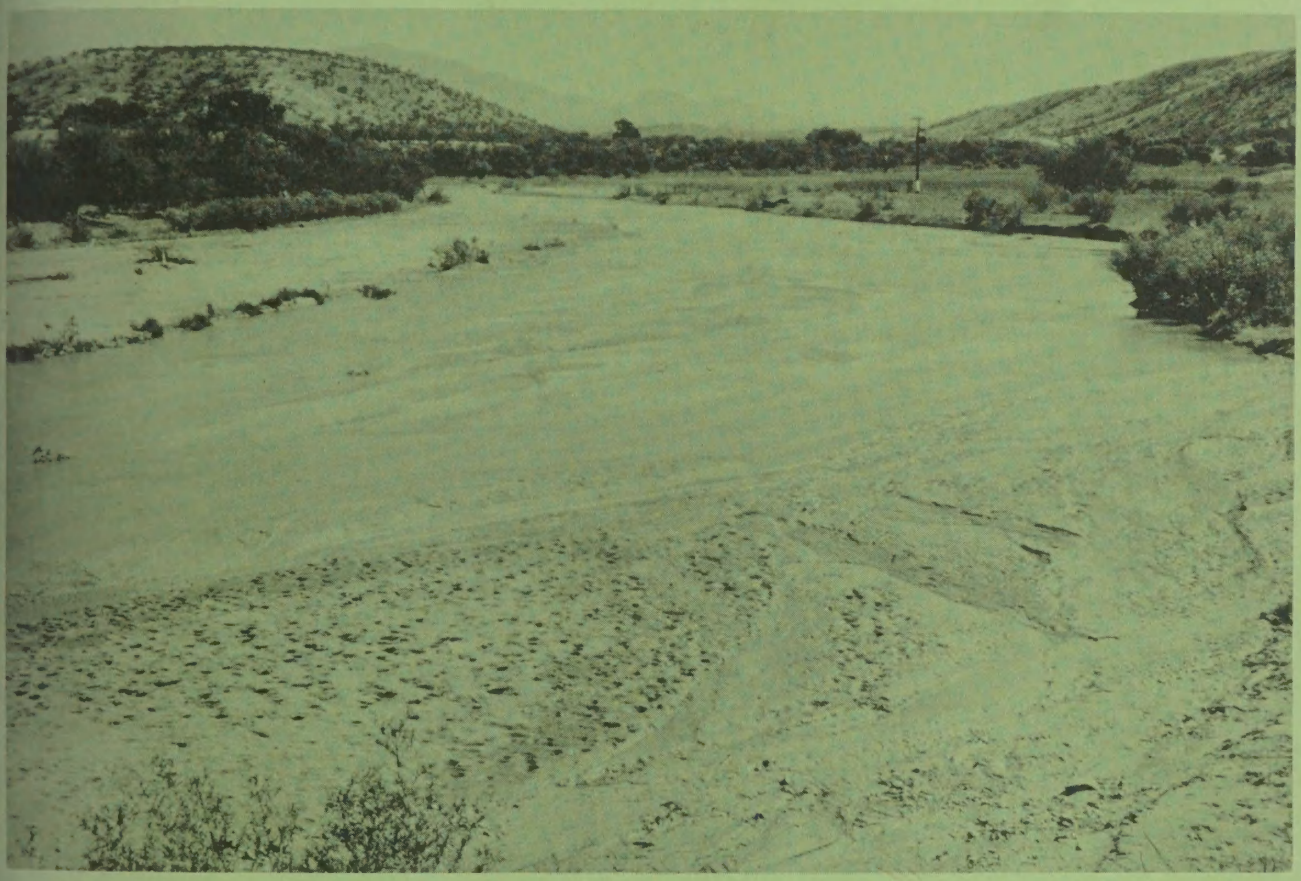
CRUZ - SAN PEDRO RIVER BASIN

ARIZONA

MAIN REPORT



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ECONOMIC RESEARCH SERVICE
FOREST SERVICE

In Cooperation with the

ARIZONA WATER COMMISSION

AUGUST 1977

USDA-SCS-PORTLAND, OR. 1978

SANTA CRUZ - SAN PEDRO RIVER BASIN
ARIZONA

MAIN REPORT

This report was prepared pursuant to Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 66, as amended and supplemented). The report presents information on the water and related land resources of the Santa Cruz-San Pedro River Basins in Arizona. It outlines problems and needs in the area, projects future conditions, and presents alternative plans to meet the needs of the people and to conserve and manage the natural resources. The study was conducted in general conformance with the U. S. Water Resources Council's Principles and Standards for Planning Water and Related Land Resources.

This report contains a summary of basic resource data for the basins. The reader is referred to a companion document, titled RESOURCE INVENTORY, SANTA CRUZ-SAN PEDRO RIVER BASINS, ARIZONA, U. S. Department of Agriculture, August 1977, for additional information on the basic resources in the basin.

Prepared by

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AUGUST 1977

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Cont'd)

LIST OF TABLES (Cont'd)

LIST OF TABLES (Cont'd)

LIST OF FIGURES

LIST OF PHOTOGRAPHS

MAPS

(Located in back of Report)

ADDENDUM

All of the plans that were formulated and presented in this report are evaluated using an interest rate of 6-1/8 percent. For fiscal year 1977 the interest rate to be used in evaluating federal and federally assisted water and related land resource projects was increased from 6-1/8 percent to 6-3/8 percent. It is the opinion of the authors that the rise in interest rate will not materially effect the basic relationships of beneficial and adverse effects presented in this report.

The following tabulation shows the effect of interest rate changes on those projects, presented in the various plans, that require benefit cost analysis. All of the projects produce net monetary benefits at 6-3/8 percent interest.

Effect of Interest Rate Changes

	6-1/8 Percent		6-3/8 Percent		7 Percent	
Project	Beneficial Effects	Adverse Effects	Beneficial Effects	Adverse Effects	Beneficial Effects	Adverse Effects
West Branch Santa Cruz Watershed	$110,600	$ 59,700	$ 99,100	$ 61,900	$ 94,100	$ 67,300
Cactus Forest Watershed	$676,700	$496,700	$693,600	$515,600	$737,400	$563,600
St. David Watershed	$119,100	$103,400	$117,300	$107,400	$112,900	$117,300
Leslie Canyon Recreation Measure	$229,800	$203,000	$229,800	$208,300	$229,800	$221,500
San Pedro Mesquite Bosque Recreation Measure	$145,100	$ 84,200	$145,100	$ 86,200	$145,100	$ 91,100

CHAPTER 1

SUMMARY

PURPOSE AND AUTHORITY

This report presents information on the water and related land resources of the Santa Cruz-San Pedro River Basins in Arizona. It outlines problems and needs in the area, projects future conditions, and presents alternative plans to meet the needs of the people and to conserve and manage the natural resources.

This report is based upon a cooperative study by the Arizona Water Commission and the U. S. Department of Agriculture (USDA). The study was initiated at the request of the Governor of Arizona. The Arizona Water Commission was designated to cooperate in this activity because the study is directly complementary to the State Water Plan and other activities in which the Commission is involved. Participation by the Department of Agriculture was authorized under provisions of Section 6 of Public Law 566, 83rd Congress, as amended and supplemented.

SUGGESTED USES AND VALUES OF THE REPORT

The report is developed from field surveys and analysis of material collected from many sources. It is hoped that the information contained herein will be used as a basis for wise decisions in the use and proper management of the resources of the area. The information can be used by county and city governments, natural resource conservation districts, irrigation and drainage districts, flood control districts, planning commissions, councils of government, and other local groups in planning land use and setting priorities for allocation of resources.

The report can be helpful in long-range planning by state and federal agencies for planning transportation, public utility systems, fish and wildlife improvements, parks and natural areas, water resources, forestry programs, range improvement programs, erosion and sediment control, flood prevention, water quality, and other natural resource uses.

The Arizona Water Commission can use the report in the development of the State Water Plan. The Coronado and Hohokam Resource Conservation and Development Projects may find the information useful in their program activities. The Office of Economic Planning and Development and councils of governments can use the information in preparation of the Section 208 of Public Law 92-500 water quality plans. The U. S. Department of Agriculture can use the report as the basis for directing its efforts in cooperation with natural resource conservation districts, watershed groups, and other resource development groups.

Information about soils, flood problems, and water resources can assist the consulting engineer and private developer in the selection of suitable development sites.

DESCRIPTION OF THE STUDY AREA

The total area of study is shown on the Location Map. It covers 16,501 square miles of southeastern Arizona and includes all or portions of six counties (Cochise, Graham, Santa Cruz, Pima, Pinal, and Maricopa), the Coronado National Forest, fourteen natural resource conservation districts, and five Indian reservations (San Xavier, Papago, Maricopa, Gila River, and San Carlos Apache). (See Land Ownership and Administration Map.) The city of Tucson is located near the center of the area. Interstate 10 and the Southern Pacific Railroad bisect the basin.

This report presents information in terms of two separate study areas, the Santa Cruz and the San Pedro areas.

The Santa Cruz study area includes the hydrologic drainage areas of the Santa Cruz River within Arizona and those south side tributaries of the Gila River between the mouths of the San Pedro and Santa Cruz Rivers. This portion of the total area of study covers 9,483 square miles.

The San Pedro study area covers 7,018 square miles and includes the Arizona portion of the San Pedro River, Willcox Playa (a closed basin) Whitewater Draw, and Black Draw hydrologic drainage areas.

About 1,200 square miles in the Republic of Mexico and 30 square miles in the state of New Mexico drain into, but are not included in, the study.

The arid, warm, and temperate climate is favorable for irrigated agriculture and light industry. Mean annual precipitation averages from 8 to 12 inches in the valleys and plains and from 16 to 20 inches in the generally inhabited parts of the mountains. The climate makes the area attractive as a tourist area and as a location for retirement communities. It is one of the fastest growing areas in the United States from a population standpoint. The area has many advantages for continued growth: abundance of land suited for many purposes, substantial mineral reserves, and a favorable climate. Water is the major natural resource in short supply. The area is essentially 100 percent dependent upon ground water. The city of Tucson is one of the largest metropolitan areas in the nation that is solely dependent upon ground water.

Climate zones range from the hot, dry Sonoran Desert with an elevation as low as 1,000 feet MSL to the cool, moist, conifer-forested mountains ranging between 6,000 to more than 10,000 feet MSL.

Distribution of land ownership and administration in the total area is shown in the following tabulation (refer also to the Land Ownership and Administration Map):

	Acres	Percent
Federal		
Forest Service	1,319,555	12.50
Bureau of Land Management	722,525	6.84
National Park Service	90,875	.86
Department of Defense	169,096	1.60
Federal by Others	7,880	.08
State		
State Trust	3,382,215	32.03
Other State	7,903	.07
County and Municipal	12,890	.12
Indian Trust	1,469,099	13.91
Private	3,378,394	31.99
Total	10,560,432	100.00

Population more than doubled from 1950 (225,200) to 1970 (495,500). The growth is occurring primarily in the cities. Per capita income is about 86 percent of the national average.

There are 330,100 irrigated acres in the Santa Cruz study area and 148,800 irrigated acres in the San Pedro study area. Sorghum grain is the main crop in the San Pedro area (70,278 acres) and cotton is the main crop in the Santa Cruz area (102,919 acres).

Beef cattle are practically the only class of livestock produced. The land used for grazing livestock is about 3.8 million acres in the San Pedro area and 4.3 million acres in the Santa Cruz area. Nearly one-half the land grazed falls in the desert grassland classification.

Ninety percent of the land cover is native vegetation. These plant communities include: riparian, pine-mixed conifer, oak woodland-chaparral, desert grassland, and Sonoran and Chichuahuan Deserts. There are 76,000 acres of nearly barren "badlands," which are severely eroded.

Geologically, the area is characterized by broad semi-arid to arid valleys oriented in a north to northwest direction and separated by mountain ranges rising abruptly above the "plains." The valleys consist of consolidated alluvial deposits and contain the principal water supplies.

The vast majority of streams can be classified as either ephemeral or intermittent flow streams. Most of the flow is in response to direct runoff from rainfall. Ground water sustains flow in only a few places.

Open water is rare in the San Pedro study area, consisting of about 10 acres of lakes, 115 miles of running streams, and 1,830 acres in 1,766 ponds. The Santa Cruz study area has about 2,577 acres of lakes, 70 miles of running streams, and 1,690 acres in 1,500 ponds. Many of the ponds in both study areas are seasonally dry and contribute little to fishery habitat and only seasonally to visual quality.

Ground water occurs under both artesian (confined) and water table (unconfined) conditions in the many types of aquifers. The depth to ground water beneath the land surface in 1970 is illustrated on the Depth to Water Map (back of report).

The Santa Cruz and San Pedro study areas were administratively divided into ground water basins for the purpose of evaluating water resources for the report. The location of these basins is shown on Figure 3.2. There are five of these ground water study areas in the Santa Cruz (Lower Santa Cruz, Upper Santa Cruz, Avra Valley, Altar Valley, and Gila River) and six in the San Pedro (Lower San Pedro, Upper San Pedro, Aravaipa Valley, Willcox, Douglas and San Bernardino Valley). The total dependable water supply, the overdraft, and the ground water in storage are shown in Table 5.3.

The ground water overdraft is that amount by which total depletions exceed dependable supply. Best estimates of the overdraft and the ground water in storage are summarized below:

Study Area and Ground Water Basin	Over-draft	Ground Water in Storage 0' to 700'	Ground Water in Storage 700' to 1200'
	(Thousands of Acre-Feet)		
San Pedro Study Area			
Douglas	64	24,000	7,600
Willcox	182	43,000	11,000
Aravaipa	0	-	-
Lower San Pedro	-	27,000	3,000
Upper San Pedro	-	36,000	12,000
San Bernardino Valley	0	-	-
Santa Cruz Study Area			
Avra Valley	119	9,800	6,200
Lower Santa Cruz	520	48,800	42,300
Upper Santa Cruz	133	28,800	28,800
Altar Valley	-	11,000	4,000

Total ground water in storage represents the relative quantities of this resource available. Using the estimated storage volumes and present rates of overdraft, enough water is stored in the aquifers between 0 and 700 feet beneath the land surface to last 236 years in the Willcox Basin, 375 years in the Douglas Basin, 82 years in the Avra Valley, 94 years in the Lower Santa Cruz Basin, and 210 years in the Upper Santa Cruz Basin. Lack of overdraft data on the other basins prevents estimating the period ground water would last in those areas.

BASIN PROBLEMS

The Santa Cruz-San Pedro River Basins were recommended by the state for study because of the critical water and related land resource problems. Those problems identified and addressed by this study are discussed in Chapter 3 and summarized on Table 3.9.

Flood damage is a major problem in the area. Desert conditions are highly conducive to flooding as the sparse vegetation does little to impede runoff. Most of the flooding is of the alluvial fan and riverine type. There are 87,630 irrigated acres in the San Pedro study area subject to inundation by the 100-year frequency storm and 186,100 irrigated acres in the Santa Cruz study area. Average annual flood damages to both agricultural and nonagricultural properties are $762,800 in the San Pedro study area and $1,484,700 in the Santa Cruz study area.

Erosion ranges from slight to severe. (See Erosion Classification Map.) Sheet and rill erosion account for the majority of total erosion, although there are large areas where stream channel and gully erosion is dominant.

Severe channel erosion is taking place in the deeply incised valley fill of the San Pedro Valley, near Picacho Peak where the Santa Cruz River is diverted into Greens Wash, on the Santa Cruz River just north of Tucson, and on McClellan Wash near Eloy.

The estimated total average annual sediment yield is 3,880 acre-feet. Of this, it is estimated that 1,895 acre-feet are discharged from the San Pedro River into the Gila River, much of which is diverted into the San Carlos Irrigation District at Ashurst-Hayden Diversion Dam. The average annual sediment yield at this dam is 5.4 million tons. Sediment removal operations to keep water flowing has cost $5,000,000 since 1934. The sediment is causing rapid depletion of storage capacity in Picacho Reservoir.

The renewable water supply of the study areas has been developed and utilized for decades. The expanding economy has been supported by the overdraft of ground water. The annual overdraft is estimated to be 246,000 acre-feet for the San Pedro study area and 772,000 acre-feet for

the Santa Cruz study area under normalized 1970 conditions. Increased pumping and farm operation costs associated with inefficient farm management have resulted in many acres lying idle each year. Only 60 percent of the total area developed for irrigation in Pinal County is cropped in any one year.

One apparent result of ground water overdraft has been the occurrence of earth fissures. (See Water Level Change Map.) This condition has disrupted natural drainage and irrigation water applications, damaged wells and canals, caused misalignment of highways, and endangered homes.

Surface water supplies for recreational purposes are extremely limited. The 1970 demand for boating and water skiing amounted to about 731,000 recreational activity occasions. Presently, surface water for recreation provides only 51,000 activity occasions. The limited rainfall and legal restrictions over downstream water rights limit the construction of new lakes.

Although crops may be grown with relatively high yields, there are problems in the development and maintenance of irrigated croplands. Some problems are localized, others are general. Such problems include inadequate water supply and irrigation systems; inefficient water management on the land; poor soil conditions; soil erosion; salt concentrations in the soil and in irrigation water; and flooding from intense storms. Such problems have caused 53,000 acres to be abandoned.

Approximately 65,000 acres, about 17 percent of the area used for crop production, is adequately treated and managed. Approximately 144,700 acres (37%) have irrigation efficiencies of 50 percent or less.

Reduced productivity of forage plants is the foremost range problem of the study areas. The potential production of the native grazing lands is about two and one half times the present production (Table 3.8). Of the many influences causing reduced productivity, displacement of grassland communities by unpalatable trees and shrubs is most prevalent.

Most problems involving the development of water for livestock are associated with ponds and charcos. High losses of impounded water are caused by seepage and evaporation. Displacement of water by sediment is another problem.

The threat of highly destructive wildfires is increasing in wilderness, primitive, and natural areas because of the ingrowth of trees and shrubs and the accumulation of forest debris. Appropriate management policies are needed to control fuels.

Subdivision of land is occurring years before any people arrive: these subdivisions are merely land speculation ventures. In 1974, remote

subdivided lands in Cochise, Santa Cruz, Pima, and Pinal Counties had the capacity to accommodate more than twice the rural population projected for the year 2000. (See the Vegetation, Croplands, Urban and Mining Areas Map in the back of the report.)

Of the 312,000 acres of remote subdivision land in the study area, 200,000 acres are estimated to contain soils that have moderate to severe limitations regarding septic tank filter fields, solid waste disposal and/or building foundations.

The major solid waste disposal problem involves residential, institutional, and industrial sources. The open dump disposal system is still used extensively as a form of solid waste disposal. Most of these open dumps are burned on an intermittent basis. There are sixteen communities utilizing sanitary landfills; however, not all can comply on a full-time basis with Arizona Department of Health Service regulations. There are twenty-five communities using the open dump system. This does not include communities on the Papago Indian Reservation. The large amount of uninhabited public lands make the control of "wildcat" dump sites difficult.

Natural beauty of the area has been impaired as roads, overhead power and communication lines, gas and oil pipelines, and mining activities encroach into relatively undisturbed areas. Establishment of remote subdivisions, which far outstrip demand, has been a source of severe disturbance and consequent loss of natural esthetic values. As an example, in the area west of Highway 666 between Pearce and Cochise, 20 square miles of one of the finest grassland areas in the State have been divided by eight east-west roads and four north-south roads per square mile.

Many historical and archeological sites are being abused by relic hunters and vandals. There are 82 sites in the San Pedro study area which are either included or considered as having potential for inclusion in the National Register of Historic Places. Only 12 of these sites have been provided with the means for adequate and continued protection. In the Santa Cruz study area, only 8 of 117 such sites are adequately protected. Some unprotected sites are also being abused and destroyed by development and the activities of vandals and amateur relic hunters.

The problems that directly affect the most species of wildlife are overgrazing, brush control with no provisions for wildlife, fencing, and the conversion of rangeland to other uses. Overgrazing, while not as severe a problem as it has been in the past, remains a major problem in many areas.

Habitat losses due to fire supression, single species pine plantings, mining activity, real estate development, and heavy recreation use

are problems in the non-wilderness section of timberlands. Abandoned and unreclaimed lands such as those used for mining and partially developed urban areas will be very slow to recover without planned rehabilitation.

Riparian vegetative communities are more subject to loss through man's activities than any other habitat type with the possible exception of wetland. Various vegetative manipulation programs contribute to loss of this vegetative type.

Wetlands in the area are primarily of Type 5, inland open fresh water, as described in the U. S. Fish and Wildlife Services Circular 39, "Wetlands of the United States." Natural wetland habitat is in extremely short supply. Many manmade water impoundment structures are designed and operated in such a manner that they provide very little wetland habitat. Unrestricted livestock use limits or eliminates growth of hydrophytic plants.

Problems associated with endangered and threatened animals and plants and their habitats are more or less defined in the several endangered species acts, the latest being the Endangered Species Act of 1973. There are several species of fish and wildlife that are either threatened or endangered. There is a need to preserve and protect these and other unique biotic species.

OBJECTIVES AND NEEDS

The problems as summarized in the previous section were translated into specific study objectives to identify the types of actions needed. These objectives, (second level components or preferences), are shown on Table 3.9. The net (without plan) needs for each of the study objectives are quantified on Table 7.1.

Specific objectives of the study are:

NATIONAL ECONOMIC DEVELOPMENT

1. Reduce floodwater, erosion, and sediment damages.

2. (a) Increase net returns from crop production.

   (b) Increase livestock forage production.

3. Create water-based recreation facilities.

ENVIRONMENTAL QUALITY

1. Maintain quantity and quality of fishery habitat and esthetics adversely affected by sediment deposition and channel erosion and modification.

2. (a) Establish wildlife oriented grazing use and brush management techniques on grazing land; silviculture and controlled burning techniques on forest lands; and food and cover plants on farmland which would preserve and increase plants important for wildlife productivity.

   (b) Provide additional wildlife water developments to complement existing habitat.

   (c) Provide for restoration of rangeland and forest land habitat when overused.

   (d) Promote restoration of abandoned irrigated land to natural conditions (Critical Ground Water Areas and Irrigated Lands Map).

   (e) Assure against unwise conversion of rangeland, forest land, and irrigated land habitat to other uses through adequate multiple use planning.

   (f) Insure proper multiple use considerations on grassland to improve habitat for unique biotic inhabitants.

3. (a) Discourage or prevent vegetation manipulation in riparian communities.

   (b) Restore quality riparian or riparian-type vegetation on areas which have been converted to other uses and lost through vegetative manipulations or are supporting low quality vegetation.

4. (a) Expand wetland facilities.

   (b) Install facilities and manage existing and all future ponds (stockwater, tailwater recovery ponds, etc.) to allow growth of wetland plants.

5. Maintain and protect areas of unique biotic significance.

6. Establish areas of natural beauty suited for restricted use.

7. Exhibit areas of accelerated erosion in various environmental zones for study by the general public.

8. Prevent fuel buildup on wilderness areas.

9. Prevent exploitation of archeologic and historic sites by amateur relic hunters and development.

10. (a) Manage vegetation in combination with structural measures to decrease sediment yield from critical areas.

    (b) Install streambank protection measures on rapidly eroding banks.

    (c) Reduce erosion by increased application of erosion control practices and measures on grazing lands.

11. (a) Provide solid waste disposal facilities for communities.

    (b) Clean up existing dumps.

Plan Elements and Plan Effects

This study identified two alternative plans, National Economic Development (NED) Plan A and Environmental Quality Plan (EQ) Plan B for the Santa Cruz and San Pedro study areas.

The specific plan elements and the plan effects are shown in Chapter 8. The Summary Table 1.1, titled Plan Summary, Page References to the Plan Contents, show the pages where information on the plans, plan effects, and program opportunities can be found in the report.

Summary of Plan A (See Table 8.1)

NED-1 Watershed protection projects in the St. David, West Branch of the Santa Cruz and Cactus Forest watershed (see Project Site Map).

NED-2(a) The application of Resource Management Systems (Conservation Land Treatment) on irrigated cropland (see Table Table 8.2).

NED-2(b) The application of grazing land resource management systems on native grazing lands (see Table 8.5).

NED-3 Develop water-based recreation areas at the San Pedro Mesquite Bosque and Leslie Canyons.

Summary of Plan B (See Table 8.16)

EQ-1 Apply resource management system on watersheds above live streams to reduce sediment and erosion.

EQ-2(a) Apply resource management system on grazing land, forest land, and irrigated cropland to improve wildlife habitat.

EQ-2(b) Install and improve 2,170 wildlife watering facilities.

EQ-2(c) Reseed and protect from overuse, 66,000 acres of historically overgrazed lands.

EQ-2(d) Return 50,000 acres of abandoned cropland to native vegetation.

EQ-2(e) Utilize multiple use planning on 154,000 acres to guard against unwise conversion to urban and utility uses.

EQ-2(f) Apply resource management system on grazing lands to improve habitat for unique biotic species.

EQ-3(a) Prevent removal of and improve riparian vegetation on 78,000 acres.

EQ-3(b) Restore riparian or riparian-type vegetation (39,000 acres).

EQ-4(a) Expand wetland areas at Willcox Playa and Bog Hole.

EQ-4(b) Fence 1,100 livestock ponds and other water areas to limit livestock access.

EQ-5 Transfer entirely to public ownership the unique areas of Aravaipa, Ramsey, Carr, Parker, and Gardner Canyons; Patagonia-Sonoita Creeks, and Blue Haven.

EQ-6 Establish 37,000 acres of restricted use areas in the Santa Catalina, Whetstone, and Santa Rita Mountains to be managed as "wilderness" type areas.

EQ-7 Establish 40 acres of erosion exhibit areas.

EQ-8 Control fuel buildup on 63,000 acres of wilderness, primitive, and natural areas through controlled natural fire and prescribed burning.

EQ-9 Provide restoration, excavation, stabilization and/or protection for 155 historic and archaeological sites.

EQ-10(a) Construct diversion and sediment storage structures on side drainages to the San Pedro River, Aravaipa Creek, and Greens Wash.

EQ-10(b) Install streambank protection measures on 144 miles of streams.

EQ-10(c) Apply resource management system on 746,000 acres of grazing land to reduce erosion.

Program Opportunities

Those programs or actions of the U. S. Department of Agriculture (USDA) that could be used to implement the alternative plans and satisfy total needs are discussed in Chapter 9 and summarized on Table 9.1.

There are other (non-USDA) programs that would help implement the plans and satisfy the needs. These programs are summarized on Table 10.1. The table also shows where special coordination between agencies and between programs is needed.

Recommended New Programs and Criteria

The USDA and non-USDA programs will not be able to completely satisfy all of the needs in the basin. There are physical, financial, legal, and institutional constraints against this attainment.

Recommendations related to new programs or changes in existing programs are discussed in Chapter 10.

TABLE 1.1

PLAN SUMMARY - PAGE REFERENCES TO PLAN CONTENTS

Problems and Components of Objectives (Chapter 3)	Plan Elements (Chapter 8)	Plan Effects (Chapter 8)				Program Opportunities	
		National Economic Development Account	Environmental Quality Account	Regional Development Account	Social Well-Being Account	USDA (Ch. 9)	Others (Ch. 10)
NED Page 3.47	Plan A NED San Pedro Page 8.3	San Pedro Page 8.9	San Pedro Pages 8.11 to 8.14	San Pedro Pages 8.18 to 8.22	San Pedro Page 8.29	NED pp. 9.3 to 9.4	NED pp. 10.5 to 10.7
	Plan A Santa Cruz Page 8.3	Santa Cruz Page 8.10	Santa Cruz Pages 8.15 to 8.17	Santa Cruz Pages 8.23 to 8.28	Santa Cruz Page 8.30		
EQ Pages 3.47 to 3.52	Plan B EQ San Pedro Page 8.57	San Pedro Pages 8.43 to 8.44	San Pedro Pages 8.47 to 8.50	San Pedro Pages 8.55 to 8.60	San Pedro Page 8.66	EQ pp. 9.4 to 9.8	EQ pp. 10.8 to 10.10
	Plan B EQ Santa Cruz Page 8.37	Santa Cruz Pages 8.45 to 8.46	Santa Cruz Pages 8.51 to 8.54	Santa Cruz Pages 8.61 to 8.65	Santa Cruz Page 8.67		

CHAPTER 2

INTRODUCTION

GENERAL

This is a report of a study of problems, needs, and opportunities for development and management of water and related land resources in the Santa Cruz-San Pedro River Basins. Information available in this report will be helpful in development of the Arizona State Water Plan. State and local governments and private agencies involved in developing water and related land resources of the basins should find information in this report very useful. This study provides agencies of the U. S. Department of Agriculture (USDA) with information to assess the value and impact of their ongoing programs, the potential for project developments, and the need for accelerated or new programs to better meet the needs of the people and conserve the basins' natural resources. The need for other agency programs or projects are also identified.

The report contains two alternative plans for conservation land treatment, recreation, fish and wildlife, esthetics, upstream flood prevention, irrigation water management, historic and archeologic resources, and solid waste disposal consistent with and complementary to ongoing water related developments and the objectives of the State Water Plan. The alternatives identified and evaluated provide a basis for an action program through the year 2000. Those projects which are needed in the next 30 years are identified.

A recommended or "preferred" plan has not been developed at the request of the Arizona Water Commission (AWC) because the AWC is preparing a detailed State Water Plan; the regional councils of governments are preparing water quality management plans under the provisions of Section 208 of Public Law 92-500; and the preparation of a state land use plan has been considered by the state legislature.

The basins were recommended by the State for study because of the critical water and related land resource problems. Although the average annual surface water yield is low, much of the cropland and a major portion of the urban areas are subject to flooding. Sediment derived from upstream areas causes extensive damage to downstream areas. These conditions, along with planned and anticipated development and growth, marked this as an area requiring early investigation.

Population growth is occurring primarily in the cities and somewhat in the rural non-farm group. Farm population is declining. Population in the area more than doubled between 1950 (225,200) and 1970 (495,500). Per capita income is about 86 percent of the national average.

Agriculture showed a decline in total earnings from 1950 to 1969. Manufacturing and government showed the most rapid growth over the two decades.

Data for this study were compiled, analyzed, and presented by employees of three USDA agencies; Soil Conservation Service, Economic Research Service, and Forest Service, as well as the Arizona Water Commission. Additional data and cooperation were provided by other federal and state agencies. Data, assistance, cooperation, and recommendations received from all agencies are greatly appreciated.

The study was carried out in general conformance with the U.S. Water Resource Council's Principles and Standards for Planning Water and Related Land Resources. Because these procedures were being formulated while the study was underway, they were not available to serve as guides in all aspects of the study. As they became available, however, a conscientious effort was made to follow them.

Data on the Central Arizona Project (CAP) water allocations were not available during the study. As a result, the approach for the area to be effected by CAP water allocations was different from the approach used for the area not to be effected. The effected area is referred to in this report as the Santa Cruz study area. It includes the hydrologic drainage areas of the Santa Cruz River within Arizona and those south side tributaries of the Gila River between the mouths of the San Pedro and Santa Cruz Rivers referred to as the Gila River Subarea (see Figure 3.1). The study area covers 9,483 square miles in parts of Pinal, Pima, Santa Cruz, Maricopa, and Cochise Counties. Because of uncertainties concerning water allocations, no projections were made for the Santa Cruz study area. Alternative plans are based on existing problems and needs. Ongoing programs, however, were taken into account.

The area not affected, referred to in this report as the San Pedro study area, covers 7,018 square miles and includes the Arizona portion of the San Pedro River, Willcox Basin, Douglas Basin, and San Bernardino Valley drainage areas. This study area lies in parts of Cochise, Graham, Santa Cruz, Pima, and Pinal Counties. Projections were used in developing alternative plans.

Participation of the USDA agencies was carried out in accordance with assigned responsibilities and was coordinated through the Washington Advisory Committee and a Field Advisory Committee. The personnel assigned to the river basin survey by the three USDA agencies functioned as a team, coordinated by a river basin staff leader, and under guidance of the Field Advisory Committee. The Soil Conservation Service had overall responsibility for the coordination of USDA inputs to the survey and was responsible for administration of USDA activities. The Forest Service

was responsible for aspects of the study relating to federal and non-federal woodlands and forested lands and the rangelands within and adjacent to the national forests. The Economic Research Service was responsible for basin-wide economic aspects and elements of the USDA program in the study.

Responding to the June 24, 1969, request by the Governor of Arizona, the USDA authorized a comprehensive water resources planning study of the Santa Cruz-San Pedro River Basins in Arizona, in cooperation with the Arizona Water Commission (formerly the Interstate Stream Commission). Participation of the USDA was authorized in July 1970, under provisions of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 66, as amended and supplemented). On November 11, 1971, the Governor of Arizona requested that the original area of study be enlarged to include the drainage areas of Whitewater Draw, the Willcox Playa, and Black Draw. The USDA agencies were given authority to include the additional area for study on December 9, 1971.

The statutes as revised in April 1971 for the state of Arizona vest in the Arizona Water Commission certain powers, jurisdiction, and authorities. Relevent to cooperative river basin studies, the revised Arizona statutes give authority to:

> Formulate plans and develop programs for the practical and economical development, management, conservation and use of the watersheds and waters of the state.
>
> Investigate works, plans or proposals pertaining to waters of the state, including management of watersheds, and acquire, preserve, publish and disseminate information relating thereto which the commission deems advisable.
>
> Receive and review all reports, proposed contracts and agreements from and with the United States or any agency thereof, other states, governments or representatives thereof and recommend to the governor and the legislature action to be taken on such reports, proposed contracts and agreements, and in the case of reports to take action on such reports where authorized by law, and review and coordinate the preparation of formal comments of the state on both the preliminary and final reports relating to water resource development of the Chief of Engineers, Department of the Army, the Secretary of the Interior, and the Secretary of Agriculture, as provided for in the Flood Control Act of 1944 (58 Stat. 887, 33 U.S.C. 701-1).
>
> Collect and investigate information upon and prepare and devise means and plans for the development, conservation, and utilization of all waterways, watersheds, subterranean waters, groundwater basins and water resources in the state and of all matters and

subjects related thereto, including irrigation, drainage, water quality maintenance, regulation of flow, diversion of running streams adapted for development in cooperation with the United States or by the state independently, flood control, utilization of water power, prevention of soil waste, storage, conservation and development of water for every useful purpose.

Measure, survey and investigate the water resources of the state and their potential development and may cooperate and contract with agencies of the United States for such purposes. The commission shall maintain a permanent public depository for existing and future records of stream flow, groundwater levels and water quality and other data relating to water resources of the state.

Recommend to the administrative heads of agencies, boards and commissions of the state, and the political subdivisions thereof, regulations to promote and protect the rights and interests of the state and its inhabitants in any matter relating to the waters of the state.

The Arizona Water Commission arranged for cooperation as needed with state and other federal agencies; provided information on the status and findings of state water planning; assisted with the compilation, analysis, and review of all data; helped in determining projected needs for future development; and participated in the analysis and review of study conclusions and project proposals.

REPORT FORMAT

The study was conducted in general conformance with the U. S. Water Resource Council's Principles and Standards for Planning Water and Related Land Resources. These procedures require planning in terms of two major objectives: (1) National Economic Development (to increase the value of the Nation's output of goods and services and improve national economic efficiency) and (2) Environmental Quality (to enhance environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems).

The format of this report is presented in light of these objectives and Principles and Standards procedures. As such, the format is relatively new and different than used in the past for most planning reports. The reader is referred to the Table of Contents for detailed guidance on the format and contents and the explanation as discussed herein.

First, all report chapters, 3-10, are interdependent and all contents relate to the quantified problems and objectives as presented in Chapter 3 and summarized on Table 3.9. These desired plan outputs are termed "specific components of the objectives." The remaining chapters relate to these components.

Chapter 4, Economic Development and Environmental Preferences, provides a basis for establishing future requirements and determining quantified net needs for Chapter 7. Selected future projections are made and called the "Desired Condition." (See Table 4.6.)

Chapter 5, Resource Base and Existing Programs, establishes the resources available. It describes the conditions, the potential, and the limitations of those resources related to the components of the objectives. This chapter also provides needed information on existing programs which will modify the use and availability of resources. Information in this chapter is used in establishing future without plan conditions (Chapter 6), in the determination of net needs (Chapter 7), and in selection of specific plan elements for the two alternative plans (Chapter 8).

Chapter 6, Present and Future Without Condition, is an expression of conditions which are anticipated as a result of developments and changes over time without any new projects or accelerated programs to solve problems which exist or arise. The projections are summarized on Table 6.3. Note that projections are not made for the Santa Cruz study area.

Chapter 7, Needs, defines the present and future net (without plan) needs (see Table 7.1). The values are a subtraction of values in Chapter 6 from values in Chapter 4. These are the needs to be addressed by the alternative plans in Chapter 8.

Chapter 8, Alternative Plans, presents two plans, the National Economic Development Plan A and the Environmental Quality Plan B. Beneficial and adverse effects of these plans are displayed in four accounts: 1. National Economic Development, 2. Environmental Quality, 3. Regional Development, and 4. Social Well-Being.

Chapter 9, Opportunities for USDA Programs, Development and Impact, presents the possibilities of implementing all or portions of the Chapter 8 Plans A and B through U.S. Department of Agricultural programs (see summary on Table 9.1.)

Chapter 10, Coordination and Programs for Further Development, discusses other (non-USDA) programs that might help implement plans A and B and where special coordination is needed (see Table 10.1). This Chapter also includes recommendations for new programs or criteria to satisfy the remaining needs.

ACKNOWLEDGMENTS

Many federal, state, and local organizations have contributed to the study by providing counsel and information and by participating in public meetings. Their cooperation and assistance is appreciated. Significant contributions were made by those organizations listed below.

Local

Counties
Irrigation Districts
Irrigation and Drainage Districts
Municipalities
Natural Resource Conservation Districts

Private

Defenders of Wildlife
Smithsonian Institution

State

Arizona Bureau of Mines
Arizona Environmental Planning Commission
Arizona Game and Fish Department
Arizona Outdoor Recreation Coordinating Commission
Arizona State Department of Health
Arizona State Land Department
Arizona State Parks Board
Arizona State University
Arizona Water Commission
Office of Economic Planning and Development
Cooperative Extension Service
University of Arizona

Federal

U.S. Department of Agriculture

Agricultural Research Service
Agricultural Stabilization and
Conservation Service
Economic Research Service
Farmers Home Administration
Federal Extension Service
Forest Service
Rural Electrification Administration
Soil Conservation Service
Statistical Reporting Service

U.S. Department of the Army

Corps of Engineers
Fort Huachuca Military Reservation

U.S. Department of Commerce

Bureau of the Census
National Weather Service

U.S. Department of the Interior

Bureau of Indian Affairs
Bureau of Land Management
Bureau of Reclamation
Fish and Wildlife Service
Geological Survey

U.S. Department of State

International Boundary and
Water Commission

U.S. Department of Transportation

Bureau of Public Roads

Other Federal

National Science Foundation
Kitt Peak National Observatory
U.S. Department of the Air Force

CHAPTER 3

PROBLEMS AND OBJECTIVES

INTRODUCTION

Information gathered by the Arizona Environmental Planning Commission through public hearings was particularly valuable in gaining insight into the problems and needs as viewed by society.

Inventories made during the study included pertinent data on use, productivity, and characteristics of the land; quality, quantity, and use of water; and socio-economic characteristics of the population. Identification of problems and needs was refined by comparing resource uses with resource availabilities and limitations. A discussion of the identified problems follows:

PROBLEMS

Flood Damages

Floods over extensive areas occur infrequently in the desert low-lands. Rainfall is scanty in normal years. Even during periods of heavy storm activity, rainfall amounts are extremely variable. The probability is low that either high intensity or large volumes of rain will fall over an extensive drainage area. As a general rule, the floodwaters are derived from only a part of a drainage basin. Both flood volumes and peaks are influenced by the sizes of areas affected by storms.

The desert conditions are highly conducive to flooding when rainfall does occur. The sparse vegetation does little to impede runoff, promote infiltration, and prevent soil movement.

The Generalized Flood Prone Areas Map (back of report) shows general locations of flooding, but more detailed studies are necessary to identify flood problems at a specific location. This is especially true in areas designated as alluvial fan flood plains.

Agricultural Damage

The majority of the floodwater damages to agriculture (see Table 3.1 and photographs 1-4) caused by inundation, sediment, and erosion occur in tributaries to the Santa Cruz River and the Gila River Subarea, the drainage area of Willcox Basin, and the Douglas Basin, drained by Whitewater Draw (see Figure 3.1). The San Pedro Valley sustains relatively little damage to agriculture, and damages in the San Bernardino Valley are negligible, because only small amounts of land are developed in these areas.

Most of the flooding in the prime damage areas is of the alluvial fan and bottom land type. In this type of flooding runoff from the mountains and steeper fans flows toward the flatter areas, inundating farmlands and improvements. Crop growth is often stunted or destroyed, irrigation facilities are damaged, and normal farm operations are disrupted. Although nearly all of the lands in the alluvial fans are subject to flooding, only a portion would be inundated from any given flood.

Non-Agricultural Damage

Non-agricultural damages (see Table 3.2 and photographs 5-7) include inundation, erosion, and sediment damages in (1) developed commercial and residential areas, (2) remote subdivisions (planned and being developed), and (3) other developments such as roads, bridges, utilities, etc. Of the total average annual damages of $1,327,900, about $709,000 (53 percent) occur in the Santa Cruz study area, $410,600 (31 percent) occur in the Douglas Basin, $134,000 (10 percent) in the Willcox Basin, and $74,300 (6 percent) in the San Pedro Basin. The San Bernardino Valley has no known damages.

FIGURE 3.1- Surface Water Study Areas and Locations of Gaging Stations in the Santa Cruz-San Pedro River Basins.

EXPLANATION

▲ 4800
Gaging Station
(See Tables 2-3, 2-4, and 2-5)

Drainage Divide

1. Gila River Subarea
2. Santa Cruz River Basin
3. San Pedro River Basin
4. Willcox Basin
5. Douglas Basin
6. San Bernardino Valley Area

TABLE 3.1

AGRICULTURAL

Acres Subject to Flooding and Average Annual Damages Incurred
by Sub-Basin, Santa Cruz-San Pedro River Basins
1970

Item	Surface Water Study Area 1/				
	San Pedro Study Area			Santa Cruz Study Area 3/	Total
	Willcox	Douglas	San Pedro		
	(acres)				
ACRES SUBJECT TO DAMAGES					
Irrigated Acres in Flood Prone Areas	114,600	40,000	5,400	349,350	509,350
Irrigated Acres in Flood Plain Inundated by the 100-year Frequency Storm	62,030	21,350	4,250	186,100	273,730
Average Annual Irrigated Acres Flooded	12,370	4,270	170	37,220	54,030
	(Dollars)				
AVERAGE ANNUAL FLOOD DAMAGES 2/					
Irrigated Land	$292,200	$102,600	$ 5,600	$621,900	$1,022,300
Other Agricultural Improvements	264,700	90,300	7,400	862,800	1,225,200
TOTAL DAMAGES	$556,900	$192,900	$13,000	$1,484,700	$2,247,500

1/ Damages insignificant in San Bernardino Valley.
2/ Includes damages from inundation, erosion, and sediment.
3/ Includes damages occuring in the Gila River Subarea.

Source: River Basin Staff, Soil Conservation Service.

Photograph 1. A lettuce crop was completely lost when a section of dike (foreground) broke, allowing floodwater to inundate the field behind the dike. Notice flood flow damage to the ditch on the left side of the field. *(SCS Photograph)*

Photograph 2. Even though the above cotton crop was not lost, this flooding caused a significant reduction in yield. *(SCS Photograph)*

Photograph 3. Flood damage to a concrete-lined irrigation ditch (Whitewater Draw). *(SCS Photograph)*

Photograph 4. Floodwater completely destroyed sections of this dike. Lettuce crop in foreground was destroyed. Note light colored sediment deposits. *(SCS Photograph)*

TABLE 3.2

NON-AGRICULTURAL

Acres Subject to Flooding and Average Annual Damages Incurred by Sub-Basin, Santa Cruz-San Pedro River Basins 1970

Item	Surface Water Study Area 1/				
	San Pedro Study Area			Santa Cruz Study Area 3/	Total
	Willcox	Douglas	San Pedro		
	(acres)				
Developed Residential and Commercial-Acres Existing	350	5,750	1,450	63,500	71,050
Developed in 100-year Flood Plain	250	1,150	50	18,050	19,500
Average Annual Acres Flooded	50	100	-	3,600	3,750
Being Developed in 100-year Flood Plain	15,900	16,300	10,700	162,300	205,200
	(Dollars)				
Average Annual Flood Damages - Developed Residential & Commercial Areas 2/	$ 43,800	$381,100	$60,800	$481,200	$966,900
Remote Subdivisions	14,100	8,600	2,600	7,100	32,400
Subtotal	$ 57,900	$389,700	$63,400	$488,300	$999,300
Other Developments	$ 76,100	$ 20,900	$10,900	$220,700	$328,600
TOTAL	$134,000	$410,600	$74,300	$709,000	$1,327,900

1/ Damages insignificant in San Bernardino Valley.
2/ Includes damages from inundation, erosion, and sediment.
3/ Includes damages occuring in the Gila River Subarea.

Source: River Basin Staff, Soil Conservation Service.

Photograph 5. Flooded streets prevented residents from leaving or returning to their homes (Casa Grande). *(SCS Photograph)*

Photograph 6. Costly cleanup, repairs, and replacement of damaged items will follow the receding floodwater. *(Tucson Daily Citizen Photograph)*

Photograph 7

Floodwater damage to businesses in Tucson on August 20, 1959.
(Tucson Daily Citizen Photograph)

Erosion and Sediment Damages

The term erosion is defined as the detachment of soil and rock particles by water, wind, ice, or gravity. Sediment is the product of erosion and is defined as solid material that has been detached and is being transported or has been deposited (see photographs 8 and 9).

Erosion

Erosion in the basins ranges from slight to severe. The lower rates are occurring on nearly level irrigated croplands and on the forested and well-grassed areas which are usually found at higher elevations. Severe erosion is taking place in the deeply incised valley fill of the San Pedro Valley. Moderately severe erosion is occurring along Altar Wash and the upper reaches of the Santa Cruz River. Such erosion appears to be largely the result of climatic changes and unstable geologic conditions. Destruction of vegetation by overgrazing has made erosion in these areas more severe, but the impact of over-grazing is not easily separated from geologic erosion. Additionally, man's diversion of water has resulted in small local areas of severe erosion in the Lower Santa Cruz Basin.

Four major types of erosion are recognized: (1) sheet and rill, (2) stream channel and gully, (3) flood plain scour, and (4) piping. Sheet and rill erosion account for the majority of total erosion, although there are large areas where stream channel and gully erosion is the dominant process. Stream channel and gully erosion account for substantial portions of total erosion in the San Pedro, Aravaipa, and Altar Valleys. Severe channel erosion is also occurring near Picacho Peak where the Santa Cruz River is diverted into Green's Wash, on the Santa Cruz River just north of Tucson, and on McClellan Wash near Eloy. (See the Erosion Classification Map in the back of the report.) Less severe but significant channel erosion is occurring along Whitewater Draw, Black Draw, Greenbush Creek, Babocomari River, Sopori Wash, and Santa Rosa Wash. Except for isolated localities, stream channels in the remaining parts of the basins are relatively stable.

Scarring of the landscape and the accumulation of waste and tailings, associated with open-pit mining operations, present locally severe erosion problems. These areas contribute sediment and chemical pollutants to streams. There are more than 41,000 acres in such uses in the Santa Cruz-San Pedro River Basins. (See the Vegetation, Croplands, Urban, and Mining Areas Map in the back of the report for location of mining lands.)

Arizona has no statute governing the reclamation of surface-mined private lands. Abandonment of major mining operations (e.g. Phelps-Dodge Corporation in the Bisbee area) will require considerable treatment to control erosion. Phelps-Dodge is presently making field tests of

Photograph 8. Erosion pavement reduces erosion on this soil. *(SCS Photograph)*

Photograph 9. Large blocks of soil lie on channel bottom following severe streambank erosion. *(SCS Photograph)*

plant species and soil amendments for this purpose. Considerable success has been achieved by the Pima Mining Company in vegetating steep tailing slopes south of Tucson. Reclamation is planned in conjunction with mining operations by the American Smelting and Refining Company in the Casa Grande vicinity. It is assumed that reclamation of mined lands will be achieved through implementation of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500).

Accelerated erosion and reduced grazing use of some of the best grasslands has resulted from speculative real estate sales. The impact goes beyond subdivision boundaries, as sediment derived from eroded road systems within the subdivided area is deposited in downstream areas. Gullies, initiated by improper road construction, often advance headward into surrounding areas. Recent legislation discourages future real estate speculation. Lands that are already subdivided in excess of needs and have road systems established, however, will require conservation treatment to reduce the residual effects.

Floodwaters sweeping across irrigated cropland usually result in scour damage. While this type of erosion accounts for only a slight portion of total erosion, it is highly important monetarily. Scoured areas in cultivated fields must be filled with soil and releveled in order to maintain proper irrigation grades.

Piping is a process of subsurface erosion. Soil material is removed by seepage water flowing through subsurface channels or "pipes." This process is common in the San Pedro Valley alluvial fill. It ultimately becomes part of the gully systems as surface soils collapse into the "pipes."

Five erosion classes are recognized in this report. (The location and relative size of each class are shown on the Erosion Classification Map. Table 3.3 lists the characteristics and average annual erosion rate for each class. Table 3.4 shows the area in each class and average annual total erosion by subarea. Photographs 10-15 are representative of erosion classes occurring within the study area.)

TABLE 3.3

CHARACTERISTICS AND EROSION RATES BY CLASS

Santa Cruz-San Pedro River Basins

Class	Characteristics	Average Annual Erosion Rate (Ac. Ft./Sq. Mi.)
1.	Incised valley alluvium: gully erosion predominant over sheet and rill erosion; numerous headcuts; piping common; steep slopes; mostly barren; no protective coarse fragments on surface; some silty, saline soils.	>4.50
2.	Incised valley alluvium: severe gully erosion; some piping; steep slopes; very sparse vegetation to barren; little or no protective coarse fragments on surface; some silty, saline soils.	1.50-4.50
3.	Incised valley alluvium: sheet and rill erosion predominant; some active gully erosion; well defined sand bed channels; steep to moderate slopes; sparse desert shrub cover; protective coarse fragments on surface; gravelly soils.	0.75-1.50
4.	(a) High alluvial fan deposits: minor channel erosion; steep gradient channels with coarse bedload; moderate to steep slopes; desert shrub and poor grass cover; well developed protective coarse fragments on surface; gravelly soils.	0.35-0.75
	(b) Low alluvial fan deposits: minor gully erosion; broad, sand filled channels; gentle slopes; desert shrub and poor grass cover; surface mostly protected by coarse sand and fine gravel; medium and fine textured soils.	

TABLE 3.3, CHARACTERISTICS AND EROSION RATES BY CLASS (Cont'd)

Class	Characteristics	Average Annual Erosion Rate (Ac. Ft./Sq. Mi.)
	(c) Arid mountains composed of granite and schist: minor gully erosion; rocky channels; steep slopes; desert shrub and poor grass cover; gravelly, cobbly, and stony soils; substantial area in rock outcrop.	
5.	(a) Nearly level valley floors: little or no gully erosion; poorly defined channels; desert shrub, grassland, or irrigated crop cover; little or no coarse fragments on surface; fine and medium textured soils. The only significant erosion occurs as flood plain scour.	<0.35
	(b) Subhumid mountains: little or no gully erosion; rocky channels; conifer forest, oak woodland, or good grass cover; gravelly, cobbly, and stony soils; substantial area in rock outcrop.	

Source: River Basin Staff, Soil Conservation Service

TABLE 3.4

EROSION CLASSES AND AVERAGE ANNUAL TOTAL EROSION

Santa Cruz-San Pedro River Basins [1]

Study Area and Subarea	Erosion Class [2] 1	2	3	4	5	Average Annual Total Erosion [3] (Ac. Ft.)	(Ac. Ft./Sq.Mi.)
	(Square Miles)						
San Pedro Study Area							
Douglas Basin and San Bernardino Valley	-	-	-	906	670	619	0.39
Willcox Basin	-	-	-	948	705	648	0.39
San Pedro River	30	270	417	2572	500	4059	1.07
Subtotal	30	270	417	4426	1875	5326	
Santa Cruz Study Area							
Santa Cruz River and Gila River Subarea upstream from Rillito	-	-	121	2339	734	1574	0.49
Santa Cruz River downstream from Rillito	1	11	113	3079	3085	2440	0.39
Subtotal	1	11	234	5418	3819	4014	
TOTAL	31	281	651	9844	5694	9340	

1/ Excludes drainage area in Mexico.
2/ Dash (-) indicates not significant.
3/ Rounded to closest significant number.

Source: River Basin Staff, Soil Conservation Service

Photograph 10. Erosion class 1, erosion along San Pedro River near St. David. Areas of class 1 erosion are too small to be shown on the Erosion Classification Map. *(FS Photograph)*

Photograph 11. Erosion class 1 (background) and class 4 (foreground). *(SCS Photograph)*

Photograph 12. Erosion class 3 in San Pedro Valley where erosion pavement protects steep slopes. Class 4 occurs on gently sloping lower areas which are well protected by grass. *(SCS Photograph)*

Photograph 13. Erosion class 2 in San Pedro Valley near St. David. Note lack of erosion pavement on steep slopes. *(SCS Photograph)*

Photograph 14. Erosion class 5 on gently sloping desert grassland. *(FS Photograph)*

Photograph 15. Erosion class 4 on mountain slopes and pediment in Sonoran Desert. *(FS Photograph)*

Sediment

Most of the streams of the area transport sediment only during infrequent flows which occur mainly in response to intense summer thunderstorms. Such flows normally contain high concentrations of suspended and bedload sediment. Very large flow events may inflict tremendous sediment damages on lands and improvements. Because of infrequent occurrence and short duration of large flows, the average annual sediment yield for much of the area is relatively low.

The estimated total average annual sediment yield is 3,880 acre-feet. Of this, it is estimated that 1,895 acre-feet are discharged from the San Pedro River into the Gila River, much of which is diverted into the San Carlos Irrigation District at Ashurst-Hayden Diversion Dam; 315 acre-feet enter the Republic of Mexico via Whitewater Draw and Black Draw; 330 acre-feet are deposited in Willcox Playa; 1,180 acre-feet are delivered to the Gila River by the Santa Cruz River; and 160 acre-feet reach the Gila River subarea. (See Table 3.5 for estimates of average annual sediment yield at various locations and photographs 16 and 17 for examples of sediment damage.)

The base flow of the San Pedro River upstream from Charleston is normally clear, but floodflows carry moderately high concentrations of sediment. The rate of sediment yield increases downstream from Charleston because of highly active dissection of the valley fill. At Winkelman, just above the mouth of the San Pedro River, the maximum daily suspended sediment concentration measured by the USGS is 123,000 mg/l; and the estimated total average annual sediment yield, including bedload, is 0.5 acre-feet per square mile.

The San Pedro River contributes a very large percent of total sediment load of the Gila River at the Ashurst-Hayden Diversion Dam. (See photographs 18 and 19.) Nearly all Gila River sediment originating upstream from the mouth of the San Pedro River is deposited in San Carlos Reservoir. Of the estimated total average annual sediment yield of 5.4 million tons 1/ at the diversion dam, an estimated 3.9 million tons 2/ are derived from the San Pedro River watershed. All flows at the Ashurst-Hayden Diversion Dam, with the exception of infrequent floodflows, are diverted to the San Carlos Project for irrigation. Large amounts of sediment are removed mechanically from behind the diversion dam and from the canal system. Such removal to keep water flowing at the diversion has cost

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1/ Based on flow duration-sediment rating curve analysis for Gila River at Kelvin (1963-71) by Soil Conservation Service.

2/ Based on flow-duration-sediment rating curve analysis for San Pedro River at Winkelman by Soil Conservation Service.

TABLE 3.5

SEDIMENT YIELD

Santa Cruz-San Pedro River Basins

Study Area and Location	Average Annual Sediment Yield 1/ (Ac. Ft.)	(Ac.Ft./Sq. Mi.)
San Pedro Study Area		
Whitewater Draw and Black Draw at the International Boundary 2/	340	0.20 4/
Willcox Playa 3/	330	0.20 4/
San Pedro River at Mouth	1,895	0.50 5/
Santa Cruz Study Area		
Santa Cruz River at Mouth	1,230	0.13 4/
Gila River Tributaries between San Pedro and Santa Cruz Rivers	160	0.39 4/

1/ Includes estimate of sediment yields from Mexico portions of drainage areas (Whitewater Draw - 109 sq. miles; San Pedro River - 696 sq. miles; Santa Cruz River - 395 sq. miles).

2/ Tributaries of Rio Yaqui in Mexico.

3/ Closed basin. Sediment does not leave study area.

4/ Based on Erosion Classification Map and estimated ratio of sediment yield to total erosion by River Basin Staff, Soil Conservation Service.

5/ Based on Soil Conservation Service analysis of U. S. Geological Survey gage records on San Pedro River at Winkelman.

Photograph 16. Sediment will have to be removed from irrigation ditch before next irrigation. *(SCS Photograph)*

Photograph 17. Workers trying to save peach tree from sediment deposit in the Douglas Basin. *(SCS Photograph)*

Photograph 18. Ashurst-Hayden Diversion Dam: Dredge in right background is continuously removing sediment near inlet to Florence-Casa Grande Canal. *(SCS Photograph)*

Photograph 19. Downstream along Florence-Casa Grande Canal in immediate vicinity of Ashurst-Hayden Diversion Dam. Note sediment (right) which has been dredged from canal. *(SCS Photograph)*

about $5,000,000 since 1934. Irrigating with this sediment laden water causes deposition which necessitates releveling of fields and reduces the infiltration rate making adequate irrigation difficult if not impossible. A portion of the sediment load is causing rapid depletion of storage capacity in Picacho Reservoir, a small regulating reservoir and a habitat for waterfowl. The reservoir has been dredged and rebuilt once to maintain storage capacity.

After construction of the proposed Buttes Dam on the Gila River, a unit of the authorized Central Arizona Project, nearly all the sediment yield from the San Pedro River will be trapped. The San Pedro sediment problem would be transferred from the San Carlos Project to Buttes Reservoir. Costly storage for a large volume of sediment must be provided to avoid encroachment on conservation storage. Also, fish habitat created by the reservoir will be degraded, and the visual quality of the water body will be impaired during periods of heavy inflow.

The Santa Cruz River has a well defined channel and efficiently transports its sediment load in the reaches upstream from its confluence with Brawley Wash. Downstream, however, the gradient becomes progressively flatter, and eventually the channel loses its identity. Flows course in many directions through the irrigated area of western Pinal County. The sediment transport capacity is so greatly diminished that a very small percentage of the sediment which passes the Brawley Wash confluence reaches the Gila River. Southwest of Picacho Peak, most of the river flow and sediment load are diverted westward into Green's Wash. Much of the diverted sediment is deposited in and just downstream from the diversion channel and in downstream irrigation and roadside ditches, on fields, and on poorly drained flats.

Water Shortages

The renewable water supply has been developed and utilized for many decades. Except for infrequent large floods or exceptional runoff sequence, outflow from the study areas is negligible under present conditions. The expanding economy has been supported by the overdraft of ground water. Overdraft, a depletion type of operation, is drawing on a stored, almost fixed, quantity rather than the utilization of a renewable resource. Unless another source of water is introduced, or an economic or institutional means to better utilize and conserve the present source is adopted, the overdraft will continue. The annual overdraft is estimated to be 246,000 acre-feet for the San Pedro study area and 772,000 acre-feet for the Santa Cruz study area under normalized 1970 conditions. (Table 5.3 shows overdraft by ground water study area. The ground water study areas are shown in Figure 3.2.)

FIGURE 3.2 - Ground Water Study Areas in the Santa Cruz-San Pedro River Basins.

EXPLANATION

LSC - Lower Santa Cruz
USC - Upper Santa Cruz
AVR - Avra Valley
ALT - Altar Valley
LSP - Lower San Pedro
USP - Upper San Pedro

GSK - Gila River from Head of San Carlos Reservoir to Kelvin
ARA - Aravaipa Valley
WIL - Willcox
DOU - Douglas
SBV - San Bernardino Valley

Irrigation

Water requirements for irrigation are supplied both by surface and ground water resources. The current amount of ground water pumped exceeds the amount of surface water diversion several times. The only major use of surface water for irrigation is in the Santa Cruz study area and occurs in the San Carlos Project located in the Florence-Coolidge-Casa Grande area. In the San Pedro study area, minor diversions of surface water occur from the San Pedro River by the Pomerene Canal, the St. David Irrigation Ditch, and other small ditches.

The San Carlos Project receives most of its surface water from San Carlos Reservoir. Coolidge Dam, which forms the reservoir, was built following a period of above normal runoff. Rainfall of subsequent years has not been adequate to produce the expected runoff. As a result, large acreages in the project remain idle each year. There are approximately 100,000 acres of designated lands within the San Carlos Project - about 50,000 acres in the San Carlos Indian Irrigation Project on the Gila River Indian Reservation and about 50,000 acres of non-Indian land in the San Carlos Irrigation and Drainage District. The non-Indian lands have been fully developed for irrigation; but only about 80 percent, or 40,000 acres, of the designated Indian lands have been developed as of 1974. Project water delivered to designated lands over the life of the project from both surface and ground water sources has been about two acre-feet per acre per year and has varied from one to three acre-feet per acre per year. Assuming a 1970 cropping pattern (see Table 4.4) and an average on-farm irrigation efficiency of about 60 percent, a full water supply would be about 5.0 acre-feet per year for each of the designated acres. This amounts to a total of about 500,000 acre-feet annually. Because of large losses in the unlined canals, this would require a total withdrawal (surface and ground water) of about 830,000 acre-feet annually. About 40 percent of the total withdrawal is lost before it reaches the farm headgate. The loss would be 10 to 15 percent with a lined system.

The result of the limited water supply has been that, on the average, about 40 to 50 percent of the designated land lies fallow. Irrigated acreages vary annually, but not necessarily in direct ratio to the water supply. The average acres irrigated for the period 1958-69 was approximately 50,400 acres.

The Pomerene area and the St. David Irrigation District have had to supplement their surface water supplies through ground water pumping almost from inception. Flow is intermittent through the stream reaches where water is diverted for irrigation. Ground water supplies in the San Pedro River Valley, however, are adequate for the present level of agricultural development. In the last 25 years, the net water level change has been small except in the Sierra Vista-Fort Huachuca area where a cone of depression has developed in response to pumpage for municipal and industrial purposes.

The ground water resources in most of the area are being utilized faster than they are being replenished. Increased pumping and farm operation costs associated with some inefficient farm management have resulted in many acres lying idle each year. Only 60 percent of the total area developed for irrigation in Pinal County is cropped in any one year.

Large sections of the Santa Cruz study area have been declared critical ground water areas (Critical Ground Water Areas and Irrigated Lands Map in the back of the report). Only the Douglas Basin has been declared critical in the San Pedro study area. The net effect of the critical ground water designations has been to limit the development of any new irrigated land within an area declared critical, but the law does allow for the replacement or deepening of an existing irrigation well. The replacement or deepening of an existing well is dependent "upon a satisfactory showing that the well intended to be replaced or deepened will no longer yield sufficient water to irrigate the land normally supplied by it within the five years immediately prior to filing the application for the permit" (Section 45-316 of Arizona Revised Statutes). The critical designation does not restrict municipal and industrial withdrawals.

One apparent result of ground water overdraft has been the occurrence of earth fissures in the Lower Santa Cruz and Willcox Basins where water table declines have been pronounced (see Water Level Change Map at the back of the report). Various studies indicate that water table declines are accompanied by consolidation of fine textured alluvium which has been dewatered. The consolidation evidently causes tensile stresses to be built up around the peripheries of the heavily pumped areas and ultimate rupture of the valley alluvium. This condition has disrupted natural drainage and irrigation water application, damaged wells and canals, caused misalignment of highways, and endangered homes. (See photographs 20 and 21.) The fissures are expected to continue to appear with continued ground water overdraft.

Municipal and Industrial

Water supply development for municipal and industrial (M&I) purposes is dependent solely on ground water resources and has been generally adequate to meet present level demands. Except for the City of Nogales, there have been no major water shortages for municipal purposes. Some of the smaller communities have problems in financing well construction, storage facilities, and water distribution systems that are adequate to meet peak demands (see Table 3.6 for water supply and distribution needs for the rural communities).

To meet the increasing water demand, the City of Tucson has purchased irrigated farmland in the Avra Valley so that the underlying ground water could be transferred into the Upper Santa Cruz Basin. Also,

Photograph 20. Earth fissure threatening homes.
(SCS Photograph)

Photograph 21. Earth fissure in irrigated cropland.
(SCS Photograph)

water could be transferred into the Upper Santa Cruz Basin. Also, Tucson is having legal difficulty in transporting ground water within the Upper Santa Cruz Basin. The Farmers Investment Company (FICO) contested the right of several mining companies to transfer ground water underlying farmlands which have been retired from agricultural production. In August 1976, the Arizona Supreme Court ruled in favor of FICO, stating that the fact that two parcels of land overlie a common source of supply is not sufficient basis to pump from one parcel to the other if lands or wells are adversely affected. This decision has unsettled Arizona ground water laws.

In Santa Cruz County, valley fill is not as thick as in other counties; and where concentrated development has occurred, the aquifers have been pumped dry on occasion. Nogales has a recurring water shortage problem. The present source of supply is a well field developed in a limited aquifer in the streambed of the Santa Cruz River, both upstream and downstream from the State Highway 82 bridge. The water bearing alluvium is small in areal extent and is underlain by a conglomerate which is not water bearing. Although the ground water is recharged by streamflow in the river, the water level drops dangerously low during periods of extensive pumping or drought.

Recent studies have indicated three possible sources of water for future development in Nogales. These include (1) surface flows of the Santa Cruz River, (2) surface flows of Sonoita Creek, and (3) ground water along the Santa Cruz River in the Calabasas area.

Additional M&I water will be supplied to selected cities through construction of the authorized Central Arizona Project (CAP). Water from the Colorado River system will be made available through the Salt-Gila Aqueduct to areas in Pinal and Pima Counties, while areas in Cochise County may benefit from additional supplies developed from the San Pedro River. The planned Buttes and Charleston Dams located on the Gila and San Pedro Rivers, respectively, will have a total combined conservation storage of about 203,000 acre-feet. The probability for construction of Buttes Dam appears excellent; however, construction of Charleston Dam is uncertain.

Large quantities of water are required for mineral production and processing. Electrical power generation also requires minor amounts of water. The copper industry, the largest user of water in the mineral resource section of the economy, makes extensive use of recirculated water and water transferred from adjacent basins. Of the total water required for a plant's operation, 74 percent is either recirculated or transferred water. Thus, only 26 percent of the total water required to process a ton of ore is new water, i.e., water used for the first time in the operation. 3/

3/ Percentage figures based on weighted average of 14 plants' operations as shown in Figure 7, Bureau of Mines Information Circular 8162, "Water Requirements and Uses in Arizona Mineral Industry, 1963."

TABLE 3.6
EXISTING WATER SUPPLY AND DISTRIBUTION
NEEDS IN RURAL COMMUNITIES
OF
COCHISE, PIMA, AND PINAL COUNTIES
1970

Study Area	Community of Developed Area	Existing]/ Needs				
		1	2	3	4	5
San Pedro	Cochise County					
	Tombstone	x	x			
	Benson	x				
	Huachuca City	x	x			
	Sierra Vista				x	
	Naco					
	Willcox	x				
	Pinal County					
	Coronado				x	
	Dudleyville				x	
	Oracle	x				
	San Manuel	x				
	Mammoth	x				x
	Aravaipa		x			
Santa Cruz	Pima County					
	Green Valley					
	Marana			x	x	
	Tucson	x			x	
	Rillito			x		
	Pinal County					
	Casa Grande					x
	Arizona City					x
	Cactus Forest					
	Kelvin & Riverside				x	
	Marana Air Park					
	Maricopa	x				
	Picacho					
	Stanfield	x				
	Val Vista					
	Lake in the Desert					
	Coolidge					x
	Eloy	x				
	Florence		x			x
	Kearney					
	La Palma	x				
	Mountain View	x				

(See next sheet for footnote)

Footnote to Table 3.6

1/ Needs Classification:

1. Replacement and/or modification (expansion) within the distribution system.

2. Water storage or additional storage facilities.

3. Combining of water systems for more economical delivery of services or consideration of municipal ownership and operation of water supply system.

4. Water supply augmentation.

5. Modification and expansion of equipment utilized in supplying water to distribution networks (well motors, booster pumps, etc.).

Source:

Existing needs based on data developed by Planning Division, Department of Economic Planning and Development, State of Arizona, and published in "Environmental Services Needs Study" for the respective counties.

Data for Pinal County were interpreted by Soil Conservation Service personnel from "Comprehensive Plan for Water and Sewer Development in Pinal County, Arizona" as developed and submitted to the Pinal County Planning Commission by the Ken R. White Company, December 1969.

Other

Surface water supplies for recreational purposes are extremely limited. Present and future demand for water-based outdoor recreation activities probably cannot be satisfied. The 1970 demand for boating and water skiing amounted to about 200,000 recreational activity occasions in the San Pedro study area and about 531,000 recreational activity occasions for the Santa Cruz study area. Presently, surface water for recreation provides about 51,000 activity occasions for boating and water skiing. Small ponds and reservoirs provide some fishing waters but are not suitable for boating or water skiing. Partial fulfillment of the need for surface water will be accomplished through the construction of the Buttes Dam which adjoins the Santa Cruz study area.

Water Quality

The subject of water quality is not included as a specific item for this study because of the recent passage of two major federal acts dealing with water pollution; The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) and the U.S. Safe Drinking Water Act of 1974 (Public Law 93-523). These acts have extensive requirements for the control of water pollution and deal with the subject in much greater detail than could be afforded by this study.

In these basins the degradation of ground water is the main potential water quality problem because of the meager surface water resources and almost complete dependence on ground water.

The major surface water quality problem is the high suspended sediment load in the San Pedro River, which is discussed under Erosion and Sediment Damages. The major non-point source of pollution in both study areas is sediment. Most of the sediment is derived from erosion of desert lands.

Water quality as related to forest land is not a serious problem. In some areas heavy grazing and highly impacted recreation areas result in minimal erosion and subsequent sediment yield.

Reseeding and intensive management systems are needed to correct the sediment yield from grazed forest lands.

Heavily impacted recreation areas also may require revegetating and controlled use in the future. Proposed developments must be carefully planned to assure minimum disturbance during construction. Site selection and area layout must be done to minimize the impact of people use.

Animal wastes from feedlots are not known to cause any surface water pollution problems, but the trend toward confined feeding of livestock and poultry does present potential water quality hazards. These facilities must be located out of flood plains and defined drainageways.

Fertilizers and pesticides are used widely on the irrigated lands in the area. Due to the very small amount of irrigation return flow to surface waters, these pollutants are not considered a major problem at this time. Some amounts are transported into streams by runoff from thunderstorms. The amount of this and to what degree it is a problem has not been determined. No nutrient-associated problems have been identified.

Irrigation has an adverse effect on water quality because of its tendency to concentrate salts. Consumptive use of water by crops and evaporation remove water but leave mineral accumulations on or near the land surface. To prevent inhibited growth of plants, excess water is applied to leach the accumulated minerals beneath the rooting zone. Some of the surplus water often reaches ground water reservoirs. In ground water occurring at shallow depth, the concentration of dissolved solids is increased. Part of the fertilizers applied to the soil, primarily nitrates, also are carried downward by the surplus water. However, there is little evidence that ground water quality is affected by excess application of irrigation water where the water table depth is several hundred feet.

Ground water beneath the Willcox Playa contains considerably higher concentrations of dissolved solids than that of the surrounding area. There is a threat that cones of depression formed by pumpage in the Kansas Settlement area (southeast of the Playa) and Stewart area (north of the Playa) will cause ground water to flow from beneath the Playa and contaminate good quality water.

Significant sodium and/or salinity hazards exist in the Casa Grande, Stanfield, and Tucson areas. There are no major sodium-salinity problems evident in the San Pedro study area at this time. (The sodium-salinity hazard for irrigation water is shown on the map, Well Water Irrigation Classification. This map was developed from consolidation of data from thirteen different reports on water quality.)

Vegetation which depends on a water table for survival (phreatophytes), has an effect in some areas on the content of dissolved solids in ground water. As phreatophytes use large volumes of water, the salts are left behind, thus concentrating dissolved solids in ground water. In the study areas, only the riparian vegetation growing along live streams has this effect.

Improper Land Water Management

Irrigated Agricultural Land and Irrigation Water

Although crops may be grown with relatively high yields, there are problems in the development and maintenance of irrigated croplands. Some problems are localized, others are general. Such problems include inadequate water supply and irrigation systems; insufficient water

management on the land; poor soil conditions; soil erosion; salt concentrations in the soil and in irrigation water; and flooding from intense storms. Such problems have caused 53,000 acres to be abandoned, including 19,000 acres in the San Pedro study area and 34,000 acres in the Santa Cruz study area.

Irrigation Systems

Irrigation systems operating at less than 60 percent efficiency of water use result in excess pumping of water, reduction of crop yields and inefficient use of fertilizer. There may be deep percolation in one part of the field and inadequate water supply for crop growth in another part of the field. Excessively sloping fields result in large amounts of tailwater which may be lost to non-beneficial consumptive use or captured and used to irrigate fields below. The latter use is still inefficient due to the lack of control of the water and improper timing of irrigations. Tailwater recovery systems help to reduce the inefficiency but require high cost of operation. Other factors on the farm that result in low irrigation efficiencies include:

1. Irrigation runs too long.

2. Insufficient water measuring devices and water control structures.

3. Borders not properly spaced to meet the needs of the soil, slope, crop, and water supply.

4. Insufficient ditch lining or piping to reduce seepage, provide control, and reduce excessive maintenance.

5. Overall system design considerably below the potential possible with present technology.

6. Improper rate of water application.

7. Lack of followup to determine if correct amount of water was applied.

Improved efficiencies both on and off the farm can be accomplished through the installation of improved irrigation systems and by the application of new and improved management techniques.

The major portion of the area is supplied irrigation water through on-farm wells. In the San Pedro study area, the St. David Irrigation District and the Pomerene area have off-farm conveyance systems. There

is a need for a permanently installed diversion structure on the San Pedro River to divert water into the St. David Irrigation Canal. Both the St. David and Pomerene main canals should be lined and improved.

In the Santa Cruz study area, the San Carlos and Cortaro-Marana Irrigation Districts' water distribution systems need some realignment, consolidation, lining or piping, and control structures.

Irrigating land efficiently is a problem. It is difficult to develop sufficient measurement and control systems and apply management. Approximately 15,000 acres, 10 percent of the irrigated acreage in the San Pedro study area (Table 3.7) is adequately treated and managed for efficient irrigation. The remaining lands have shortages in both systems and management. About 75 percent of these lands are irrigated with water use efficiencies ranging from 50 to 70 percent, and about 15 percent of the land is irrigated below an efficiency of 50 percent.

About 42,000 acres, 10 percent of the irrigated acreage in the Santa Cruz study area, is adequately treated and managed with irrigation efficiencies of 70 percent or more. About 43 percent of the land is irrigated with water use efficiencies ranging from 50 to 70 percent. The remaining land, 47 percent, has irrigation efficiencies of 50 percent or less.

Wind erosion and evaporation of irrigation water are also problems. Idle land (Table 3.7) especially in Pinal County in the Santa Cruz study area, leaves large areas without vegetation. The area used for crop production is shifted from year to year. Therefore, idle land is not termed abandoned land.

Soil Condition and Erosion

Less than ideal soil conditions are common in most desert and semi-desert climates. Major factors causing this include:

1. Low organic matter content in the soil.

2. Rapid decomposition of the available soil organic materials.

3. Soil structure that impedes root development and water movement.

4. Tendency of some soils to accumulate enough salt to cause adverse effects on soil structure and plant growth.

5. Compaction of soil from use of machinery.

TABLE 3.7 - ACREAGE IN CULTIVATION AND RELATED USES IN THE CROPLAND AREA

Santa Cruz-San Pedro River Basins

	Item	Total	San Pedro Study Area 1/	Santa Cruz Study Area
		-------1000-------		
1.	Acres Harvested	369.8	122.0	247.8
2.	Acres used for crop production	391.3	127.0	264.3
3.	Nonharvested acres	21.5	5.0	16.5
4.	Irrigated acreage - total	549.1	148.8	400.3
5.	Idle irrigated acreage	157.8	21.8	136.0
6.	Highways, roads, ditches, farmsteads, etc. 2/	40.9	11.2	29.7
7.	Total acres in irrigated area 3/	590.0	160.0	430.0

1/ Does not include 3700 acres of irrigated land along the San Pedro River in Pima and Pinal Counties - this was included in the Santa Cruz Basin.

2/ Within the irrigated area; does not include urban areas.

3/ Does not include 19,000 acres and 34,000 acres of abandoned cropland in the San Pedro and Santa Cruz study areas, respectively.

All of these factors tend to restrict water, air, and plant root movement through the soil. Soil conditions are poor enough in some areas to cause difficulty in plowing, discing, or otherwise preparing the seedbed. Practices to replace organic matter, improve soil structure, and guard against compaction are generally needed.

Soil erosion on cropland is generally slight to moderate except in small, localized areas along the San Pedro River and in Graham County where moderate erosion occurs. Most of the cropland erosion is caused by short duration, intensive rainstorms, usually during July and August. These storms produce enough runoff on fields with slopes in excess of 0.3 percent to cause significant soil loss. For example, the average annual soil loss caused by rainfall on an unprotected acre of silty soil, with a one percent slope and a 1,000 foot slope length, would be six to seven tons. 4/ Additional soil losses result from the application of irrigation water. Three to five tons per acre per year is considered a tolerable loss.

The ability of the soil to resist erosion is reduced in those areas where salts have concentrated, excessive tillage is used, organic matter content has not been maintained or improved, and/or soil compaction has occurred. Scour of cropland caused by flooding is discussed in this chapter under Flood Damages and Erosion and Sediment Damages.

Soil erosion by wind is moderate during the time frontal storm systems move across the area and during periods when fields are bare. Idle lands with sandy and loamy soils, which make up about 150,000 acres, and 53,000 acres of abandoned croplands are most susceptible. Wind erosion occurring on such lands adjacent to highways results in safety hazards. Unprotected mine tailings are also sources of blowing dust.

Alkali and saline salts tend to accumulate in some areas of clayey soils. Affected areas amount to 1,000 to 2,000 acres in the San Pedro study area and about 19,000 acres in the Santa Cruz study area. Poor drainage caused by hardpans in the soil is an associated factor. Crop yields on these soils are reduced.

Grazing Land and Livestock Water

Reduced productivity of forage plants is the foremost range problem of the study areas. The potential production of the native grazing lands is about two and one half times the present production (Table 3.8). Of the many influences causing reduced productivity, displacement of grassland communities by unpalatable trees and shrubs is most prevalent. Mountainous areas covered with dense oak woodland-chaparral stands are highly susceptible to wildfire and have limited usefulness for livestock. Soil erosion under dense oak woodland-chaparral stands become apparent only after denudation by wildfire.

4/ Based on use of the Universal Soil Loss Equation.

TABLE 3.8

AREA GRAZED AND PRESENT POTENTIAL LIVESTOCK FORAGE PRODUCTION

Santa Cruz-San Pedro River Basins

Study Area	Area Grazed Acres 1/ (1000)	Present Production AUMs 2/ (1000)	Present Production Acres per AUM	Potential Production AUMs (1000)	Potential Production Acres per AUM
San Pedro	3,762	783	(4.8)	1,809	(2.1)
Santa Cruz	4,342	612	(7.1)	1,757	(2.5)
TOTAL	8,104	1,395	(5.8)	3,566	(2.3)

1/ Excludes cropland grazed in study area.

2/ AUM is the amount of forage required for one mature animal per month.

At the highest elevations, control of wildfire has caused the open conifer forests and open meadows to be invaded by understory trees and shrubs and to become choked with forest debris. Overstory tree and shrub densities in oak woodland-chaparral areas have also increased with a consequent loss of understory grasses and forbs. Displacement of forage grasses and forbs by mesquite, burroweed, snakeweed, and other woody species has reduced the productivity of desert grasslands. Grassland communities of the Chihuahuan Desert, where woody species were once partly controlled by reoccurring wildfires, have been invaded by creosote bush, whitethorn, Mortonia, tarbush, mariola, graythorn, saltbush, catclaw, mesquite, and other woody species. With its sparse cover of shrubs, the Chihuahuan Desert is subject to erosion. In the Sonoran Desert, low growing shrubs and half shrubs have been displaced by larger woody species such as mesquite, catclaw, ironwood, palo verde, yuccas, and cholla cacti.

Progress has been made in shifting toward rotation systems of grazing, but some ranches still practice continuous grazing. Moderate acceleration of soil erosion has resulted from overuse and loss of adequate vegetation on over 15 percent of the grazing lands.

Most problems involving the development of water for livestock are associated with ponds and charcos. High losses of water impounded is caused by seepage and evaporation. Displacement by sediment is another problem. Muddy water in ponds is a problem during and after flooding and is prolonged by the trampling of livestock.

Primarily located along drainage courses, earthen ponds do not provide the flexibility needed for getting the desired distribution of livestock and even grazing use of forage. Where livestock water is limited to earthen ponds, nearby drainage courses may be overgrazed while distant slopes and ridges may be under-utilized. Many ponds are dry except for relatively short time periods after runoff. Wells, stockwater pipeline, and tanks are necessary in many locations to avoid problems with ponds and to obtain uniform distribution of water. These facilities are costly and difficult to install in remote areas.

Forest Land

Modern society is placing different emphasis on the use of the limited mountain forest lands. Commercial timber sales of sawlog trees in the Pinaleno Mountains is being displaced by the type of salvage logging being practiced in the Santa Catalina Mountains. Salvage logging is the only adaptable means of harvesting trees from forests being managed mainly for recreational uses.

Management and conservation of forest lands is directed towards satisfying the diverse demands of people. Of these, demands for using cool mountain camping and picnic areas during the hot summer months can exceed

the spaces available. When demands exceed supply, controls must be imposed on the numbers of people using the facilities.

As the cities and towns of the study areas grow, there is a corresponding increase in demand for recreational uses of forest lands. Associated with the construction of camping and picnic facilities is the problem of building access roads and parking areas. Determining how much space should be cleared of forest trees and shrubs becomes a problem when there are only 130,574 acres of conifer forest type in the study areas. In the Santa Catalina Mountains, the growing problem of forest management involves fire hazard reduction, removal of over-aged decadent trees, and controls of mistletoe, insects, and diseases. The frequency of forest fires increases with the increased recreational use. There is the growing need for maintaining open forest stands to make them resistant to destruction by wildfire. Protection from wildfire requires thinning trees and reducing forest fuels from firebreaks and around camps and picnic areas. In 1971, there were 201 fires that burned 4,195 acres within the national forest boundaries. Fire statistics are unavailable for state and private lands in the same year.

Most of these problems can be met, although shifts in allocation of resources may be required. The same, however, is not true for fuel buildup on wilderness, primitive, and natural areas. The threat of highly destructive wildfires is increasing in these areas because of the ingrowth of trees and shrubs and the accumulation of forest debris.

Urban and Industrial Land

There is a growing disenchantment with the economic, social, physical, and environmental consequences of haphazard urban and industrial growth. But this disenchantment has not been channeled into action which will fully forestall unwise development. Development that has not been properly planned and is not in balance with the ability to provide and maintain required public services and facilities is still occurring. Subdivision of land is occurring years before any people arrive; these subdivisions are merely land speculation ventures. In 1974, remote subdivided lands in Cochise, Santa Cruz, Pima, and Pinal Counties had the capacity to accommodate more than twice the capacity needed to meet the rural population projected for the year 2000. (See the Vegetation, Croplands, Urban and Mining Areas Map in the back of the report.)

Problems in the conservation of natural resources in urban and urbanizing areas are complex and often not fully understood by developers, land-use planning groups, and local decision makers. Of the 312,000 acres of remote subdivision land in the study area, 200,000 acres are estimated to contain soils that have moderate to severe limitations regarding septic tank filter fields, solid waste disposal and/or low building foundations. New construction may take take place with little knowledge of the limitations, hazards or capabilities of the soil and underlying

geologic strata. Some homes are built on unsuitable soils and steep slopes without regard to future availability of power and community services. Effective May 1973, Arizona statutes require that subdivision developers show adequate water supply for 100 years or disclose information if an inadequate water supply exists. Most of the subdivisions in the study areas were approved prior to this date. Lots have been sold where adequate water supplies do not exist, and such sales can continue. Sites that require expensive foundation treatment for buildings and roads are sometimes selected when equally acceptable sites with better foundations are available. Solid waste disposal and septic tanks can threaten water quality where improperly located. Lots have been located on flood plains. Flood peaks and volumes are increased because of increased runoff from impermeable construction such as paving and roofs. During and immediately after construction, large areas are stripped of vegetation leaving the soil vulnerable to wind and water erosion for long periods of time.

The population will continue to increase in future years, and it will have to be accommodated. The question of which land should be converted to urban and other special uses is of vital importance. Local governments realize that there are benefits from looking ahead, such as achieving economics of scale in systems of public facilities; preventing the emergence and aggravation of environmental hazards and nuisances; and meeting basic demands for power, transportation, and other utility services.

Outdoor Recreation

The vast majority of the basin area is composed of desert and grassland and is generally open to the public. Consequently, opportunities for desert and grassland related recreation experiencies are virtually unlimited. Opportunities for many other types of outdoor recreation experiences are limited.

Space for high mountain camping and picnicking sites is limited and could become even more limited if roads and parking spaces are expanded. Most of the areas that are suitable for recreational use are developed to their maximum extent, and there is little opportunity to increase the supply.

The supply of water-based recreation facilities has not kept pace with the demand. As a result, area residents are often forced to forego the desired experience or to travel great distances in search of the desired type of recreation facilities. For the San Pedro study area the estimated 1970 annual shortages of water-based recreation facilities, expressed as unmet activity occasions, amounts to 224,750 for picknicking, 714 for camping, 378,050 for lake swimming, 132,800 for boating, and 61,160 for water skiing. For the Santa Cruz study area, the unmet activity occasions amount to 1,555,900 for picnicking, 217,100 for camping, 924,000 for lake swimming, 354,400 for boating, and 125,600 for water skiing.

Solid Waste and Litter

Agricultural related solid wastes are not a problem in the two study areas, nor are future problems anticipated. Such wastes include animal and poultry manure from concentrated feeding operations, agricultural processing plant wastes, and crop residue organic matter. There are no concentrated animal feeding operations in the San Pedro study area that are considered point sources of pollution subject to National Pollutant Discharge Elimination System (NPDES) permit requirements as defined in EPA published final regulations of March 18, 1976.

In the Santa Cruz study area, there are two livestock feedlots where more than 1,000 animal units are confined. These are located northeast of Casa Grande and on the Gila River Indian Reservation. These may be defined as "concentrated animal feeding operations" subject to permit requirement. The Section 208 plans now being prepared by the Councils of Government will define the status of these feedlots and other potential sources of agriculturalrelated pollutants.

The major solid waste disposal problem involves residential, institutional, and industrial sources. The open dump disposal system is still used extensively as a form of solid waste disposal. Most of these open dumps are burned on an intermittent basis. In the San Pedro study area there are eight communities utilizing sanitary landfills; however, not all can comply on a full-time basis with Arizona Department of Health Service regulations. There are nine communities using the open dump system.

In the Santa Cruz study area there are 8 communities utilizing sanitary landfills and 14 communities utilizing open dumps. This does not include communities on the Papago Indian Reservation.

The Comprehensive Statewide Solid Waste Management Plan requires that (1) all counties, incorporated cities and towns, and such state agencies as deemed appropriate shall prepare and submit a plan for solid waste management and (2) open dumps must be closed, covered, or converted to sanitary landfills by July 1, 1975. Neither of these provisions have been complied with fully. While several local governments are quite advanced in their programs, others fail to comply with and enforce existing regulations.

Another problem is "wildcat" dump sites. Because of lack of funds to adequately police this sort of activity and the difficulty in spotting violations, about the only local governmental action is to post sites. The large amount of uninhabited public lands in the study areas contribute to the problem. Clean-up programs are hindered by lack of funds.

Natural Beauty

Natural esthetic values include mountains, canyons, desert, grassland, forest, and riparian vegetation. Natural beauty has been impaired as roads, overhead power and communication lines, gas and oil pipelines, and mining activities encroach into relatively undisturbed areas. Establishment of remote subdivisions, which far outstrip demand, has been a source of severe disturbance and consequent loss of natural esthetic values. As an example, in the area west of Highway 666 between Pearce and Cochise, 20 square miles of one of the finest grassland areas in the State have been divided by eight east-west roads and four north-south roads per square mile. Disturbance of the fine grassland could persist for many years, even if the subdivision fails. Future revegetation will be needed to restore natural beauty to many such areas if they are not occupied.

In parts of the San Pedro Valley, the disturbance of soils in conjunction with the construction of homes on steep, unstable slopes is resulting in unsightly landscapes.

Presently, there are about 126,000 acres in the Santa Cruz-San Pedro River Basins with high esthetic values which have rigid restrictions on use to preserve natural qualities. Of this, about 58,000 acres are in the Santa Cruz study area, and about 68,000 acres are in the San Pedro study area. These consist of wilderness and primitive areas administered by the Forest Service and Bureau of Land Management and land owned by the Defenders of Wildlife. Increasing human population will result in the need for restricted use on additional areas.

Archeological and Historical Resources

Evidence of ancient Indian civilization and other more recent historical developments need to be preserved to make our past more alive and vivid.

There are 82 historical and archeological sites in the San Pedro study area which are either included or considered as having potential for inclusion in the National Register of Historic Places. Only 12 of these sites have been provided with the means for adequate and continued protection. In the Santa Cruz study area, only 8 of 117 such sites are adequately protected. Some unprotected sites are being abused and destroyed by development and the activities of vandals and amateur relic hunters.

Fish and Wildlife

General

Most of the study area is rural in nature. It does not have wildlife problems generally associated with the more populous areas of the state. Most problems are directly related to rural activities such as ranching, mining, farming or speculative real estate developments.

Water is scarce in many parts of the area. It is a necessary component of existing wildlife habitat. Kinds and population of wildlife species vary with the diversity of plant species. The value of habitat for wildlife has been reduced by the loss of some plants from the original plant communities. Loss in diversity of plant species has occurred because of practices such as thinning and clearing on forest lands; brush control and seeding of single grass species on grazing lands; and single species planting and clean cultivation on croplands. These practices may be changed to improve wildlife habitat and still meet the original objectives.

Fish Habitat

At least 30 species of fish are known to inhabit the various waters of the study area. At least one of these species, the Gila topminnow, is on the U. S. Fish and Wildlife Service List of Endangered Fauna.

The most serious problem concerning the survival of fish is a dwindling supply of suitable water. The quantity and quality of both stream and reservoir habitat is being reduced by sedimentation from eroding watersheds. Overdraft of the ground water supplies has also caused springs to dry up and has lowered the water table below stream bed levels.

Rangeland Habitat

Desert range and grassland contains the greatest diversity of wildlife inhabitants. Among these is the endangered Sonoran pronghorn.

The problems that directly affect most species of wildlife are overgrazing, fencing, brush control with no provisions for wildlife, and the conversion of rangeland to other uses.

Overgrazing is a major problem in some areas, but is not considered to be as severe as in the past. The demise of the masked bobwhite quail from Arizona was blamed on overgrazing around the turn of the century. An attempt is being made to reintroduce this endangered species into Arizona. Botterie's sparrow is another example of the relationship between overgrazing and wildlife. This sparrow uses coarse desert grass as its habitat and disappears from areas where grass is eliminated. Historically, the Arizona prairie dog inhabited the shortgrass prairies of southeastern Arizona. This species has disappeared from Arizona, but since the habitat still exists and populations of the animal exist in Mexico, the loss has been attributed to the federal rodent control program in Arizona.

Overused conditions on rangeland can be created in a relatively short time while natural recovery can take many years. Severely overgrazed range lands may not ever recover naturally and have to be reseeded and rested from any grazing. During short-time dry periods or periodic droughts, grass becomes short in supply. Horses, sheep, and cattle are forced to use forbs and shrubs, thereby competing directly with many wildlife species.

Brush control, unless provisions for wildlife are made, often reduces or eliminates food and cover plants.

Fencing of grassland can be detrimental to the pronghorn antelope. While antelope are not widespread in the area, much of the grassland is historic range and restocking is being considered.

Timberland Habitat

Habitat losses due to fire supression, single species pine plantings, mining activity, real estate development, and heavy recreation use are problems in the non-wilderness section of timberlands. Abandoned and unreclaimed lands such as those used for mining and partially developed urban areas will be slow to recover without planned rehabilitation.

Farmland Habitat

Modern clean farming practices have resulted in a significant decrease in wildlife habitat. These practices include removal of windbreaks, cleaning up of fence rows and vegetated field borders, and lining of vegetated irrigation ditches. Land use conversions from irrigated cropland to grassland and woodland can improve wildlife habitat. Conversion to uses such as urban, mining, or transportation corridors results in a loss of some species of wildlife while it may benefit others.

Riparian Habitat

Riparian vegetation is extremely valuable to wildlife. It is primarily deciduous woody vegetation and is located adjacent to stream courses. This vegetative type provides interspersions of woody cover into upland areas.

Riparian vegetative communities are more subject to loss through man's activities than any other habitat type with the possible exception of wetland. Various vegetative manipulation programs contribute to loss of this vegetative type. Programs that usually contribute to loss of riparian habitat are designed to increase downstream water yields, increase livestock forage production, maintain or improve ground water conditions and improve stream flow and flood plain conditions.

Wetland Habitat

This habitat is extremely important in the arid southwest. Besides providing habitat for waterfowl, in many cases it provides watering places for other species of wildlife.

Among the several species of waterfowl in the area; at least one, the Mexican duck, is endangered. The United States range of this species is southeastern Arizona, southern New Mexico, and southwestern Texas. Reduction of wetland habitat in the study area could result in the disappearance of this species from Arizona.

Wetlands in the area are primarily of Type 5, inland open fresh water, as described in the U. S. Fish and Wildlife Service Circular 39, "Wetlands of the United States." These are associated principally with ponds and lakes, including Willcox Playa and Picacho Reservoir. Also associated with the Playa are some Type 9 wetlands, referred to in "Wetlands of the United States" as inland saline flats. Natural wetland habitat is in extremely short supply. Many manmade water impoundment structures are designed and operated in such a manner as to provide very little wetland habitat. Most stock ponds are grazed by livestock. This limits or eliminates growth of hydrophytic plants. Thus, food and cover plants are lacking. Larger impoundments are, for the most part, constructed in relatively steep walled valleys. The largest part of the shorelines is unsuitable for the establishment of emergent vegetation which would provide food or cover for waterfowl.

Unique Biotic Habitat

In addition to the various habitats already discussed, there are several areas that provide unique habitat conditions. These areas are mostly canyons which have either permanent flowing water or ground water near the surface. The problem associated with these areas is the preservation of the animal and plant species involved.

Aravaipa Canyon supports several rare fishes and a number of unique plants. Ramsey Canyon and Carr Canyon are inhabited by what are thought to be the only populations of the Arizona ridge-nosed rattlesnake in the nation. Ramsey Canyon also contains the largest number of hummingbird species in the nation and is sometimes referred to as Hummingbird Haven.

Other canyons considered to be unique biotic areas are: Madera Canyon on the northwest side of the Santa Rita Mountains in Pima County; Sabino Canyon and Rose Canyon in the Santa Catalina Mountains in Pima County; Gardner Canyon in the Santa Rita Mountains in Santa Cruz County; and Parker Canyon just west of the Huachuca Mountains in Santa Cruz County.

Sonoita Creek in the Patagonia-Sonoita area of Santa Cruz County is an area of natural scenic beauty and provides refuge for several bird species. Blue Haven, a bird sanctuary area near Patagonia, is a stream lined with large trees and flowing through semi-desert foothills of high mountains.

OBJECTIVES

The more significant problems were selected and grouped according to their relationship to either of two primary objectives as defined in the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources. The two primary objectives are (1) to enhance national economic development (NED) and (2) to emphasize environmental quality (EQ). The NED objective is to increase the output of goods and services and improve the national economic efficiency. The EQ objective is to emphasize management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

The identified problems are the basis for the study objectives. Study objectives were graduated from first level specific components to second level specific components to identify types of actions needed (Table 3.9). The second level specific components are listed separately for the San Pedro and the Santa Cruz study areas because of the different approaches used in developing alternative plans.

TABLE 3.9

PROBLEMS AND OBJECTIVES

Santa Cruz-San Pedro River Basins

Santa Cruz-San Pedro River Basins

Primary Objective	Problems (Public Concerns)	Specific Components of the Objectives			
		First Level (Desires)	Second Level (Preferences)	San Pedro Study Area	Santa Cruz Study Area
National Economic Development	1. Frequent damage due to floodwater, erosion, and sediment.	Increased or more efficient output of goods and services.	1. Reduce floodwater, erosion sediment damages.	1. Fullest feasible extent.	1. Fullest feasible extent.
	2. Inefficient use of resources.		2. (a) Increase net returns from crop production.	2. (a) Maximum extent possible.	2. (a) Maximum extent possible.
	(a) Crop production.		(b) Increase livestock forage production.	(b) Maximum extent possible.	(b) Maximum extent possible.
	(b) Beef cattle production.				
	3. Underdeveloped and/or underutilized water-based recreation resources.		3. Create water-based recreation facilities	3. Satisfy future population demand at present participation rate.	3. Satisfy existing demand.
Environmental Quality	1. Reduced quantity and quality of fishery habitat.	Management and enhancement of biological resources.	1. Maintain quantity and quality of fishery habitat and esthetics adversely affected by sediment deposition and channel erosion and modification.	1. 150 acres of lakes; 1,830 acres of ponds; and 115 miles of stream.	1. 580 acres of lakes; 1,690 acres of ponds; and 70 miles of stream.

TABLE 3.9

PROBLEMS AND OBJECTIVES

Santa Cruz-San Pedro River Basins
(Continued)

Primary Objective	Problems (Public Concerns)	Specific Components of the Objectives			
		First Level (Desires)	Second Level (Preferences)	San Pedro Study Area	Santa Cruz Study Area
Environmental Quality (Cont'd)	2. Reduced quality of rangeland and forestry wildlife habitat and loss of wildlife productivity on irrigated land.	Management and enhancement of biological resources.	2.(a) Establish wildlife oriented grazing use and brush management techniques on grazing land; silviculture and controlled burning techniques on forest lands; and food and cover plants on farmland which would preserve and increase plants important for wildlife productivity.	2.(a) 3,167,000 acres of grazing land; 78,000 acres of forest land; 1,700 acres of farmland.	2.(a) 5,078,000 acres of grazing land; 52,000 acres of forest land; and 4,200 acres of farmland.
			(b) Provide additional wildlife water developments to complement existing habitat.	(b) 1,267 wildlife water developments.	(b) 1,500 wildlife water developments.
			(c) Provide for restoration of rangeland and forest land habitat when overused.	(c) 50,000 acres.	(c) 55,000 acres
			(d) Promote restoration of abandoned irrigated land to natural conditons. (Critical Ground Water Areas and Irrigated Lands Map).	(d) 19,000 acres	(d) 34,000 acres

TABLE 3.9

PROBLEMS AND OBJECTIVES

Santa Cruz-San Pedro River Basins
(Continued)

Primary Objective	Problems (Public Concerns)	Specific Components of the Objectives			
		First Level (Desires)	Second Level (Preferences)	San Pedro Study Area	Santa Cruz Study Area
Environmental Quality	2. (Cont'd)	Management and enhancement of biological resources.	(e)Assure against unwise conversion of rangeland, forest land, and irrigated land habitat to other uses through adequate multiple use planning.	(e)61,000 acres	(e)124,000 acres
			(f)Insure proper multiple use considerations on grassland to improve habitat for unique biotic inhabitants.	(f)1,936,000 acres of habitat for antelope, Arizona black-tailed prairie dog, masked bobwhite and Botteri's sparrow.	(f)1,157,000 acres of habitat for antelope.
	3.Loss of quality of riparian habitat.		3.(a)Discourage or prevent vegetation minipulation in riparian communities (Vegetation, Croplands, Urban and Mining Areas Map).	3.(a)35,000 acres.	3.(a)43,000 acres.

TABLE 3.9

PROBLEMS AND OBJECTIVES

Santa Cruz-San Pedro River Basins
(Continued)

Primary Objective	Problems (Public Concerns)	Specific Components of the Objectives			
		First Level (Desires)	Second Level (Preferences)		
				San Pedro Study Area	Santa Cruz Study Area
Environmental Quality (Cont'd)	7. Lack of public knowledge of the causes of accelerated erosion.		7. Exhibit areas of accelerated erosion in various environmental zones for study by the general public.	7. San Pedro Valley (Benson vicinity)	7. Lower Santa Cruz Valley (Picacho Peak vicinity).
	8. Potential loss of wilderness quality caused by inadequate fuel management.	Management and protection of areas of natural beauty and human enjoyment.	8. Prevent fuel buildup on wilderness areas.	8. 68,000 acres in Galiuro and Chiricahua Wilderness Areas, Aravaipa Canyon Primitive Area, and privately owned Aravaipa Canyon Natural Area.	8. 5,000 acres in Santa Catalina and Butterfly Peak Natural Areas.
	9. Lack of protection for ghost towns, historic buildings, and prehistoric Indian culture.	Management and preservation of historic, archeologic, unique scenic, and geologic resources.	9. Prevent exploitation of archeologic and historic sites by amateur relic hunters and development.	9. 70 additional sites needing protection.	9. 109 additional sites needing protection.

TABLE 3.9

PROBLEMS AND OBJECTIVES

Santa Cruz-San Pedro River Basins
(Continued)

Primary Objective	Problems (Public Concerns)	Specific Components of the Objectives			
		First Level (Desires)	Second Level (Preferences)	San Pedro Study Area	Santa Cruz Study Area
Environmental Quality (Cont'd)	10. Deterioration of land and water quality and loss of reservoir capcity caused by: (a) Severe geologic erosion and the related sediment deposition. (b) Severe and moderate streambank erosion. (c) Moderate accelerated erosion on grazing land and wildlife habitat.	Enhancement of quality aspects of land and water.	10. (a) Manage vegetation in combination with structural measures to decrease sediment yield from critical areas.	10. (a) 192,000 acres of critical area in San Pedro and Aravaipa Valleys.	10. (a) 7,500 acres of critical area in Lower Santa Cruz Valley.
			(b) Install streambank protection measures on rapidly eroding banks.	(b) 115 miles on San Pedro River, Aravaipa Creek, Whitewater Draw, Greenbush Draw, Babocomari River. and Black Draw.	(b) 75 miles on Santa Cruz River, Altar Wash, Sopori Wash, McClellan Creek, Santa Rosa Wash, and Green's Wash.
			(c) Reduce erosion by increased application of erosion control practices and measures on grazing lands.	(c) Total grazing land - 3,762,000 acres.	(c) Total grazing land - 4,342,000 acres.
	11. Indiscriminate dumping of solid waste caused by inadequate disposal facilities.	Enhancement of quality aspects of land and water.	11. (a) Provide solid waste disposal facilities for communities.	11. (a) 17 communities presently needing facilities.	11. (a) 18 communities presently needing facilities.
			(b) Clean up existing dumps.	(b) 160 existing dumps.	(b) 400 existing dumps.

CHAPTER 4

ECONOMIC DEVELOPMENT AND ENVIRONMENTAL PREFERENCES

INTRODUCTION

This chapter, together with the analysis of conditions without planned action given in Chapter 6, provides the basis for determining the "Needs" in Chapter 7. Information presented here pertains to population, employment, economic activity, outdoor recreation, and environmental aspects of the San Pedro and Santa Cruz study areas.

Material for the two areas is presented together in the tables and text. However, it should be noted that projections are included for the San Pedro study area, whereas they are not included in the Santa Cruz study area because water allocations from the Central Arizona Project have not been made as of this writing.

Some of the data are for a hydrologic area and some are presented on a county basis. Moreover, some of the data were derived from 1972 OBERS projections for the Santa Cruz-San Pedro four-county area (Cochise, Pima, Pinal, and Santa Cruz Counties) and some were derived from other sources. The following tabulation indicates for each item the area to which the data apply, the term used to identify the projections, and the source of the projected data.

Item	Area Included	Projections Identification	Projections Source
San Pedro Study Area			
Population	Cochise County	1972 OBERS	Derived from 1972 OBERS Projections for Santa Cruz-San Pedro 4-county area 1/
Employment	Cochise County	1972 OBERS	
Earnings	Cochise County	1972 OBERS	
Per Capita Income	Cochise County	1972 OBERS	
Crops	Hydrologic area in Cochise and Graham Counties	1972 OBERS	
Santa Cruz Study Area			
Population	Three Counties 2/		Projections not included in the study
Employment	3-county area 2/		
Earnings	3-county area 2/		
Per Capita Income	3-county area 2/		
Crops	Hydrologic area in 3-county area 2/		

1/ Source: 1972 OBERS Projections, Volume 4, p. 212.
2/ Pima, Pinal, and Santa Cruz Counties.

The 1972 OBERS projections were based upon Series C population growth and represent estimates of economic activity expected to develop during the projection period if all assumed conditions materialize. 3/ The general assumptions, in addition to the population growth rate, which underlay the projections were as follows: 4/

1. Nationally, reasonably full employment, represented by a four percent unemployment rate, will prevail at the points for which projections were made. Disproportionality of unemployment among regions will diminish.

2. No foreign conflicts are assumed to occur at the projection dates.

3. Continued technological progress and capital accumulation will support a growth in private output per man-hour of three percent annually.

4. The new products that will appear will be accommodated within the existing industrial classification system, and, therefore, no new industrial classifications are necessary.

5. Growth in output can be achieved without ecological disaster or serious deterioration, although diversion of resources for pollution control will cause changes in the industrial mix of output.

6. Most factors that have influenced historical shifts in regional "export" industry location will continue into the future with varying degrees of intensity.

7. Trends toward economic area self-sufficiency in local service industries will continue.

8. Workers will migrate to areas of economic opportunities and away from slow growth or declining areas.

9. Regional earnings per worker and income per capita will continue to converge toward the national average.

10. Regional employment/population ratios will tend to move toward the national ratio.

3/ The OBERS Series C projections assume that the total fertility rate (sum of age-specific birth rates) in the Unites States will be 2,777 per 1,000 women in the year 2000, a substantial decline from the high of 3,767 reached in 1957. By way of further comparison, Series E projections reflect a total fertility of 2,100 by the year 2005. Under the E series, births and deaths approach equality.

4/ Source 1972 OBERS Projections, Vol. 1, p. 6.

The 1972 OBERS projections are considered baseline projections, with the term "baseline" denoting a statistical framework of consistent National-regional projections for use in planning and evaluation of actions. They were used in this context in subsequent analyses and in preparation of the National Economic Development Alternative--Plan A, presented in Chapter 8.

ECONOMIC ACTIVITY INDICATORS

Population

The base period population for the San Pedro and Santa Cruz study areas is shown in Table 4.1 together with 1972 OBERS projections for the former area. Arizona and United States figures are shown for comparison.

Population of Cochise County, which totaled 61,900 in 1970, is projected to increase substantially although at a much lower rate than Arizona as a whole, and at a somewhat slower rate than the United States.

Population of the Santa Cruz 3-county area totaled 433,000 in 1970, nearly 25 percent of the State total. Pima County accounted for a major part of the 3-county total.

The population of Cochise County was primarily urban or rural non-farm in 1970, and was projected to become more so throughout the projection period (Table 4.2). The population of the Santa Cruz 3-county area was even more urban concentrated in 1970, with only 2.5 percent being classified as rural farm population.

Employment, Earnings, and Income

Employment, earnings, and per capita income in 1970, with projections for the San Pedro area, are shown in Table 4.3. Projections for Arizona and the United States are also shown in relative terms for comparison. The employment/population ratio was estimated to be .36 in both the San Pedro 1-county area and in the Santa Cruz 3-county area in 1970, and was projected to gradually increase in the San Pedro area. Estimated earnings per worker in the San Pedro 1-county area were relatively high in 1970 both in comparison with the Santa Cruz 3-county area and the United States. In fact, estimated earnings in 1970 in Cochise County were 25 percent above the United States average, while the Santa Cruz 3-county earnings were below the National average. Estimated per capita income, however, falls somewhat below the United States average in both areas.

TABLE 4.1 - POPULATION IN THE SAN PEDRO 1-COUNTY AREA AND IN THE SANTA CRUZ 3-COUNTY AREA IN 1970 WITH PROJECTIONS AND COMPARISONS AS SHOWN

Area	1970 1/	1972 OBERS Projections 2/ 1980	2000	2020
		1000		
San Pedro 1-County Area				
Cochise County	61.9	69.3	88.5	105.9
Santa Cruz 3-County Area				
Pima County	352.0			
Pinal County	68.0		Projections not	
Santa Cruz County	14.0		included in the	
3-County Total	434.0		study	
Arizona	1,770.0	2,221.0	3,063.0	3,947.0
United States	203,212.0	234,208.0	306,782.0	399,013.0
		Percent - 1970 = 100		
Cochise County	100.0	111.9	142.9	171.9
Arizona	100.0	125.3	172.8	222.7
United States	100.0	115.3	151.0	196.4

1/ Source: Arizona and county figures are from the 1970 Census of Population Characteristics, Bureau of the Census, U.S. Department of Commerce. The United States figure is from the Statistical Abstract of the United States, 1972, p. 5. Data are as of April 1. Counties do not add to total due to rounding.

2/ Projections for Cochise County were derived by the Arizona Water Commission by disaggregating 1972 OBERS Series C projections for the 4-county area given on page 212 of 1972 OBERS Projections, Vol. 4, U. S. Water Resources Council, Washington, D.C. Projections for Arizona and the United States are given in Volume 5.

TABLE 4.2 - POPULATION IN THE SAN PEDRO 1-COUNTY AREA AND IN THE SANTA CRUZ 3-COUNTY AREA IN 1970 CLASSIFIED URBAN AND RURAL, WITH PROJECTIONS FOR THE FORMER AREA

Area and Residence	1970 1/	Projections 2/ 1980	2000	2020
	----------	----------1000----------		
San Pedro 1-County Area				
Cochise County				
Urban	39.9	44.6	57.0	68.2
Rural nonfarm	19.6	22.3	29.2	35.4
Rural farm	2.4	2.4	2.3	2.3
Total	61.9	69.3	88.5	105.9
Santa Cruz 3-County Area				
Pima County	)			
Urban	299.9)			
Rural nonfarm	47.7)			
Rural farm	4.0)			
	351.6)			
Pinal County	)			
Urban	32.5)		Projections	
Rural nonfarm	29.3)			
Rural farm	6.1)		not	
	67.9)			
Santa Cruz County	)		included	
Urban	8.9)			
Rural nonfarm	4.4)		in the	
Rural farm	.6)			
	13.9)		study	
3-County Total	)			
Urban	341.3)			
Rural nonfarm	81.4)			
Rural farm	10.7)			
	433.4)			
	----------	----------Percent----------		
Cochise County				
Urban	64.4	64.4	64.4	64.4
Rural nonfarm	31.7	32.1	32.9	33.4
Rural farm	3.9	3.5	2.7	2.2
	100.0	100.0	100.0	100.0
3-County Total				
Urban	78.7			
Rural nonfarm	18.8			
Rural farm	2.5			
	100.0			

1/ Source: 1970 Census of Population, General and Economic and Social Characteristics, Arizona.

2/ Based upon population projections given in Table 4.1 and historical trends.

BASE PERIOD AND DESIRED ECONOMIC DEVELOPMENT

Major Crop Enterprises

Base Period

The estimated acres harvested, production, and value of crops produced in the San Pedro and Santa Cruz study areas in 1970 are given in Table 4.4. Sorghum grain stands out as the major crop in the San Pedro study area, comprising 58 percent of the acreage harvested and 48 percent of the value of production. Wheat ranks second in acreage harvested, followed by upland cotton, alfalfa hay, barley, and vegetables. In the Santa Cruz study area upland cotton stands out, comprising 38 percent of the acreage harvested and 49 percent of the value of production. Barley ranks second in acreage harvested followed by sorghum grain, wheat, vegetables, and alfalfa hay. It may be noted that while vegetables rank relatively low in acres harvested, they rank second in value of production in both areas.

Desired Economic Development

The desired economic development objective in both the San Pedro and Santa Cruz study areas is to maximize income by increasing crop production as far as feasible and by increasing production efficiency. The specific desired condition for each of the second level components (preferences) listed in Chapter 3, Table 3.9, is shown in Table 4.6, located at the end of this chapter.

The desired economic development objective for the San Pedro study area is considered first, followed by that for the Santa Cruz study area. Since projections were made for the San Pedro study area, the desired economic development objective is presented as the desired future condition. In the Santa Cruz study area, where projections were not included in the study, it is presented as the desired 1970 condition, or the condition which would have been achieved in 1970 if action had been fully applied to overcome problems which existed.

San Pedro Study Area

Two primary limiting factors in increasing crop production in the San Pedro study area are: the amount of ground water available for irrigation and the amount of crop production it will pay to produce. Adequate productive land is available in the primary farming areas of the study area, but to expand beyond the base period irrigated acreage would involve capital expenditures to develop desert grassland for crop production which in turn would involve drilling new wells.

The Douglas Basin was declared a critical ground water area in 1965 and it is anticipated that the Willcox Basin will also be declared critical within the near future. While replacement wells can be drilled in

TABLE 4.4 - CROP PRODUCTION IN THE SAN PEDRO AND SANTA CRUZ STUDY AREAS, 1970 1/

Area and Crop	Acres Harvested	Production Unit	Production Quantity	Value ($1000)
San Pedro Study Area				
Cotton, upland	9,201			
Lint		1000 lbs.	4,910.7	1,866.1 2/
Seed		1000 Tons	4.1	217.3
Barley	4,327	1000 Cwt.	157.5	406.4
Sorghum grain	70,278	1000 Cwt.	3,923.1	9,611.6
Wheat	12,894	1000 Cwt.	503.9	1,269.8
Alfalfa hay	7,978	1000 Tons	44.8	1,348.0
Vegetables 3/	1,773	1000 Cwt.	425.0	2,804.9
Other crops	15,570			2,529.8
Total	122,021			20,053.9
Santa Cruz Study Area				
Cotton, upland	94,870			
Lint		1000 Lbs.	98,233.6	39,391.6 2/
Seed		1000 Tons	82.9	4,346.7
Cotton, Am.-Pima	8,049			
Lint		1000 Lbs.	4,468.7	2,323.7 2/
Seed		1000 Tons	4.6	241.3
Barley	38,151	1000 Cwt.	1,311.9	3,384.7
Sorghum grain 3/	31,169	1000 Cwt.	1,438.6	3,524.5
Wheat	20,824	1000 Cwt.	757.9	1,909.9
Safflower	2,250	1000 Cwt.	53.4	248.8
Alfalfa hay	9,797	1000 Tons	49.1	1,477.5
Vegetables, including potatoes 3/	10,508	1000 Cwt.	2,129.3	14,053.5
Other crops	32,212			9,801.0
Total	247,830			80,703.2

1/ The San Pedro estimates exclude the relatively small acreage of crops in the San Pedro Basin in Pima and Pinal Counties. This acreage was included in the Santa Cruz study area estimates.

2/ Includes price support payments.

3/ The acreage of sorghum grain and of vegetables is the "single crop" acreage, while production and value include the production on the "double cropped" acreage.

critical ground water areas, drilling of other new wells is prohibited. Thus, the irrigated acreage in the Douglas Basin is restricted to that which can be served by existing or replacement wells and it is expected that the same will be true in the Willcox Basin within the near future. As a result it was assumed that the irrigation water pumped in the study area in Cochise and Graham Counties would be restricted to the 434,000 acre feet pumped in 1970 and that the projected acreage used for crop production in the area would be limited to the irrigated acreage in the base period less the small acreage lost to urban and other non-crop uses. (The estimated irrigated acreage in the San Pedro study area in Cochise and Graham Counties in 1970 and projected maximums are shown in Table 4.5.)

In making these irrigation water and acreage projections it was recognized that some expansion occurred in pumpage and probably in irrigated acreage following the base year of the study, 1970, particularly in the Willcox Basin. The estimated acreage used for crops (harvested, skip-rows in cotton, and failure) in the study area in Cochise and Graham Counties in 1970 totaled 127 thousand acres, 21.8 thousand acres less than the irrigated acreage. Hence, a substantial part of the increase in harvested acreage which occurred in the early 1970's undoubtedly was on irrigated land that was idle in 1970. However, indications are that there may have been some additional expansion. As a result, perhaps the projections are low. However, they also may be high. The expansion in crop acreage following 1970 was in large measure due to unusually favorable feed grain prices, from a historical standpoint. With more normal relationships in the future, the acreage may stabilize or decline. Costs of production, commodity prices, and cost-price relationships used in the linear programming analyses were based upon relationships in the base period (1970 normalized). It was recognized that over time the price of one commodity may change relative to another, and that the relative cost of inputs may change. For example, it was recognized that the unit price of natural gas used in pumping irrigation water in the San Pedro study area may increase relatively more than some other input prices. However, this may be partially offset by improvements farmers make in efficiency of water use, such as by shifting to sprinkler irrigation, and partially by improvements they make in use of other inputs or by an increase in commodity prices. In other words, it was assumed that the relationship of costs as a whole and of commodity prices as a whole would be similar in the projection time-frame as in the base period. With this relationship there probably would be some idle cropland in the projection period as there was in the base period, indicating that there may be a contraction in harvested acres from the expansion which occurred following 1970. Moreover, the particular cropland acreage is not of prime importance in analyses of maximization of crop production and irrigation efficiency, since any new land brought into cultivation after 1970 would respond similarly to existing cropland and action to increase irrigation efficiency also would be similar. The amount of beneficial and adverse effects associated with various types of action would vary with the acreage of cropland but their ratio probably would not be significantly affected.

TABLE 4.5 - BASE PERIOD AND PROJECTED IRRIGATED ACRES AND IRRIGATION WATER PUMPED, SAN PEDRO STUDY AREA

Item	Unit	Time Period			
		1970	1980	2000	2020
Irrigated Land 1/	1000 Acres	148.8	148.4	147.9	147.4
Water Pumped 1/	1000 Acre Feet	434.9	434.9	434.9	434.9

1/ Excludes the relatively small amount of irrigated acreage (3700 acres) and water pumped for irrigation in the San Pedro study area in Pima and Pinal Counties.

Santa Cruz Study Area

Since projections were not included in analyses of the Santa Cruz study area, the desired objective was, as indicated above, to portray the situation as it would have been if planned action had been fully applied to overcome problems which held production and income in 1970 below the maximum potential. While there was some idle irrigated land in the basin in 1970, it was assumed that because of the critical ground water situation the acreage of crops would not be increased. Rather, emphasis would be placed on increased efficiency. Since there were no economically feasible flood control projects which would affect crop production in the basin under 1970 conditions, the planned action involved in the analysis was full (100 percent) land treatment to increase crop yields, production, production efficiency, and income.

Major Livestock Enterprises

Beef cattle are practically the only class of livestock produced in the study area. Most of these are produced on the range and those not kept for breeding purposes go primarily to the feeder livestock industry. The number of cattle on feed range from about 150,000 to about 200,000. Nearly all of these are in Pinal County with small feedlots, less than 500, in other counties. In addition to the feeder cattle, there are about 69,000 head of cattle in the San Pedro study area and about 81,000 head in the Santa Cruz study area.

The land used for grazing livestock in the San Pedro study area was about 3.8 million acres. About 38 percent of the grazing land is in private ownership, 36 percent in State ownership, and the remaining 26 percent is administered by the federal government.

Land use for grazing livestock in the Santa Cruz study area was about 4.3 million acres. About 26 percent is in private ownership, 26 percent is State ownership, 21 percent is administered by the federal government, and 27 percent on Indian reservations.

While the production of native forage in the San Pedro study area has declined from the original level due to overuse in the late 1800's and early 1900's, it continues to be relatively high compared with most other areas in the State. Nearly one-half the land grazed falls in the desert grassland classification.

The production of native forage in the Santa Cruz study area has also declined from the original level. Improvement in forage production with protection of the land from erosion and other deterioration is possible.

Irrigated pasture and aftermath of crops provide some feed in both areas. Some of this feed is utilized by horses, sheep, and other livestock kept on farms.

Change in land use as population increases is most evident on the forested lands where recreation demands are growing. Also, increased use is seen around water bodies.

Flood Damages

The desired situation concerning flood damages for both the Santa Cruz and San Pedro study areas is to reduce these flood damages to the greatest extent possible. Total fulfillment of this component would be to completely eliminate floodwater, sediment, and erosion damages caused by flooding within the study areas. However, it is recognized that the total elimination of these damages would not be economically or environmentally feasible and would probably not be physically possible.

Forestry

Nearly all forest resources of the study area are within National Forest boundaries. Therefore, economic activity related to forest resources on private, Indian Trust, Bureau of Land Management, and State lands is insignificant.

Presently, none of the study area is classified as commercial forest. Forest management generally aimed at providing a sustained yield of commercial lumber has been gradually revised toward a form of management that best serves recreation needs of people living in the desert towns and cities. This is exemplified by the Chiricahua Mountains which have been taken out of production of wood products and placed in a national monument and a wilderness area. The forested areas at higher mountainous elevations have numerous uses such as varied recreation activities and various types of nature studies. With emphasis on these activities, lumbering activities are largely limited to salvage operations and provide minimal employment and income within the study area.

A timber policy statement for timber management of the conifer forests in the Graham Mountain Range is still in operation; it is gradually being changed to meet increasing recreational demands. The programmed allowable harvest is only 1 million board feet of sawtimber and 2,000 cords of other products annually. The lumber and other wood product needs of the basin will continue to be met by importing from outside the basin.

Water-Based Outdoor Recreation

The estimated demands for water-based recreation in 1970 reflect the desires of people as indicated in the State-Wide Comprehensive Outdoor Recreation Plan, No. 2, Demand Research, prepared for the Arizona Outdoor Recreation Coordinating Commission, June 1972. Projections for the San Pedro study area were derived from the base period demands, 1970, and projected increase in population. Projections were not made for the Santa Cruz study area and the demand was based on base year conditions. The total recreation demand was calculated for those activities commonly associated with water. These activities are picnicking, camping, lake swimming, boating, and water skiing. (See Table 4.6.)

BASE PERIOD AND DESIRED ENVIRONMENTAL CONDITIONS

Environmental problems and components from Chapter 3 and associated base period and desired conditions are summarized in Table 4.6. These are discussed in the following section.

Areas of Unique Biotic Significance

There are seven areas of unique biotic significance that need to be preserved or protected. Aravaipa, Ramsey, and Carr Canyons are located in the San Pedro study area. Parker and Gardner Canyons, Patagonia-Sonoita Creek, and Blue Haven are in the Santa Cruz study area. Most of the concerned areas are in public ownership but are interspersed with private lands and, therefore, subject to change and possible loss of the desired environmental qualities. The desired condition is to protect or preserve these areas in their present environmental condition.

Areas of Natural Beauty

The natural processes in the basins have resulted in the formation of many unique, biologic, and geologic features. Esthetic values include timber clad mountains, canyons, stands of riparian vegetation, grassland, desert, and even eroding "badlands" which add contrast to surrounding areas.

Natural beauty has been impaired by poorly planned roads, utility lines, mining, and remote subdivisions. The area is subject to continued impairment because of rapid development.

Presently there are 68,244 acres in the San Pedro study area protected from such impairment. (See Table 4.6.) This acreage includes 58,217 acres administered by the Forest Service in the Chiricahua and Galiuro wilderness areas, 4,357 acres in the Aravaipa primitive area administered by the Bureau of Land Management, and 5,670 acres of natural area on private land owned by the Defenders of Wildlife. There are 58,242 acres with similar protection in the Santa Cruz study area. Included

are 5,142 acres in the Santa Catalina and Butterfly Peak natural areas administered by the Forest Service, and 53,100 acres managed as wilderness in the Saguaro National Monument. Through rigid restrictions on uses, it is intended that these areas retain their pristine qualities for the enjoyment and appreciation of this and future generations. These are areas of retreat from the pressures of civilization.

As indicated in Chapter 3, additional areas will need protection through restricted use to provide continued opportunities for the increasing human population. Without additional areas of restricted use, either the existing ones will become overused and their qualities degraded, or the numbers of people using them will have to be strictly controlled. The desired conditions (Table 4.6) are based on the OBERS population projections.

Erosion and Sediment

Except for the San Pedro and Aravaipa Valleys and relatively small portions of the Santa Cruz study area, erosion is slight to moderate. Improved management is desired on grazing lands with slight erosion; 3,263,000 acres in the San Pedro study area and 3,820,000 acres in the Santa Cruz study area. Installation of erosion control practices with improved management is desired on grazing lands with moderate erosion; 522,000 acres in the Santa Cruz study area and 499,000 acres in the San Pedro study area. Such treatment would reduce erosion by an estimated 570 acre-feet per year in the Santa Cruz study area and 1,410 acre-feet per year in the San Pedro study area.

Establishment of drought resistant, salt tolerant plant species and provision for sediment storage on small tributaries are desired. Such treatment on 192,000 acres in the San Pedro study area and 7,500 acres in the Santa Cruz study area could reduce sediment yield to the Gila River by an estimated 335 and 8 acre-feet per year, respectively.

Streambank erosion protection is desired on 115 miles of channels in the San Pedro study area and 75 miles in the Santa Cruz study area, resulting in an estimated sediment yield reduction of 35 and 25 acre-feet per year, respectively.

Much of the critically eroding areas are on State land. The State Land Department does not have funds for the improvement or treatment of State lands and relies on leasees for funding such work. Legislation is desired to establish a revolving fund which would enable the State Land Department to enter into a program of intensive management and treatment.

The general public does not have a good understanding of the processes of erosion and the causes of accelerated erosion. The lower, drier

areas of the San Pedro Valley offer excellent opportunities for establishing exhibits which would promote both human enjoyment and education. At higher elevations, opportunities are not as well suited because of slower erosion rates. Exhibits are desired, however, in several environmental zones in order to show the effects of various parameters on the erosion process.

Ghost Towns, Historic Buildings, and Indian Culture

Provision for adequate restoration, excavation, stabilization, and/or protection of 70 historic and archeological sites in the San Pedro study area and 109 sites in the Santa Cruz study area is desired. Nine sites in the San Pedro area and 12 sites in the Santa Cruz area have been identified by the State Parks Department as needing immediate protection.

Solid Waste and Litter

In 1970 solid wastes collected in urban areas amounted to five pounds per day for each person and is expected to increase to eight pounds per day by 1980. 5/ Several factors could modify present trends. 6/

1. Rates of population increase.
2. Affluence and consumption by the population.
3. Types of package material and products used.
4. Advances in recycling techniques.
5. Legislation designed to lower solid waste volume.
6. Changes in public attitude.

Based upon population projections, the amount of solid waste generated in the San Pedro study area will be 280 tons per day by 1980, 355 tons per day by 2000, and 425 tons per day by 2020. The present solid waste production in the Santa Cruz study area is estimated at 970 tons per day. The estimates for both study areas do not include solid waste from sewage wastewater treatment plants.

The desired condition for solid waste disposal is to provide adequate regulation, collection, and disposal services for waste disposal and to clean up existing dumps in order to maintain a quality environment for current and future residents in the basins. There are no physical resource base limitations to the attainment of this desired condition. The land is available. The solution lies in the area of education for public awareness, enforcement of existing statutes, possible shifts in current fund allocation priorities, and financial assistance to local governments.

5/ Fogg, Charles E., Agricultural Waste Management, USDA, SCS, January 1973.

6/ Arizona Department of Health Services, Solid Waste Management Plan, July 26, 1973.

Fish and Wildlife

During pre-Columbian time, man depended upon fish for food and on wildlife for food, clothing, and shelter. At that time, wildlife was the primary product of the land. With the introduction of domesticated plants and animals to produce a more dependable food supply for man, wildlife has become a by-product in the study area. Production of domestic plants and animals increased to the point that production of some species of wildlife was reduced. Some wildlife species have disappeared from the area.

Man's need for wildlife remains, however, whether it be for hunting, wildlife study, or purely for esthetic purposes. The desired condition for wildlife and wildlife habitat is to protect the existing quality and quantity of habitat and diversity of fish and wildlife species while expanding selected habitat types to compensate for the quality of life needs for expanding human populations.

The primary concern with open water is the perpetuation of the resource in the quantity and quality in which it occurs under present conditions. The desired condition is to manage the existing resource to provide all individuals equal opportunity to avail themselves of the quality of life experience associated with the resource.

TABLE 4.6 - DESIRED CONDITIONS - SANTA CRUZ-SAN PEDRO RIVER BASINS

Second Level Component From Table 3.9 1/	Unit	San Pedro Study Area Time Period 1970	1980	2000	2020	Santa Cruz Study Area Desired Present
NATIONAL ECONOMIC DEVELOPMENT						
1. (Floodwater, erosion, and sediment damages)						
Desired Damage Reduction						
Agricultural Damage Avg. Ann.	Dollars	762,800	889,000	1,061,000	1,241,000	1,484,700
Nonagricultural Damage Avg. Ann.	Dollars	618,900	695,800	942,300	1,362,500	709,000
2(a). (Crop production)						
Net Return	Dollars	3,241,000 2/	4,874,800	7,965,400	10,964,400	13,660,600
2(b). (Livestock forage production)						
Production	AUM	783,000 2/	990,000	1,400,000	1,809,000	1,757,000
Value of Production	Dollars	2,741,000 2/	3,465,000	4,900,000	6,332,000	6,149,500
3. (Water-based recreation)						
Satisfy Recreation Demand	Activity					
Picnicking	Occasions	845,600	947,100	1,209,200	1,446,000	4,243,800
Camping	"	180,700	202,400	258,400	309,000	1,026,400
Lake Swimming	"	378,000	423,400	540,600	646,500	950,000
Boating	"	139,000	155,700	198,800	237,700	396,000
Water Skiing	"	61,200	68,500	87,500	104,600	135,000
ENVIRONMENTAL QUALITY						
1. (Fishery habitat and esthetics)						
Lake Habitat	Sur. Ac.	150	150	150	150	580
Pond Habitat	Sur. Ac.	1,830	1,830	1,830	1,830	1,690
Stream Habitat	Str. Mi.	115	115	115	115	70

TABLE 4.6 - DESIRED CONDITIONS - SANTA CRUZ-SAN PEDRO RIVER BASINS
(Continued)

Second Level Component From Table 3.11 1/	Unit	San Pedro Study Area Time Period 1970	1980	2000	2020	Santa Cruz Study Area Desired Present
2(a).(Wildlife oriented management techniques)						
Wildlife Oriented Grazing Lands	Ac.	3,167,000	3,167,000	3,167,000	3,167,000	5,078,000
Forestland-Silviculture and Controlled Burning Techniques Practiced	Ac.	78,000	78,000	78,000	78,000	52,000
Cropland Acres Producing Food and Cover for Wildlife	Ac.	1,700	1,700	1,700	1,700	4,200
2(b).(Wildlife water developments)						
Additional Water Developments Desired	No.	1,267	1,267	1,267	1,267	1,500
2(c).(Restoration of rangeland and forestland habitat)						
Restore Overused Acres	Ac.	50,000	50,000	50,000	50,000	55,000
2(d).(Restoration of abandoned irrigated land)						
Area to be Restored	Ac.	19,000	19,000	19,000	19,000	34,000
2(e).(Multiple use planning)						
Area in Need of Adequate Multiple Use Planning	Ac.	61,000	62,000	64,000	65,000	124,000
2(f).(Unique biotic inhabitants)						
Preserve or Improve Habitat for:						
1. Antelope	Ac.	1,936,000	1,936,000	1,936,000	1,936,000	1,157,000
2. Arizona Black Tail Prairie Dog	Ac.	1,936,000	1,936,000	1,936,000	1,936,000	--

TABLE 4.6 - DESIRED CONDITIONS - SANTA CRUZ-SAN PEDRO RIVER BASINS
(Continued)

Second Level Component From Table 3.11 1/	Unit	San Pedro Study Area Time Period 1970	1980	2000	2020	Santa Cruz Study Area Desired Present
3. Masked Bobwhite Quail	Ac.	1,936,000	1,936,000	1,936,000	1,936,000	1,157,000
4. Botteri's Sparrow	Ac.	1,936,000	1,936,000	1,936,000	1,936,000	--
3(a).(Riparian communities)						
Maintain Riparian Communities	Ac.	35,000	35,000	35,000	35,000	43,000
3(b).(Restore riparian communities)						
Area to be Restored or Improved	Ac.	17,500	17,500	17,500	17,500	21,500
4(a).(Expand wetland)						
Expand Wetland Area	Ac.	100	100	100	100	100
4(b).(Encourage wetlands)						
Wetland Management and Faciltiies	No.	350	480	740	1,000	430
On Ponds	Sur. Ac.	365	500	772	1,043	448
5. (Unique biotic areas)						
Area to be Preserved and Protected	No.	3	3	3	3	4
6. (Restricted use areas)						
Establish Areas of Natural Beauty	Ac.	68,000 2/	78,000	101,000	126,000	68,000
7. (Erosion exhibit areas)						
Exhibit Areas	Ac.	40	40	40	40	10
8. (Fuel buildup)						
Prevent Fuel Buildup on Wilderness Areas	Ac.	68,000	68,000	68,000	68,000	5,000

TABLE 4.6 - DESIRED CONDITIONS - SANTA CRUZ-SAN PEDRO RIVER BASINS
(Continued)

Second Level Component From Table 3.11 1/	Unit	San Pedro Study Area Time Period 1970	1980	2000	2020	Santa Cruz Study Area Desired Present
9. (Archeological and historical) Areas to be Protected	No.	82	82	82	82	117
10(a). (Critical erosion areas) Manage Vegetation and Install Structures on Critical Areas	Ac.	192,000	192,000	192,000	192,000	7,500
Reduce Sediment Yield	AF/Yr.	335	335	335	335	8
10(b). (Streambank protection) Protect Streambank	Mi.	115	115	115	115	75
Reduce Sediment Yield	AF/Yr.	35	35	35	35	25
10(c). (Grazing land erosion control) Install Erosion Control Practices	Ac.	3,762,000	3,762,000	3,762,000	3,762,000	4,342,000
Reduce Erosion	AF/Yr.	1,410	1,410	1,410	1,410	570
11(a). (Solid waste disposal) Provide Disposal Facilities	No.	17	17	17	17	18
11(b). (Dump cleanup) Clean up Dumps	No.	160	180	200	220	400

1/ See Table 3.9 for the complete statement of the second level components (preferences).
2/ Reflects conditions that existed in 1970 and are not necessarily the desired condition.

CHAPTER 5

RESOURCE BASE AND EXISTING PROGRAMS

LOCATION

The San Pedro study area, located in portions of Cochise, Graham, Pima, Pinal, and Santa Cruz Counties, includes the Arizona portions of the San Pedro River, Willcox Basin, Douglas Basin, and San Bernardino Valley Area. The San Pedro River heads in Mexico and outlets into the Gila River in Pinal County, Arizona. Six hundred and ninety-six square miles of its drainage area are in Mexico, and 3,789 square miles are in Arizona. Willcox Basin is a closed basin which receives runoff from northern Cochise County and southern Graham County. Douglas Basin and San Bernardino Valley area head in Cochise County, Arizona but flow southward into Mexico and drain into the Rio Yaqui. Also, the Arizona part of Douglas Basin receives runoff from 109 square miles in Mexico.

The Santa Cruz study area includes the drainage areas of the Santa Cruz River within Arizona and minor north flowing tributaries of the Gila River lying between the mouths of the San Pedro and Santa Cruz Rivers. The area covers 9,483 square miles in parts of Santa Cruz, Pima, Pinal, Maricopa, and Cochise Counties. Heading in southeastern Santa Cruz County, the Santa Cruz River flows southward into Mexico, changes directions to a northerly flow, and re-enters Arizona in southern Santa Cruz County. Three hundred and ninety-five square miles of its drainage area are in Mexico. In Arizona, the river flows northward and northwestward to its confluence with the Gila River about 12 miles southwest of Phoenix.

CLIMATE

Climatic zones range from the hot, dry, Sonoran Desert with an elevation as low as 1,000 feet above sea level to the cool, moist, conifer-forested mountains ranging between 6,000 and more than 10,000 feet elevation. The major lowland areas between the mountain ranges are warm and dry. Large fluctuations in precipitation occur from year to year. Where irrigation removes the uncertainty of available moisture, the long, warm, frost-free growing seasons are highly favorable to cropland agriculture. The climate also makes the region attractive as a tourist area and as a location for retirement communities.

Mean annual precipitation is between 8 and 12 inches in the valleys and plains and 16 to 20 inches in the generally inhabited parts of the mountains. In the higher mountain regions, representing less than one percent of the area, the average annual precipitation is more than 30 inches (Figure 5.1). Almost half of the total annual precipitation falls during July and August (Figure 5.2). A second wet season extends from December through the middle of March. The driest season is during May and June.

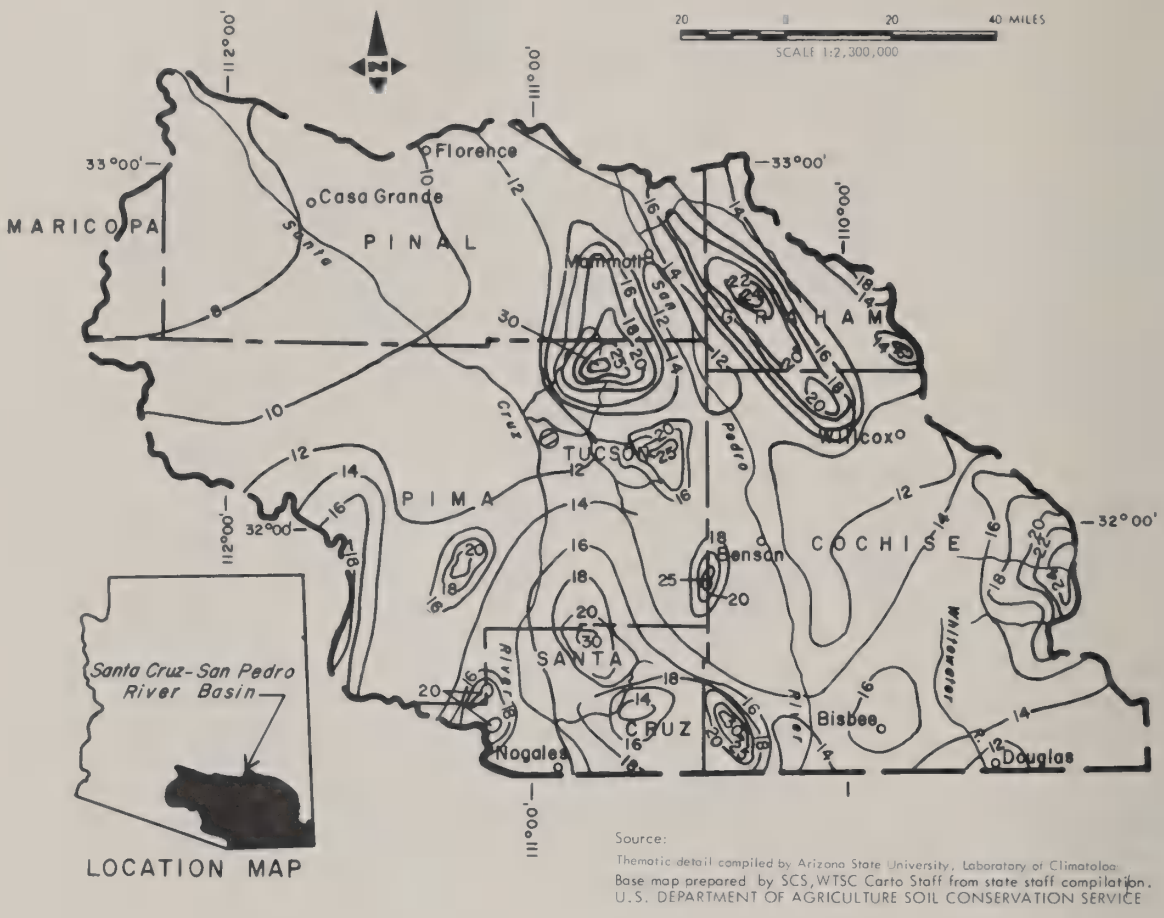

FIGURE 5.1 - Normal Annual Precipitation in the Santa Cruz-San Pedro River Basins.

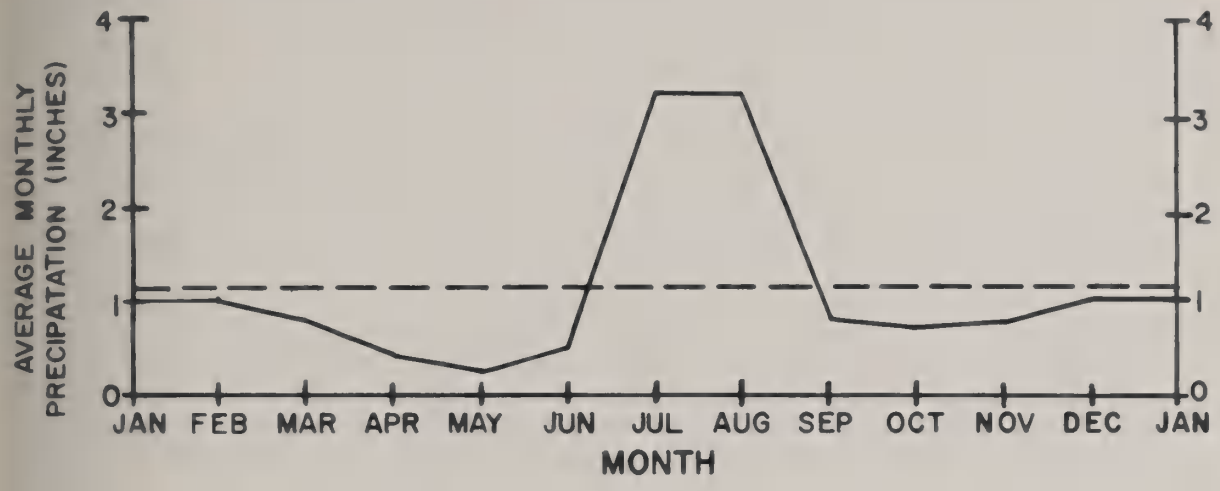

FIGURE 5.2 - Average Variation of Mean Monthly Precipitation in the Santa Cruz-San Pedro River Basins. Horizontal dashed line superimposed on curve indicates the average twelve monthly values. (Arizona Climate, C.R. Green and W.D. Sellars, 1964, page 10.)

There are moderate variations of temperature across the area. Mean minimum temperatures in January are near freezing or below over practically the entire desert floor and valley slopes. The mean minimum January temperatures range from about 32.7 degrees Fahrenheit at Casa Grande to a low of 25 degrees at Willcox. Extreme January temperatures of 17 degrees and minus one degree, however, have been recorded at these two locations, respectively.

The mean high July temperatures range from 105 degrees in the valleys and plains to the upper 80's in the generally inhabited parts of the mountains. The maximum extreme July temperature recorded in the area was 122 degrees at Casa Grande.

Few locations have comfortable temperatures all year. One of the most comfortable parts of Arizona, however, is located in the hill country in the southern portion of the river basins. The communities of Sierra Vista, Bisbee, Sonoita, Patagonia, Tombstone, and Canelo have especially mild climates, and many retirement communities are being located in their vicinities.

The combination of high temperatures and low humidity causes high rates of evaporation and transpiration within the area. In the valleys and plains where the human need for water is greatest, there is the least amount of precipitation; and the potential for evapo-transpiration is greatest. Mean annual lake evaporation rates range from about 64 inches near Willcox to 72 inches near Maricopa.

The length of growing season ranges widely and depends on the local elevation and the nature of the surrounding terrain. Based on the 32-degree threshold, the growing season ranges from about 180 days in the Willcox area to 300 days on the western edge of the Santa Cruz study area.

Wind patterns throughout the entire area are greatly affected by the slopes and character of the terrain. Wind speeds are generally less than 10 miles per hour, but maximum velocities of over 60 miles per hour have occurred during intense thunderstorms. The direction of the wind associated with thunderstorms is generally of a random nature.

Wide daily and seasonal variation in relative humidity occur within the river basins. It reaches its peak in August, has moderate peaks during December through February, and declines to a low in May and June.

PHYSIOGRAPHY

The Santa Cruz-San Pedro River Basins lie entirely within the Basin and Range physiographic province. The area is characterized by broad, semi-arid to arid valleys oriented in a north to northwest direction and separated by mountain ranges rising abruptly above the "plains."

The positions of alternating mountains and valleys were set mainly during Miocene and Pliocene time when the earth's crust underwent disturbances resulting in uplift, faulting, and tilting. Today's mountain ranges are generally uplifted fault blocks, and the valleys are down-faulted blocks. While erosion was wearing away the young mountains, the valley basins were being filled with sediment. The area continued to be subjected to varying degrees of uplift, subsidence, faulting, and tilting. As a result of intermittent volcanism, there are places where lavas are interbedded with valley alluvium.

Poorly developed drainage systems and the existence of many lakes retarded sediment movement and accounted for rapid filling of the basins. For millions of years, the basins had no outlets; but drainage patterns became progressively more defined; and during Pleistocene time, westward drainage of the Gila River was established. Presently, all but one basin within the area has through-drainage. In the Willcox Basin, all surface water flows inward toward the Willcox Playa. The Playa is a shallow lake, covering about 51 square miles, where water gathers infrequently and evaporates quickly.

Within the study areas, the Basin and Range province is further divided into two parts the Mexican Highland section and the Sonoran Desert section (Figure 5.3).

Mexican Highland Section

Approximately 95 percent of the San Pedro study area and 51 percent of the Santa Cruz study area lie within the Mexican Highland section. Mountain masses, ranging from 4 to 20 miles wide and from 10 to 35 miles long occupy nearly half the section. Generally, their summits rise 2,000 to 5,000 feet above the adjoining valley floors. The highest point in the study areas, at 10,713 feet above mean sea level, occurs on the northeastern divide on Mt. Graham. This peak is the summit of the Pinaleno Mountains and towers more than 7,800 feet above the Gila River Valley just outside the San Pedro study area. Other prominent peaks include Chiricahua Peak on the southeastern divide at 9,695 feet above sea level; Mt. Wrightson (9,432 feet) in the Santa Rita Mountains in Santa Cruz County; Miller Peak (9,466 feet) in the Huachuca Mountains of southeastern Cochise County; and Mt. Lemmon (9,157 feet) in the Santa Catalina Mountains just northeast of Tucson.

Valley elevations range from nearly 1,800 feet to nearly 5,000 feet above sea level. Relief of the valley floors ranges mostly between 500 and 1,000 feet. Most of the relief occurs adjacent to the mountains on the bajada, an apron of confluent alluvial fans sloping away from the mountain front (See Figure 5.4). With the exception of the San Pedro Valley, the valley interiors slope very gently. The valley fill in the narrow San Pedro Valley, however, has been dissected deeply. The river lies as much as 1,500 feet below the mountain bases, and most of the relief occurs within a narrow strip adjacent to the river flood plain. Steep barren slopes, headcutting gullies, severe streambank erosion, and piping soils are common.

Sonoran Desert Section

About 5 percent of the San Pedro study area and 49 percent of the Santa Cruz study area lie within the Sonoran Desert section. In comparison to the Mexican Highland section, the Sonoran Desert is characterized by lower elevations; drier climate; generally less defined stream systems; gentler, more expansive valleys; and shorter, more narrow mountain ranges. The deeply dissected San Pedro Valley is a major exception to the usual expansive valleys and less defined stream systems.

Valley elevations in the Sonoran Desert section range from less than 1,000 to about 3,500 feet above sea level. Mountain summits range from less then 2,400 feet above sea level to 4,788 feet on Mt. Devine in the North Comobabi Mountains.

GEOLOGY

The variety of rock types in the mountain ranges and their complex structure bear mute testimony to violent events which have taken place through geologic time. The area has been subjected to many disturbances including subsidence, sea invasions, upwarping, erosion, igneous intrusions, volcanism, faulting, and metamorphism.

Rocks ranging in age from Precambrian through Quaternary are exposed in the river basins (Geology Map at back of report).

Older Precambrian rocks, including granitic and highly deformed metamorphic rocks, underlie the area and are exposed in many of the mountain ranges. Some of the outcrops are extensive, as exemplified in the Tortilla, Tortolita, and the northern end of the Santa Catalina Mountains.

Small scattered outcrops of Younger Precambrian rocks, consist of quartzite, shale, limestone, diabase, and basalt. They exist in the Aravaipa Canyon area, Tortilla Mountains, and on the northern end of the Santa Catalina Mountains.

A sequence of sedimentary rocks was laid down as seas advanced and receded several times during the Paleozoic Era. Most of these strata have been removed by erosion or covered by valley fill. Remnants of limestone, dolomite, shale, sandstone, and quartzite occur in mountain ranges of the southern part of the study areas. In places, the sequence is more than 5,000-feet thick. Outcrops tend to be elongated and limited in extent.

Triassic and Jurassic rocks are primarily volcanic, pyroclastic, and granitic. They bear evidence of upwarping, igneous intrusions, volcanic activity, faulting, and metamorphism. These rocks are found in mountain ranges of Santa Cruz County and southwestern Cochise County.

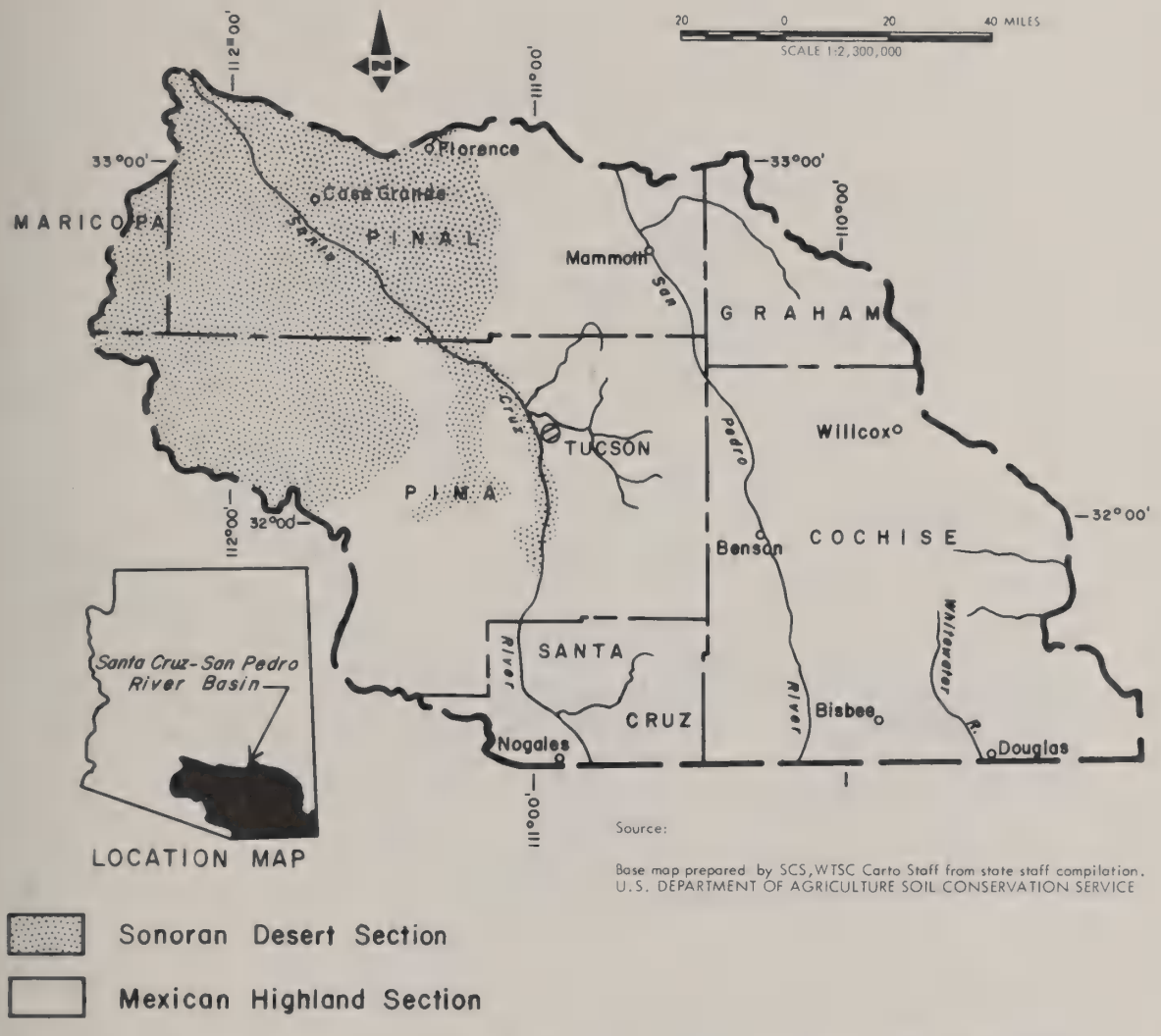

FIGURE 5.3 - Physiographic Sections of the Santa Cruz-San Pedro River Basins.

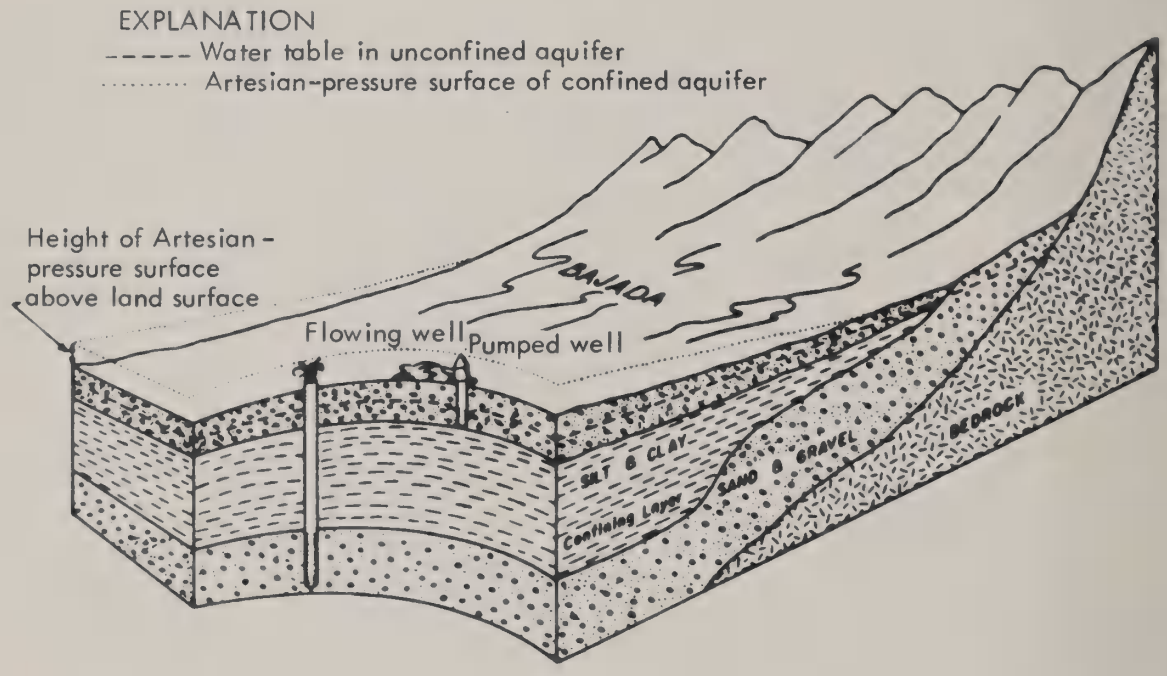

FIGURE 5.4 - General Geologic Conditions and Occurence of Ground Water in a Typical Alluvial Basin of the Santa Cruz-San Pedro River Basins.

Several thousand feet of shale, conglomerate, and sandstone in the southern part of the area mark two advances of the sea during the Cretaceous period.

Late Cretaceous and early Tertiary igneous intrusive rocks and a large variety of volcanic rocks in most mountain ranges are evidence of the major mountain building activity which uplifted all of western North America.

Volcanic activity continued into the Tertiary and Quaternary periods while alluvium accumulated to great thicknesses in the present-day valleys. The Quaternary period is predominantly represented by valley alluvium. The majority of the Chiricahua and Galiuro Mountains are covered with thick accumulations of Tertiary volcanic rocks, and the San Bernardino Valley contains a large mass of Quaternary basalt flows and cinder cones.

The alluvial valleys are filled with Tertiary and Quaternary gravel, sand, silt, and clay to thicknesses which exceed 5,000 feet in places. These semi-consolidated and consolidated deposits contain the principal water supplies of the area.

MINERAL RESOURCES 1/

The Santa Cruz-San Pedro River Basins are well endowed with mineral resources. Important metallic minerals are contained in rocks of various types and ages. Presently, the most important mineral resources are copper, sand and gravel, molybdenum, gold, stone, lime, silver, cement, zinc, and gypsum. The 1970 value of mineral production was greater than $900,000.

Arizona has ranked first among the United States in copper production since 1910 and presently accounts for more than half the Nation's annual production. Many copper deposits have been and are being mined within the study areas. The Warren (Bisbee), Old Hat (Mammoth), Pima, and Silver Bell districts are among the leading producers. Mining operations at Bisbee, however, were phased out early in 1974. Santa Cruz County is within an area which appears especially favorable for new discoveries of economic importance.

Early silver bonanzas, especially in the Tombstone and Pearce areas, greatly influenced Arizona history. Since 1903, however, the output of silver has come mainly as a by-product of base-metal ores. Recently,

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1/ The principal sources for this section were: Arizona Bureau of Mines, A Resume of the Geology of Arizona, Bulletin 1971, September 1962, and U. S. Geological Survey, Arizona Bureau of Mines, and U. S. Bureau of Reclamation, Mineral and Water Resources of Arizona, for use by Committee on Interior and Insular Affairs, 90th Congress, 2nd Session, 1969. Also published as Arizona Bureau of Mines Bulletin 180, May 1969.

the mines at Bisbee were among the leading silver producers in Arizona. Santa Cruz, western Cochise, and southeastern Pima Counties are considered to be particularly favorable for further prospecting.

Since 1940, gold also has been taken mainly as a by-product of base-metal ores. The Bisbee and Mammoth districts have been the major producers

Arizona has ranked high in the production of lead and zinc since 1940. The Warren, Old Hat, Tombstone, Harshaw, Pima, Ruby, and Patagonia districts are largely responsible for Arizona's high lead production. Leading zinc producing districts within the area are Warren, Harshaw, Old Hat, Pima, and Cochise. Santa Cruz and western Cochise Counties are included in the areas expected to produce the bulk of future lead and zinc.

Expanding uses and demands for molybdenum since 1914 have encouraged its mining in Arizona. Since 1933, essentially all of Arizona's molybedenum has been recovered as a by-product of treating copper ores from several districts, including Old Hat, Pima, and Silver Bell.

Limestone, dolomite, and marble are important resources occurring mainly in mountain ranges in the southeastern part of the study areas. They are quarried mostly as crushed, broken, and dimension stone. The more important uses of the crushed and broken stone include Portland cement and lime. Major producers are located at Rillito, on the north end of the Santa Rita Mountains, and at Camp Grant in the Lower San Pedro Valley.

The annual value of sand and gravel ranks second to copper. Deposits occur in recoverable concentrations in Cenozoic sediments mainly in alluvial fans, buried stream channels, and terraces near mountain fronts. The best and most accessible deposits are being exploited in the Tucson area. Significant production is occurring in the Bisbee, Willcox, Florence, Casa Grande, and Nogales areas.

Deposits of gypsum occur in the Empire, Whetstone, Sierrita, and Santa Rita Mountains, but the major share of Arizona's production comes from Cenozoic valley fill in the San Pedro Valley.

Many other mineral resources occur within the area. Those which have been produced, are being produced on a small scale, or have apparent potential for future production include iron, vanadium, antimony, tungsten, manganese, beryllium, tellurium, selenium, uranium, rare earths, zircon, barite, diatomaceous earth, bentonite, refractory clay, structural clay, pumice, perlite, feldspar, fluorspar, gem stones, mica, quartzite, brines, shale, sulphur, and zeolites. Improved methods of prospecting, mining, metallurgy, and transportation and new uses for various minerals will undoubtedly result in initiating or increasing the production of many mineral resources in the future.

There is the possible existence of economically significant geothermal resources at great depth. Presently, there are only surface indications in the form of thermal springs and wells. These do not necessarily indicate great geothermal resources. Test drilling has occurred north of the Santa Cruz study area near Chandler, but very little data are available at this time.

SOILS

Soil is the product of soil-forming processes acting on accumulated geologic material. The five important factors in soil formation are parent material, climate, plants and animals, relief, and time. All five factors come into play in the formation of every soil, and the relative importance of each differs from place to place. In general, however, it is the combined action of the five factors that determines the present character of each soil.

General Soil Areas

The General Soil Map of the study areas (at back of report) shows 26 soil associations. A soil association is a landscape that has a distinct proportional pattern of soils or land types. It usually consists of one or more major soils or land types and some minor soils. It is named for the major soils or land type. The soils in one association may occur in another, but in a different proportion or pattern. The 26 soil associations on the General Soil Map legend have been arranged into six groups. These groups are: (1) soils of the river bottoms and alluvial fans; (2) soils of the valley slopes; (3) shallow soils over bedrock; (4) limy soils on valley slopes and high fans; (5) soils of the mountains; and (6) eroded lands. The General Soil Map does not show the kind of soil at any particular point. It does show land patterns made up of different kinds of soils.

PLANT COVER

Ninety percent of the cover in the study areas is native vegetation. These native plant communities include: riparian, pine-mixed conifer, oak woodland-chaparral, desert grassland, Sonoran and Chihuahuan deserts (Vegetation, Croplands, Urban, and Mining Areas Map at back of report). Although introduced species of trees and grasses are prominant in some areas, they represent a small percentage of the total plant population. Plant succession occurring naturally, and in some cases accelerated by man, has caused plant species composition to change in many areas. Ten percent of the land is in cropland, urban, and other cover which in some cases also includes native plants.

The land and cover during the base period was used for crop production, grazing, timber production, urban and industrial, outdoor recreation, designated wilderness, military, mineral production, fish and wildlife, transportation, utilities, and other purposes (Tables 5.1 and 5.2).

Riparian

Riparian communities, occupying about 78,000 acres, are found mainly along streams, washes, and reservoir deltas. There are about 35,000 acres of riparian vegetation in the San Pedro study area and about 43,000 acres in the Santa Cruz study area. The occurrence ranges from the mountains to the confluences of the San Pedro and Santa Cruz Rivers with the Gila River. Tall, broadleaf deciduous dominant species include Arizona alder, Arizona sycamore, and aspen. Tall evergreens such as spruces, firs, and pines assume riparian growth habits where they grow along streams at the high mountain elevation. Other common riparian broadleaf trees include cottonwoods, willows, walnuts, ash, liveoaks, maples, mesquite, hackberries, and desert willows. Common shrubs include wild tobacco, chokeberry, seepwillow, catclaw, saltcedar, and elderberries. Understory grasses and herbaceous species are those common to adjoining vegetative types.

Pine-Mixed Conifer

Conifer forests occupy more than 130,000 acres and occur above 6,000 feet elevation on the scattered mountain ranges where annual precipitation averages more than 20 inches. About 78,000 acres are in the San Pedro study area, and more than 52,000 acres are in the Santa Cruz study area. Tall, long-lived evergreen tree dominants include ponderosa, Apache, Chihuahuan, and southwestern white pines. Douglas, white, and alpine firs, along with Engelman spruce, usually grow on moist north-facing slopes. Other common trees include aspen, Gambel oak, New Mexico locust, Arizona cypress, and Emory and Arizona white oaks. Of a large number of understory grass species, the most common include mountain muhly, Arizona fescue, pine dropseed, June grass, bromes, and several species of gramas. Other common herbaceous species include lupines, groundsels, vetches, asters, goldenrods, pussytoes, and knotweeds. Timber is harvested on a salvage rather than a commercial basis.

Oak Woodland-Chaparral

A combination of oak woodlands, pinon-juniper, and chaparral occupies more than 1,600,000 acres mainly from 4,500 to 6,500 feet elevation. About 947,000 acres lie in the San Pedro study area. The Santa Cruz study area contains about 672,000 acres. On north slopes, the plant community may drop below 4,000 feet, and it may be found above 6,500 feet on south slopes. This community is located below the conifer forest and above the desert and desert grassland. The average annual precipitation ranges between 14 and 20 inches. Oak woodland-chaparral is dominated by a common overstory of long-lived mid and short evergreen trees such as Emory, gray, silver leaf, Arizona, and Mexican blue oaks; alligator and one-seed junipers; Arizona cypress; and two species of pinons. There are few deciduous trees. The most common tall, mid, and

short evergreen shrubs include manzanitas, mountain mahogany, California buckthorn, shrub liveoak, cliffrose, silktassel, and ceanothus. The few deciduous shrubs include squaw bush, four-wing saltbush, fairy duster, and shrubby buckwheat. Other common species include yuccas, agaves, and bear-grass.

Although ground cover is sparse under woodland-chaparral stands with canopies in excess of 60 percent, a large number of perennial grasses and forbs are found where canopies are less than 30 percent. A few of the common understory grasses and forbs include three-awns, several species of muhly, sideoats and other species of gramas, deergrass, bullgrass, sprangletop, love grass, June grass, goldeneye, deer vetch, prickly poppy, asters, fleabanes, buckwheats, lupines, and groundsels. Annual grasses and forbs are found on disturbed areas in years of above average precipitation.

Desert Grassland

Desert grasslands occupy more than three million acres below the oak woodland-chaparral zone at elevations ranging mainly between 3,000 and 5,000 feet. More than 1.9 million acres are in the San Pedro study area, and nearly 1.2 million acres are in the Santa Cruz study area. The prevailing lifeforms are tall, mid, and short perennial grasses and forbs including sacaton, tabosa, bluestem, three-awns, sideoats grama, black grama, blue grama, curly mesquite, verbena, fleabanes, and Mexican poppy. Low shrubs that are common in desert grassland include false mesquite and shrubby buckwheat. Annual grasses and forbs are also common and become most abundant during winter or summer seasons of above average rainfall. Short and prostrate grasses and forbs such as curly mesquite, creeping muhly, plantains, and fluffgrass make up an important part of desert grasslands when tall and mid grasses are reduced by overgrazing. Annual three-awns, annual burrowweed, six-weeks grama, needlegrass, lupines, prickly poppy, careless weed, and annual muhly are most abundant on overgrazed ranges in years of above average winter and summer rainfall.

Southern Desert

The Chihuahuan Desert occupies more than 622,000 acres, all within the San Pedro study area. It blends with the Sonoran Desert north of Benson and extends southward along the San Pedro River to the International Boundary and eastward to the San Bernardino Valley. Large "islands" of Chihuhuan Desert occur throughout the Sulphur Springs Valley on limestone soils and hills surrounded by desert grassland. This vegetation type is normally found at elevations between 3,800 feet to 5,000 feet. Limited extensions are found down to 3,200 feet along the San Pedro River and as high as 6,000 feet in the Swisshelm Mountains northeast of Douglas. Average annual precipitation ranges from 10 to 16 inches. Average annual temperatures range between 60 to 65 degrees.

Common shrubs include creosote-bush, whitethorn, Mortonia, tar bush, mariola, crucifixion thorn, graythorn, mesquite, yuccas, sotol, saltbush, and catclaw.

Elevations and rainfall for the Chihuahuan Desert are similar to those of the surrounding desert grassland areas. Areas such as those around Tombstone have shown a recorded shift from desert grassland to the Chihuahuan Desert. Because of a close association with the desert grassland type, areas of Chihuahuan Desert that have been cleared of brush and reseeded have been converted to grassland.

The Sonoran Desert occupies more than 3.8 million acres, of which a little more than 0.5 million acres are in the lower parts of the San Pedro and Aravaipa Valleys. More than 3.3 million acres are in the Santa Cruz study area. Elevations range from about 1,000 feet near the confluence of the Santa Cruz and Gila Rivers to about 4,000 feet where the upper slopes of the desert blend into the major mountain ranges.

The Sonoran Desert receives the least precipitation of the vegetation types. Annual rainfall ranges from about 8 to 12 inches. Average annual temperatures range from 67 to 70 degrees Fahrenheit.

Sonoran Desert vegetation differs from Chihuahuan Desert by a lower density of shrubs and more cacti. The vegetation is characterized by widely spaced woody and succulent types of perennial plants that are well adapted to conserving water during long periods of little rain. Small trees that are found growing along the desert washes include paloverde, ironwood, and mesquite. Common shrubs and cacti having more general distribution include creosote-bush, saguaro (giant cactus), chollas, prickly pear, hedgehog, brittlebush, jojoba, bursage, and catclaw. Open spaces between perennial trees, shrubs, and cacti are bare most of the time but can become completely covered with annuals during infrequent years when winter and/or summer rainfall is unusually high.

Barren Lands

Barren areas include almost 76,000 acres of severely eroded land or "badlands" and areas with little or no protective vegetation. The "badlands" occur mostly along the San Pedro River. In addition, the barren Willcox Playa is a lake bed covering 32,682 acres. Most of the playa is usually dry.

Croplands

The majority of crops are grown in areas that were formerly in Sonoran Desert, Chihuahuan Desert, or desert grassland plant communities. Of a total of nearly 643,000 acres of cropland, about 183,000 acres are in the San Pedro study area. About 455,000 acres are in the Santa Cruz study area. Major crops grown include grain sorghum, cotton, wheat, barley, and alfalfa hay. Other crops grown on smaller acreages include dry beans, lettuce, carrots, peaches, pecans, melons, Irish potatoes, sugar beets, safflower, silage, corn, oats, citrus fruits, and pasture grasses.

Areas where irrigated lands have been abandoned have stands of sparse annuals and short-lived half shrubs typical of the early stages of plant succession in the native plant communities. Other various water-loving grasses and broadleaf annuals grow along ditches. Trees such as cottonwood and willow grow along these ditches, except where they are controlled through ditch maintenance.

Urban and Built-up Lands

Existing urban lands occupy more than 75,000 acres of which about 8,000 acres are in the San Pedro study area and about 67,000 acres are in the Santa Cruz study area. Native vegetation has been displaced largely by pavement and buildings. Plant cover consists mostly of lawn grasses, ornamental shrubs, shade trees, and fruit trees. Some home sites are landscaped with native species of desert shrubs, trees, or cacti which were either on the site or transplanted to the sites.

Other

Other lands include remote subdivisions and mining areas. The remote subdivisions are in various stages of planning and development. Existing vegetation on these lands are typical of the Chihuahuan Desert, Sonoran Desert, and desert grassland plant communities in which they are located. Much of the vegetation has been destroyed, however, by clearing for roads and house sites. About 80,000 acres in the San Pedro study area and more than 231,000 acres in the Santa Cruz study area have been platted for residential and business communities.

Mining areas are mostly void of vegetation except for those areas where revegetation work has been successful. The most successful plantings make use of adapted native species. About 36,000 acres of mining lands lie in the Santa Cruz study area. The San Pedro study area has about 5,000 acres used for mining purposes.

TABLE 5.1 LAND RESOURCE BASE
PRESENT CONDITIONS
SAN PEDRO STUDY AREA

TYPE	AREA		GENERAL LAND USE												
							Outdoor Recreation					Fish & Wildlife			
	Acres	Percent	Crop Production	Grazing	Wood Products	Urban & Industrial	Designated	Undesignated	Designated Wilderness	Military	Mineral Production	Designated	Undesignated	Transport & Utilities	Other
			(Acres in thousands)												
Cropland	179	4.0	127 1/	60		- 2/		120				-	120	5	52 3/
Desert															
Sonoran	503	11.2		400	-	-		400	7			-	490	3	-
Chihuahuan	622	13.8		500		-		500		2		-	550	5	-
Barren	108	2.4						20		30		-	50	-	33 4/
Desert Grassland	1,936	43.0		1,906		-		1,500	2	47		-	1,850	19	-
Oak Woodland-Chaparral															
0-30% Canopy	550	12.2		520	100	-		400	23	12			525	6	-
31-60% Canopy	379	8.4		300	100	-		300	43	18			350	4	-
61-100% Canopy	18	0.4		-	10	-		15					18	-	-
Pine-Mixed Conifer															
0-30% Canopy	8	0.2		6	8	-		7					8	-	-
31%-60% Canopy	64	1.4		31	64	-		55	4				64	1	-
61%-100% Canopy	6	0.1		-	6	-		6					6	-	-
Riparian	35	0.8		35	20		-	17				-	35	2	-
Urban-Existing	8	0.2		-	-	8	1	2				-	-	2	-
Other															
Remote Subdivisions	80	1.8		64	-	-		70					40	8	-
Mining	5	0.1				-		-			5	-	3	-	-
TOTAL	4,501	100.0	127 5/	3,822	230	8	1	3,412	79	109	5	-	4,109	55	85
PERCENT			2.8	84.9	5.1	0.2	-	75.8	1.8	2.4	0.1	-	91.3	1.2	1.9

1/ Includes irrigated pasture, skiprow acreage, and acreage planted but not harvested for various reasons.
2/ Dash (-) indicates small area or minor use.
3/ This 61,000 acres includes 22,000 acres idle irrigated land, 20,000 acres of on-farm roads and miscellaneous, and 19,000 acres of abandoned cropland.
4/ Includes Willcox Playa
5/ Excludes small amount of irrigated acreage along the San Pedro River in Pima and Pinal Counties - This was included in Table 5.2.

TABLE 5.2 LAND RESOURCE BASE
PRESENT CONDITIONS
SANTA CRUZ STUDY AREA

TYPE	AREA		GENERAL LAND USE												
							Outdoor Recreation		Desig-nated			Fish & Wildlife			
	Acres	Per-cent	Crop Pro-duc-tion	Grazing	Wood Products	Urban & Indus-trial	Desig-nated	Undesig-nated	Wilder-ness	Mili-tary	Mineral Produc-tion	Desig-nated	Undesig-nated	Transport & Utilities	Other
			(Acres in thousands)												
Cropland	464	7.7	264 1/	70		- 2/		140				-	250	13	200 3/
Desert															
Sonoran	3,336	55.0		2,600		-		2,500		61		-	3,100	33	-
Barren	-	-						-					-		-
Grassland	1,157	19.1		1,130		-		1,000	5			-	1,200	11	-
Oak Woodland-Chaparral															
0-30% Canopy	443	7.3		240	100	-		400	11				443	10	-
31%-60% Canopy	209	3.5		100	100	-		200	10				209	3	-
61%-100% Canopy	19	.3		-	19			10					19	-	-
Pine-Mixed Conifer															
0-30% Canopy	39	.7		34	39	-	-	30	23				39	-	-
31%-60% Canopy	11	.2		8	11	-		10	9				11	-	-
61%-100% Canopy	3	-		-	3	-		-					3	-	-
Riparian	43	.7		35	20		-	40				-	43	-	-
Urban-Existing	67	1.1		-	-	67	3	-				-	-	17	-
Other															
Remote Subdivisions	232	3.8		195	-	-		200					-	20	-
Mining	36	.6				-		-			36	-	15	-	-
TOTAL	6,059	100.0		4,412	292	67	3	4,530	58	61	36	-	5,332	107	200
PERCENT			264 4/ 4.4	72.8	4.8	1.1	.05	74.8	1.0	1.0	0.6	-	88.0	1.8	3.3

1/ Includes irrigated pasture, skiprow acreage, and acreage planted but not harvested for various reasons.
2/ Dash (-) indicates small area or minor use.
3/ This 211,000 acres includes 136,000 acres of idle irrigated land, 41,000 acres of on-farm roads and miscelleneous, and 34,000 acres of abandoned cropland.

Ground Water 2/

Ground water occurs under both artesian (confined) and water table (unconfined) conditions in the many types of aquifers found in the river basins. Figure 5.4 illustrates the occurrence of ground water in a typical alluvial basin in the Santa Cruz-San Pedro River Basins. The depth to ground water beneath the land surface in 1970 is illustrated on the Depth to Water Map (back of report).

The total dependable water supply, the overdraft, and the ground water in storage are shown in Table 5.3. Only the lower Santa Cruz basin has a significant surface water supply. In other areas, surface water may be physically present but unavailable for diversion because of existence of prior downstream rights. The locations of the ground water basins listed in this table are illustrated in Figure 3.2.

The total dependable supply (column 3) as shown in Table 5.3 is the estimated surface water supply, ground water recharge (column 2) plus basin imports (column 1). However, this ground water recharge is only that amount which occurs naturally, less any natural depletions such as underflow out of the basin, phreatophyte use, etc.

The overdraft (column 14) is that amount by which total depletions (column 13) exceeds dependable supply (column 3). Total depletion is equal to the sum of basin exports (column 4) and withdrawals (columns 5 and 8) minus the sum of the incidental recharge (columns 6 and 9).

Total ground water in storage (columns 15 and 16) represents the relative quantities of this resource available. The values given in the table were based on best estimates of specific yields (and/or storage coefficients) and the volume of saturated sediments for the respective ground water basins. Since data are inadequate to make completely reliable estimates of these parameters, it should be recognized that the volumes of water in storage as given in the table are also only best estimates. With this caution in mind and recognizing that the total volume of water as estimated may not be recoverable, the following estimates were made as to the extended life of each of the aquifers. At the present rate of overdraft, enough water is stored in the aquifers between 0 and 700 feet

2/ The basic descriptions for the ground water resources of the study area have been taken from publications of the U. S. Geological Survey. The data, however, have been updated to reflect the 1970 levels of development with inclusions of additional data developed by the Soil Conservation Service and the Arizona Water Commission.

Table 5.3 Estimated Average Annual Water Withdrawals, Recharge, Depletion, Dependable Water Supply and Overdraft by Groundwater Basins for the San Pedro Study Area, 1970 Normalized

STUDY AREA AND GROUNDWATER BASIN	Category 2/	Basin Import	Natural Groundwater Recharge	Dependable Supply	Basin Export	AGRICULTURAL			MUNICIPAL & INDUSTRIAL			TOTAL			Overdraft 3/	Groundwater in Storage	
						Withdrawal 1/	Incidental Recharge	Depletion	Withdrawal	Incidental Recharge	Depletion	Withdrawal	Incidental Recharge	Depletion		0' to 700'	700' to 1200'
San Pedro Study Area		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
									(Thousands of Acre Feet)								
Douglas	I	6	11	17	0	103F	33	70	13F	2	11F	116F	35	81	64	24,000	7,600
Willcox	I	0	15	15	0	288F	93	195	2.0G	-	2	290F	93	197	182	43,000	11,000
Aravaipa	II	0	-	-	0	3.8P	-	2.7	0.1P	-	0.1	3.9P	1.1	2.8	0	-	-
Lower San Pedro	II	0	-	-	10	17.1F	-	10.5	14.9F	0.9	14.0	42F	17.4	34.5	0	27,000	3,000
Upper San Pedro	II	0	-	-	6	37.0P	-	19.0	7.0G	2.0	5.0	50P	20	30.0	-	36,000	12,000
San Bernardino Valley	III	0	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-
Santa Cruz Study Area																	
Avra Valley	I	0	4	4	13.4G	136.3F	27	109.3	0.3P	-	0.3	150F		123	119	9,800	6,200
Lower Santa Cruz	I	23G 4/	23	243 5/	0	1102F	354	748	18F	3	15	1120F		763	520	48,800	42,300
Upper Santa Cruz	I	6G 4/	65	71	15G	104F	32	72	127F	10	117	246F		204	133	28,000	28,000
Altar Valley	II	0	-	-	0	3.6P	1.0	2.6	0.1P	-	0.1	3.7P		2.7	-	11,000	4,000

1/ The letter following the numbers indicates the amount of possible error. G - indicates ± 5-15%; F - indicates ± 15-25%; and P - indicates greater than 25%. The dashes indicate probable but unknown values; zeros indicate withdrawals probably do not occur or are small with respect to the total withdrawal.

2/ The category designations were developed by the Arizona Water Commission and are defined as follows:

Category I: Sufficient data available to prepare fairly reliable estimates of water balance.
Category II: Areas where estimates may be made for total withdrawal. Information largely limited to data on use. Other values shown are based on judgments not supported by detailed study.
Category III: Areas where data is sparse and depletions are believed to be less than 1000 acre-feet.

3/ Overdraft is equal to the total dependable supply minus total depletion.

4/ Import is from pumping in an overdrafted groundwater basin.

5/ Includes 197,000 ac. ft. surface water diverted from San Carlos Reservoir.

beneath the land surface to last 236 years in the Willcox Basin, 375 years in the Douglas Basin, 82 years in the Avra Valley, 94 years in the Lower Santa Cruz Basin, and 210 years in the Upper Santa Cruz Basin. Lack of overdraft data on the other basins prevents estimating the period ground water would last in those areas.

Surface Water

Surface water includes both streamflow and surface storage. Streamflow is that part of precipitation that appears in streams. Surface storage is water that is impounded on the surface in manmade reservoirs or water that is naturally detained in a drainage basin.

Streamflow is typical of that in other arid or semi-arid lands where channels are dry for long periods of time. Most of the streamflow is in response to direct runoff from rainfall. Ground water sustains flow in only a few places.

Streamflow

The vast majority of streams in the study areas can be classified as either ephemeral streams or intermittent streams. As used in this report the term ephemeral applies to stream reaches which flow only in direct response to precipitation and receive little or no water from springs and no continued supply from melting snow. The term intermittent applies to stream reaches which flow during wet weather or only during a part of the year. Streams which have flow throughout the year under average conditions have been classified as live streams. These streams were not classified as perennial streams because, during periods of unusually low rainfall, flow ceases in some reaches. For instance, the San Pedro River is classified as live from the border with Mexico to near Benson. During periods of drought, some sections of this reach may be dry; although ground water in the channel bed may be very near the surface. Another example of this is Madera Canyon which did not have flow during periods in 1973 and 1974.

Annual streamflow can be extremely variable. This variability causes the arithmetic average of annual flows to have little meaning in regard to the amount of flow that may be expected each year. Because of this, planning based on short periods of record can be seriously in error. Monthly flows also can be extremely variable.

At some time during the periods of record, flow was nonexistent at 8 of the 10 gaging stations in the San Pedro study area and at 19 of the 20 stations in the Santa Cruz study area. Even the stream reaches at higher elevation with greater unit runoff, such as West Turkey Creek and Whitewater Draw, have experienced periods of no flow. Average annual unit runoff is exhibited in Figure 5.5.

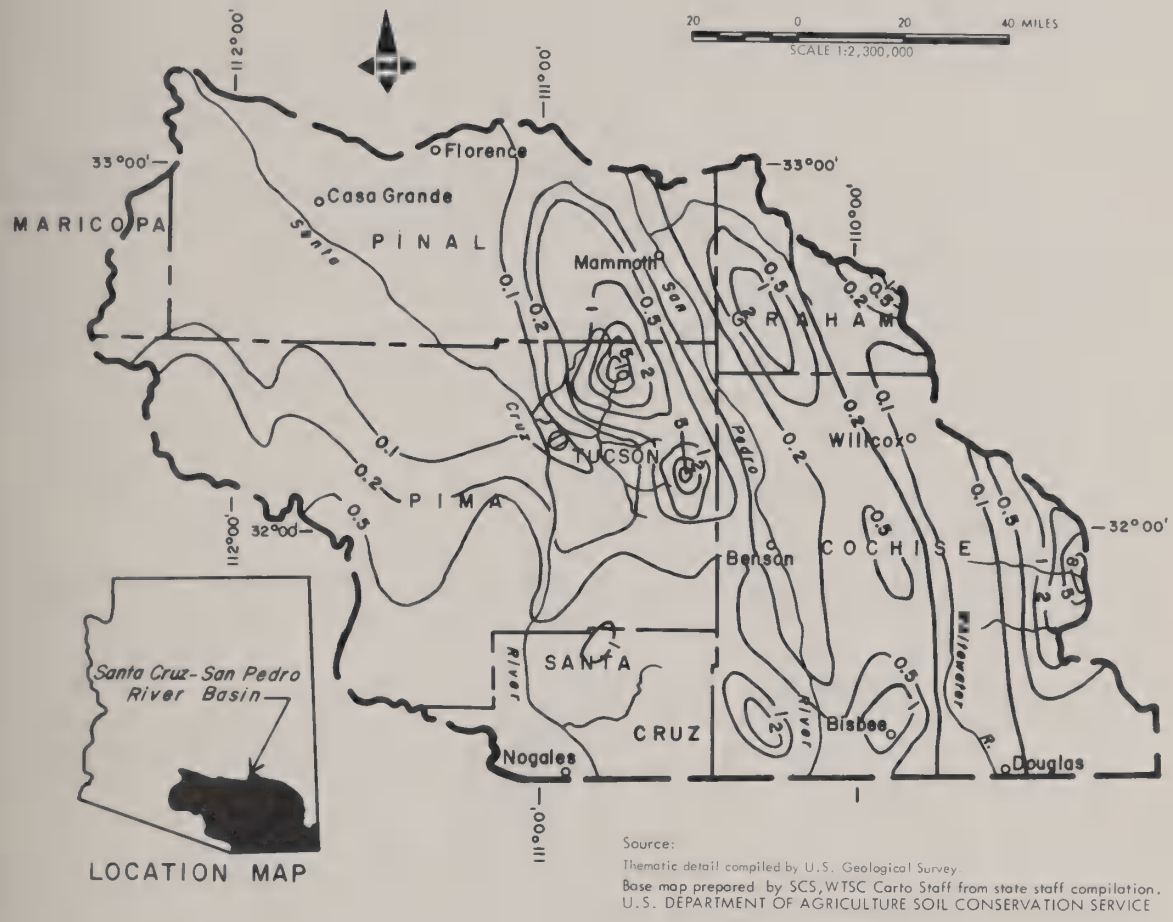


FIGURE 5.5 - Average Annual Unit Runoff in Inches for the Santa Cruz-San Pedro River Basins.

Flow in the San Pedro River is continuous where the streambed intercepts the water table or where it is fed by springs. Elsewhere, it flows only in direct response to precipitation. The percentage of time that the daily flows equal or exceed one cfs (cubic feet per second) at selected gaging stations in the San Pedro River Valley is given below:

Station	Period of Record	Percentage of Time That Daily Flow Equals or Exceeds One cfs
San Pedro River at Palominas	1930-33 1935-40 1950-67	69
San Pedro River at Charleston	1928-33 1935-67	99+
San Pedro River near Redington	1943-46 1950-67	44
San Pedro River near Mammoth	1931-40	44
Aravaipa Creek near Mammoth	1919-21 1931-40 1941-42 1966-67	88

Source: Arizona Water Commission, Bulletin No. 4

Prior to extensive ground water pumping in the Santa Cruz study area, ground water was discharged locally as streamflow and spring flow. The system has been altered so that most of the streamflow infiltrates through streambeds and recharges the ground water reservoir. The median number of days per year of no flow past the several gaging stations is about 320 to 330 days.

Water quality data on live streams are scarce. The quality is adequate, however, for fish habitat and swimming in those sections having sufficient quantity. The water is suitable for wildlife or livestock drinking. In those streams which are spring-fed, the water is generally suitable for human consumption in the upper reaches near the springs.

Lakes and Impoundments

Surface water acres in the form of lakes and impoundments are limited. Of the total 10,560,432 acres in the study areas, only 8,500 acres can be classified as surface water in lakes or impoundments. Approximately 40 percent of these surface water acres are in some 3,266 stock ponds or

other small impoundments which are scattered throughout the study areas. An additional 30 percent are in mine tailing reservoirs. The remaining 30 percent are the larger impoundments or those which are more important from a fisheries standpoint. Although the smaller impoundments generally have limited attraction to humans, they are more important from a wildlife standpoint than the larger lakes. Their number and wider distribution make them an important source of water for wildlife; however, many of them become dry annually.

Water quality data for lakes, as for live streams, is scanty. Some generalizations were made, however, from observations and past use. Turbidity lowers the attractiveness of the water esthetically and lowers the quality for fish habitat, wildlife consumption, and recreation. Turbidity levels in the lakes at the higher elevations are usually lower than the ones located in the desert. The lakes and larger stock impoundments support fisheries sufficient for sport fishing. All of these bodies of water are used as drinking water by livestock and wildlife.

RELATIONSHIP OF THE RESOURCE BASE TO THE OBJECTIVES

The objectives of this study were based on the broad concerns for national economic development (NED) and environmental quality (EQ). Problems relating to each of these broad national concerns were identified, and specific components (desires and preferences) were listed for each of the problems. The ability to satisfy most of the expressed problem-related preferences is directly dependent on the available resources of the study areas. The following discussion relates the resource base to each of the second level components (preferences) listed in Chapter 3, Table 3.9, and indicates the relative potential of the resource base to satisfy the components. Unless specifically stated, the discussion applies to both the San Pedro and Santa Cruz study areas.

NED Second Level Components (Preferences)

Number 1. (Floodwater, erosion, and sediment damages)
This component is concerned with reducing floodwater, erosion, and sediment damages. Due to economic, climatic, and geologic conditions there is limited potential to significantly reduce these damages. Low annual precipitation limits the amount of vegetation that could be established to impede runoff, promote infiltration, or prevent soil movement. Structural measures, in combination with those vegetative measures that may be practical, possibly could produce the desired effects. The monetary costs of possible measures, however, are often prohibitively high and cannot be economically justified. These high costs are brought about, in part, by the topography and geologic conditions of the area (poor foundations, land subsidence, etc.) and the widely dispersed damage areas needing protection.

Number 2(a). (Crop production)
This component is concerned with increasing farm efficiencies and net returns. The resources are well adapted to the production of quality irrigated crops and respond in a favorable manner to the application of sound conservation practices and management. Most of the farmers and ranchers of the area are progressive and have successfully applied many conservation practices over the years. This, along with improved seed varieties, etc., has resulted in higher crop yields and improved efficiencies. It is well within the capabilities of the resources to produce even higher per acre yields and net returns through improved efficiencies.

Number 2(b). (Livestock forage production)
It is well within the capabilities of the resources to increase beef cattle grazing and restore grazing lands. Many of the area's rangeland resources have been overgrazed. Implementation of a comprehensive range improvement program emphasizing sound grazing practices and brush management would produce the desired results.

Number 3. (Water-based recreation)
Water-based recreation facilities are extremely limited in the study areas. There are numerous lake sites that have been proposed by the Arizona Game and Fish Department, Arizona State Parks Department, and others. The primary restriction on the construction of impoundments involves low annual precipitation and legal restraints--water rights. The water rights issue is twofold. First is the somewhat cloudy legal issue of downstream rights to utilize floodwater run-off for wild flooding of rangeland. The Leslie Canyon Dam, proposed by the Arizona Game and Fish Department, is currently in litigation over this and other issues. Second is the issue involving the possibility of upstream surface water storage reducing downstream ground water recharge.

In 1972, the Arizona Game and Fish Department made application to appropriate public waters for the proposed Twin Peak Lake located south of Tucson in the Santa Cruz River Basin. The State Land Commissioner issued an Order of Denial based on a study conducted by the Arizona Water Commission which showed that downstream ground water levels would decline slightly because of the proposed upstream impoundment. The Order of Denial is being appealed, and the case is currently in litigation in the Arizona Supreme Court.

Because of the water-rights situation, detailed studies of potential impoundment sites were not conducted for this report. The potential to satisfy demands for water-based recreation is essentially nonexistent under current restraints. The Arizona State Lake Improvement Fund Plan has Planning District I (Pima County) and Planning District VI (Cochise, Graham, Greenlee, and Santa Cruz Counties) as numbers 1 and 3 priority respectively for the utilization of State Lake Improvement Funds.

The potential to satisfy demands for other than water-based recreation is excellent.

EQ Second Level Components (Preferences)

Number 1. (Fishery habitat and esthetics)
Fishery habitat in the study areas is extremely limited because of the limited amount of water available. Water quantity, then is the limiting factor in satisfying this component. The quality of existing habitat is deteriorating because of sedimentation and channel erosion. The crux of the problem seems to lie in the uneven distribution of naturally low annual precipitation and results in a lack of perennial streams and a wide fluctuation of water levels in lakes and ponds. Intense summer thunderstorms produce large amounts of runoff in relatively short periods of time which is directly related to erosion and sedimentation. Through management techniques on the watershed and by not increasing the amount of water diverted from streams, it is within the capabilities of the existing resources to maintain the present quality and quantity of fishery habitat.

Number 2(a). (Wildlife oriented management techniques)
Most existing criteria for cropland, rangeland and forest land management techniques contain some wildlife considerations. Those considerations, for the most part, can generally be considered to have been minimized in favor of economic considerations. The existing resources are potentially capable of satisfying this component part if wildlife considerations are optimized and added where needed.

Number 2(b). (Wildlife water development)
Because of the low annual precipitation, many of the existing watering facilities used by wildlife are frequently dry. This problem is particularly acute during prolonged droughts. It is estimated that two-thirds of the planning area has adequate distribution of watering facilities but only about one-half of those contain water the year around. The existing resources, with the possible exception of groundwater in some areas, are compatible with measures to satisfy this component part. The potential for development of suitably equipped wells, springs, ponds and artificial watersheds on the basis of one facility per section to two and one-half sections (640 to 1600 acres) is good. Lack of or extremely deep ground water could be a limiting factor in some areas.

Number 2(c). (Restoration of rangeland and forest land habitat)
Climatic conditions and relatively intense grazing practices have caused a decline in the value of much of the grazing land in the planning area for use as wildlife habitat. It is estimated that the potential for wildlife use as compared to original condition may have been lowered on some 15,000 acres of grazing lands. This acreage does not include approximately 128,000 acres of critical areas discussed later. Climatically, the planning area is not capable of rapid, natural restoration of vegetation suitable for wildlife and livestock. The potential for

satisfying this component through intensification and refinement of management practices and land treatment measures, however, is good and is within the capabilities of the resources under those conditions.

Number 2(d). (Restoration of abandoned irrigated land)
Intensive agricultural operations, by their very nature, tend to remove the near-surface seeds that are so important for the revegetative process to be successful. Natural revegetation of abandoned lands in the study areas would eventually occur, but under the existing climatic regime the process would be very time consuming. Some 53,000 acres of land in this category have the potential of being restored by land treatment and range management techniques, such as reseeding, deferred grazing and planned grazing systems. Such measures are compatible with the resources and the potential is good.

Number 2(e). (Multiple use planning)
Presently, and historically, land use is at the discretion of the owner and in the planning areas economic consideration have had a more determining influence over use than have other considerations. The resources in the area are compatible for multiple use planning wherein wildlife considerations could be used to complement all land uses, even residential.

Number 2(f). (Unique biotic inhabitants)
The inability of unique species to successfully adapt to a broad range of conditions makes them particularly sensitive to physical alteration of the habitat. Land use changes have caused several species to become nonexistent in some places but could be reintroduced. The existing resources are capable of sustaining habitat for these species but complete satisfaction of this component part will depend on adequate land use planning, compatible land treatment measures, sound management practices and state and federal research programs.

Number 3(a). (Riparian communities)
This component deals with preservation and improvement of existing communities. Satisfaction of this component is compatible with the existing resources provided adequate management is performed.

Number 3(b). (Restore riparian vegetation)
Satisfaction of this component would be limited to the amount of land and water necessary to support riparian communities. Land use planning, management techniques and proper land treatment would also be necessary.

Number 4(a). (Expand wetlands)
Quantity of water is the limiting resource in the satisfaction of this component. Potential for developing two wetland areas in the study area is fair to good. Expanding existing wetlands is dependent on acquisition of additional water rights for this use.

Number 4(b). (Encourage wetlands)
The satisfaction of this component depends largely on management decisions to commit stockpond areas to this use. Once committed, such areas could be treated and managed in such a manner that potential could be considered good. The resource base is compatible with this component part.

Number 5. (Unique biotic areas)
There are no resource limitations on satisfying this component. High potential exists when considering that unique biotic communities exist in Aravaipa, Ramsey, Carr, Parker and Gardner canyons and other places such as Blue Haven and Patagonia-Sonoita Creek and that large parts of these areas are in public ownership.

Number 6. (Restricted use areas)
There are no resource limitations on satisfying this component. About 68,000 acres have been declared restricted use areas under provisions of the Wilderness Act of 1964. Continued implementation of that act makes the potential for satisyfing this component good. Other existing restricted use areas are Saguaro National Monument, about 53,000 acres and 5,670 acres owned by the Defenders of Wildlife, a private organization.

Number 7. (Erosion exhibit areas)
Satisfaction of this component is not dependent on the commitment of additional resources. Areas of accelerated erosion could be displayed as outdoor educational sites without significant problems.

Number 8. (Fuel buildup)
Satisfaction of this component is not dependent on the commitment of resources. This is a Wilderness Area management policy matter.

Number 9. (Archeologic and historic sites)
Preservation of ghost towns, historic sites and buildings and sites of prehistoric Indian culture does not require commitment of natural resources.

Number 10(a). (Critical erosion areas)

Number 10(b). (Streambank protection)

Number 10(c). (Grazing land erosion control)
These component parts are primarily concerned with erosion control and reduction of sediment yield. The satisfaction of this component is complex and depends primarily on a combination of land treatment, structural measures and management techniques. Certain geologic, climatic and economic problems exist and tend to reduce the potential to satisfy this component. Low annual precipitation and poor soil conditions in areas where the most rapid erosion is occurring place severe limitations on the amount of vegetative cover that can be established and sustained. The extent of structural measures needed, besides being economically

distasteful, would be incompatible with the environment. Therefore, the potential to satisfy this component is considered low. Potential response to measures applied is considered greater in those parts of the study areas that have an annual precipitation of 12 inches or more.

Number 11(a). (Solid waste disposal)

Number 11(b). (Dump cleanup)
Each part of this component is legislative and enforcement in nature. Adequate solid waste disposal areas do exist that, if used as sanitary landfills, would pose few problems for the resource base.

EXISTING PROGRAMS

The following discussion points out the potential of existing programs to implement measures for satisfying each of the second level components listed in Chapter 3, Table 3.9.

National Economic Development Components

Number 1. (Floodwater, erosion, and sediment damages)
There are several different programs available which could be used to implement measures for satisfaction of this specific component.

The Department of the Army, Corps of Engineers, has the legal authority to plan and construct flood control projects and to engage in flood fighting and rescue operations under P.L. 74-738, section 201 of P.L. 89-298, section 205 of P.L. 80-858, P.L. 84-99, and others. To date, the Corps has completed the multiple purpose Santa Rosa Wash project and the Tucson diversion channel, a single purpose flood prevention project. In addition, the Corps has done emergency work and major flood fighting on Green's Wash near Eloy. Presently, the Corps is studying a flood prevention project on Green's Wash and is awaiting funds for a study of Rillito Creek.

The Department of the Interior's Bureau of Land Management is entrusted with stewardship of National Trust Lands. It carries out a coordinated program for the conservation and development of watersheds in order to preserve and protect soil and water resources. The program is a combination of land treatment and structural practices having a planned pattern in support of multiple use management. It is designed to regulate surface water runoff, to control accelerated erosion, and to stabilize the soil resources. At this time, there are no special structures or accelerated programs within the study areas, and none are anticipated in the foreseeable future.

The Department of the Interior's Bureau of Reclamation is presently working on the Central Arizona Project (CAP). The only planned feature of this project within the San Pedro study area is the proposed Charleston Dam and associated features on the San Pedro River. It does not appear that this dam will be constructed in the foreseeable future, and it is not considered in the "future without conditions" shown in Chapter 6. Potential for additional Bureau of Reclamation projects in the San Pedro study area is low.

Depending on the final design of the aqueduct and associated features, the CAP could produce significant reductions in flood damages. In addition to the CAP, the Bureau has studied the possibility of developing the floodflows of two areas. These consist of potential storage facilities located near Red Rock in Pinal County and east of Nogales on the Santa Cruz River in Santa Cruz County. Both of these facilities could produce flood prevention benefits, however, the Bureau of Reclamation has concluded that the Red Rock proposals are economically infeasible and the Nogales proposal must have political accord as a joint international development with Mexico.

The Department of Agriculture's Soil Conservation Service administers the Watershed Protection and Flood Prevention Act (PL-566). The Perilla Mountain Watershed, at Douglas, Arizona and the Florence Watershed are the only watersheds in the study areas that have been planned and approved for construction. The Florence project has been completed. Interest has been expressed in six additional P.L. 566 projects; however, it appears that only three of these, St. David Watershed in the San Pedro study area, and West Branch Santa Cruz and Cactus Forest Watersheds in the Santa Cruz study area have potential for development under this program. Consequently, it does not appear that this program could make a significant contribution to the satisfaction of this component under existing and projected conditions.

Resource Conservation and Development (RC&D) projects are another means by which the Soil Conservation Service can assist in the satisfaction of this component since most of the San Pedro study area and part of the Santa Cruz study area are within the Coronado RC&D Project. To date, there have been no RC&D cost-shared measures, planned or installed, that would reduce flood damages. Investigations conducted as a part of this study did not identify any potential RC&D measures that contribute to the satisfaction of this component.

Number 2(a). (Crop production) Technical assistance through the Soil Conservation Service (SCS) and the Extension Service of the U. S. Department of Agriculture (USDA) and the Bureau of Indian Affairs (BIA) of the U. S. Department of the Interior (USDI); USDA cost sharing through the Agriculture Stabilization and Conservation Service (ASCS); and USDA loans through the Farmers Home Administration (FmHA) are

available to landowners on private, state and Indian lands. Such assistance supports cropland land treatment programs which results in protection of natural resources and an increase in crop yields. The potential of these programs to solve problems is excellent. It is limited only by the level of funding and the number of trained agency personnel.

Number 2(b). (Livestock forage production)
Technical assistance, as listed above in number 2a, plus U. S. Department of Agriculture programs administered by the Forest Service and U. S. Department of Interior programs administered by the Bureau of Land Management and National Park Service will result in improvement of vegetation, protection from soil erosion, and increased forage production on federal lands.

The potential of these programs is excellent, limited only by funding and the number of trained agency personnel to carry out sufficient education programs and respond to requests of landusers.

Number 3. (Water-based recreation)
The existing programs with the potential to assist in the development of water-based recreation facilities are:

Federal: Department of Agriculture

(1) Watershed Protection and Flood Prevention Act (Public Law 83-566) USDA - Soil Conservation Service.

(2) Resource Conservation and Development - Section 102 of the Food and Agriculture Act of 1962 (Public Law 87-703) USDA - Soil Conservation Service.

(3) Consolidated Farmers Home Administration Act of 1961 and Food and Agriculture Act of 1962 (Public Law 87-703). USDA - Farmers Home Administration.

Department of the Interior

(4) Federal Land and Water Conservation Fund (Public Law 88-578). U. S. Bureau of Outdoor Recreation, State coordinated through Arizona Outdoor Recreation Coordinating Commission.

(5) 1965 Federal Water Project Recreation Act (Public Law 89-72) and Central Arizona Project Authorization Act (Public Law 90-537). USDI - Bureau of Reclamation.

(6) U. S. Bureau of Indian Affairs programs to assist Indians.

Department of the Army

(7) 1944 Flood Control Act (Public Law 78-534) and subsequent amendments. U. S. Army Corps of Engineers.

(8) 1965 Federal Water Project Recreation Act (Public Law 89-72), as amended by Section 77 of the 1974 Water Resources Development Act (Public Law 93-251). U. S. Army Corps of Engineers.

State: (1) State Lake Improvement Fund. Enacted 1960. Administered by Arizona Outdoor Recreation Coordinating Commission. Funding from license tax.

(2) State Water Conservation and Development Fund. Enacted 1971. Administered by Arizona Game and Fish Department.

The application of these programs in the study areas has been essentially nil. In the San Pedro study area is the authorized Willcox Lake, a small impoundment in the town of Willcox utilizing pumped water. The Resource Conservation and Development Program (Public Law 87-703 and Public Law 91-343) is being utilized for this development. The Arizona Outdoor Recreation Coordinating Commission has allocated $300,000 of State Lake Improvement Funds for the Arizona Game and Fish Department's Leslie Canyon Dam.

The city of Tucson has utilized State Lake Improvement Funds to construct Kennedy Lake (14 surface acres) and Kennison Dam Lake, renamed Lakeside Park, (8-10 surface acres). Both lakes are fed from wells and are suitable for light boating only. The city also has plans to develop a 20 surface-acre lake at the City Farms, i.e., Silverbell Park and Golf Course site.

Pima County has plans to develop a 70-acre lake in the detention basin of the constructed Corps of Engineers Tucson Diversion Channel Project. The proposed lake, called Ajo Dentention Basin, would utilize funds from the State Lake Improvement Fund, Pima County bonds, and federal funds from the Corps of Engineers under Section 77 of the 1974 Water Resource Development Act.

Progress outside the Tucson metropolitan area has been slow. Lake construction proposed by the Arizona Game and Fish Department essentially has been brought to a standstill by the issue of denial for water rights to construct at the Twin Peaks site. There may be some possibilities upstream from Patagonia Lake in the Sonoita Creek drainage area since the State Parks Board has purchased the lake.

Aside from relatively small impoundments on National Forest lands, the only completed federal project is Tat Momolikot Dam (Lake St. Clair). This project was completed in 1974 by the Corps of Engineers, Bureau of Indian Affairs, Pinal County, and the Papago Indian Tribal Council. It is located across Santa Rosa Wash in the Papago Indian Reservation about 16 miles south of Stanfield. The lake has 40,000 acre-feet of sediment storage capacity suitable for recreation use.

The major federal activity will be the construction of Buttes Dam, a feature of the Central Arizona Project. This dam, to be constructed on the Gila River east of Florence, will have a total storage capacity of about 366,000 acre-feet, of which 266,000 acre-feet are combined sediment and flood control storage capacity and 100,000 acre-feet of conservation storage capacity.

Environmental Quality Components

There are several USDA programs available within the study areas that have the potential to help land users implement measures toward satisfying the environmental components listed in Chapter 3, Table 3.9 and described in Chapter 8 as part of the resource management programs. A brief description of USDA agencies and their applicable programs follows:

The Agricultural Stabilization and Conservation Service (ASCS) administers a cost-share program known as Agricultural Conservation Program or ACP. The ACP is designed to assist land users in applying enduring conservation measures designed to solve soil and water conservation problems. ASCS also administers the Emergency Conservation Measures (ECM) Program that provides cost-sharing assistance for restoration or application of enduring conservation measures after or during natural disasters, e.g., floods or droughts. ASCS programs are limited to private and state land application.

The Cooperative Extension Service (CES) program is mainly one of disseminating research information to the general public and governmental agencies. CES participates in field research activities, monitors research publications, conducts tours and field days, utilizes news media and their own publications for providing information and provides limited onsite assistance to land users. CES information keeps ongoing programs technologically up to date.

The Farmers Home Administration (FmHA) program primarily provides low cost loans to rural land users. Those loans can be used by individuals in updating conservation programs; rural governments and communities in development of certain facilities and for meeting their financial shares when participating in other programs such as Resource Conservation and Development (RC&D).

The Forest Service (FS) is responsible for administering programs designed to protect and conserve resources on National Forest Land. Programs include technical and financial assistance to holders of grazing permits in the installation of enduring conservation practices.

The Soil Conservation Service (SCS) utilizes its Conservation Operations program to assist Arizona's natural resource conservation districts (NRCD) in carrying out their conservation programs. Through this program conservation planning and technical assistance is made available to land users within a district and in consultation with NRCD supervisors. Technical responsibility for ACP and ECM activities is also exercised under the Conservation Operations Program. Flood protection and other larger measures may be implemented under the SCS's RC&D Program or the Small Watershed Protection Program (PL-566). The latter two programs depend on local sponsoring agencies to be catalyctic in the implementation process.

The U.S. Department of the Interior has assigned certain of its resource programs to the Bureau of Land Management (BLM) and Bureau of Indian Affairs (BIA). The BLM is responsible for conservation of resources on National Resource Lands and provides technical and financial assistance toward that end. BIA provides technical assistance to land users on Indian Trust Lands through its Branch of Land Operations.

These programs have been effective to the extent that they have been used. Their potential for satisfying the environmental quality components is limited by adequate funding, availability of trained personnel and acceptance by land users.

Listed below are the environmental quality components and the existing programs that will help implement measures toward component satisfaction. Components are listed in Table 3.9 and will not be restated here.

Numbers 1, 2(c), 2(d), 10(a), 10(b), 10(c). Implementation of measures to control erosion and sediment by land treatment measures are outlined in the resource management systems in Chapter 8.

On private, state and Indian lands technical and advisory assistance is available from SCS, BIA and CES. Financial assistance in the form of loans is available from FmHA. Non-repayable financial assistance such as cost-sharing is available through the Agricultural Conservation Program administered by ASCS and the RC&D and PL-566 programs administered by SCS.

On National Resource and Forest lands technical and financial assistance is available from BLM and FS, as applicable. Advisory assistance is available from CES.

Numbers 2(a), 2(b), 2(f), 3(a), 3(b), 4(a), 4(b). Implementation of measures to enhance or develop wildlife habitat primarily by management practices and land treatment are outlined in the resource management systems in Chapter 8. However, some measures, such as watering facilities will be structural in nature. Applicable programs are essentially the same as those listed above. It is anticipated that the Arizona Game and Fish Department program will be involved in implementing measures needed for some of these components.

Numbers 2(e), 5, 6, 8, 9, 11(a), 11(b). Satisfaction of these components is primarily dependent on regulatory sanctions. However, implementation of measures to satisfy all of the components can be started with technical and advisory assistance from BIA, BLM, CES, FS and SCS depending on land ownership and agency jurisdiction. Certain existing measures are eligible for assistance under various federal programs. Included among these is agricultural waste management, applicable to component 11(a) (Solid waste disposal). Installation of that measure can be eligible for cost sharing under the ASCS' Agricultural Conservation Program and/or a federal loan from FmHA. Other measures applicable to component 11(a) are done under the sanction of the state or county health departments. Measures to satisfy component 9 (archeological and historical sites) are carried out by the responsible agency under provisions of the National Historic Preservation Act and guidelines and policies stemming thereof. All measures, regardless of the component, to be implemented on National Resource or Forest lands, will be handled by BLM or FS, as applicable.

CHAPTER 6

PRESENT AND FUTURE WITHOUT CONDITION

INTRODUCTION

The present condition, as used in this study, is the situation which prevailed in 1970 or a normalized 1970. The future without condition is an expression of conditions which are anticipated as a result of developments and changes over time without any new projects or accelerated programs to solve problems which exist or arise. For example, the future without condition portrays the future situation with existing flood control projects and those authorized for implementation. The effects of land treatment measures already in place and of those installed with ongoing programs are reflected in the future without conditions. Similarly, the future without conditions include changes and developments resulting from research such as that carried on by the Agricultural Experiment Stations and private industry, and from extension education by which the research results are disseminated. Historically, the managerial skills of farmers and ranchers have improved over time, and technological developments have occurred. Such trends are projected to continue, and their effects are reflected in the future without conditions.

In accordance with the desires of the sponsors of this study, projections were not made for the Santa Cruz study area. Consequently, the data presented in the tables in this chapter for the Santa Cruz study area reflects present conditions only.

The projected without planned action conditions are based upon the population, employment, and earnings projections, and the related assumptions given in Chapter 4. Assumptions relating to specific economic development aspects are outlined in the section where the item is considered. The future condition for the environmental quality concerns of the study area is based on projections that considered the present status of the environment, social customs and conditions, and existing laws and programs. Each of these factors were considered, and projections of future conditions were then made.

PROJECTED CROP YIELDS, SAN PEDRO STUDY AREA

Over time, crop yields have increased due to improved technology and management and assistance and/or dissemination of information by private businesses or organizations and by agencies. Assuming these trends and ongoing programs of research, education, and assistance will continue in the without planned action framework outlined above, yields of major crops in the San Pedro study area were projected to increase as follows:

Crop	San Pedro Study Area			
	1970	Projections w/o Planned Action		
		1980	2000	2020
	(Percent)			
Cotton, Upland	100	112	141	169
Barley	100	114	134	154
Sorghum grain	100	115	133	152
Wheat	100	114	135	155
Alfalfa hay	100	110	127	144
Vegetables	100	115	129	137

These projections were based upon the judgment of agricultural technicians from state universities and federal agencies involved in the study area. Available data on yield trends, use of commercial fertilizers, cultural practices, and the like were compiled. Data also were obtained from the Agricultural Stabilization and Conservation Service showing yields of individual crops being produced by top farms and by the average of all farmers in each county for consideration in developing the yield projections. Use also was made of yield data for Soil Resource Groups in the area, obtained along with other information in group interviews of county agricultural technicians.

PROJECTED LAND AND WATER AVAILABLE FOR CROP PRODUCTION, SAN PEDRO STUDY AREA

Crop production projected within the without planned action framework, as outlined above, was constrained by the same land and irrigation water limits as given in Chapter 4. It was assumed the projected acreage used for crop production would be limited to the irrigated acreage in 1970 less the small acreage projected to be lost to urban and other non-crop uses, and the irrigation water pumped would be restricted to the acre-feet pumped in 1970 (see Table 4.5).

PROJECTED REGIONAL CROP PRODUCTION AND VALUE

Estimated crop production and value in 1970 in the San Pedro study area and in the Santa Cruz study area, together with projections without planned action for the former are given Table 6.1. The projections of production were derived using the projected yields and projected land and water available for crop production. The projected value was derived by applying the 1970 commodity prices to the production. The projections for the San Pedro study area show a substantial increase over the base year, 1970. The value of all crops produced was projected to increase 27 percent by 1980, 60 percent by 2000, and 95 percent by 2020. The largest increase was projected for vegetables followed in the early part of the projection time frame by grain sorghum, alfalfa hay, and barley. Wheat and cotton show small projected increases in 1980 but subsequently show increases comparable to several of the other crops.

TABLE 6.1 - ESTIMATED PRODUCTION AND VALUE OF MAJOR CROPS FOR THE SANTA CRUZ AND SAN PEDRO STUDY AREAS IN 1970 AND SPECIFIED PROJECTIONS WITHOUT PLANNED ACTION FOR THE SAN PEDRO STUDY AREA.

Item	Units	San Pedro Study Area 1/							Santa Cruz Study Area
			Projections w/o Planned Action			Percent, 1970=100			
		1970 2/	1980	2000	2020	1980	2000	2020	1970 3/
Production									
Cotton, Upland, lint	1000 Lbs.	4,910.7	4,904.8	6,610.1	7,847.6	100	135	160	98,233.6
Cotton, Upland, seed 4/	1000 Tons	4.1	4.2	5.5	6.6	102	134	161	82.9
Cotton, Am.-Pima, lint	1000 Lbs.	-	-	-	-	-	-	-	4,468.7
Cotton, Am.-Pima, seed	1000 Tons	-	-	-	-	-	-	-	4.6
Barley	1000 Cwt.	157.5	190.9	209.9	241.2	121	133	153	1,311.9
Sorghum grain	1000 Cwt.	3,923.1	5,277.2	6,472.9	7,636.6	134	165	195	1,438.6
Wheat	1000 Cwt.	503.9	531.0	679.1	794.6	105	135	158	757.9
Safflower	1000 Cwt.	-	-	-	-	-	-	-	53.4
Alfalfa hay	1000 Tons	44.8	57.2	69.2	83.3	128	154	186	49.1
Vegetables, including potatoes	1000 Cwt.	425.0	601.9	769.9	1,000.3	142	181	236	2,129.3
Value 5/									
Cotton, Upland, lint	$1000	1,866.1 6/	1,863.8	2,511.8	2,982.1	100	135	160	39,391.6 6/
Cotton, Upland, seed 4/	$1000	217.3	220.3	288.5	346.2	101	133	159	4,346.7
Cotton, Am.-Pima, lint	$1000	-	-	-	-	-	-	-	2,323.7
Cotton, Am.-Pima, seed	$1000	-	-	-	-	-	-	-	241.3
Barley	$1000	406.4	492.5	541.5	622.3	121	133	153	3,384.7
Sorghum grain	$1000	9,611.6	12,929.1	15,858.6	18,709.7	134	165	195	3,524.5
Wheat	$1000	1,269.8	1,338.1	1,711.3	2,002.4	105	135	158	1,909.9
Safflower	$1000	-	-	-	-	-	-	-	248.8
Alfalfa hay	$1000	1,348.0	1,721.1	2082.2	2,506.5	128	154	186	1,477.5
Vegetables, including potatoes	$1000	2,804.9	3,972.9	5,081.6	6,602.1	142	181	235	14,053.5
Other crops	$1000	2,529.8	2,914.7	4,094.9	5,298.0	115	162	209	9,801.0
Total	$1000	20,053.9	25,452.5	32,168.4	39,069.3	127	160	195	80,703.2

1/ Does not include the small production of crops in Pima and Pinal Counties in the San Pedro Basin.
2/ 1968-70 for most crops.
3/ Includes the small production of crops in Pima and Pinal Counties in the San Pedro Basin.
4/ .8416 tons of seed/1000 lbs. lint @ $52.46.
5/ At 1970 comodity prices.
6/ Includes price supports payments.

ACREAGE OF CROPS HARVESTED

Estimated acres of crops harvested in the San Pedro and the Santa Cruz study areas in 1970, together with projections without planned action for the former, are given in Table 6.2. The projections were derived, using a linear programming model, in the process of deriving the projected production shown in Table 6.1. The projected acreage of most major crops in the San Pedro study area increased over the projection period but at a lower rate than production, since crop yields were projected to increase.

FLOOD DAMAGES

Flood damages in the San Pedro study area are projected to increase over time. It is assumed that damages to crops will increase in direct proportion to the projected increase in crop yields. This further assumes that the unit price of the crop remains constant. Consequently, floods occurring on cropland in the future will cause significantly greater dollar damages than floods of equal magnitude occurring today. Flood damages in the Santa Cruz study area were not projected.

Non-agricultural damages in the San Pedro study area are also expected to increase in the future. The value of damages to the contents of existing residential building was projected to increase in the same proportion as projected per capita income given in Chapter 4, Table 4.3. It was assumed that the Flood Disaster Protection Act of 1973 would remain in force and no new residential construction would be allowed in the flood plains with first floor elevations less than the elevation of the 100-year flood. Consequently, damages to residential developments to be built on a flood plain in the future were not evaluated. However, damages from floods greater than 100-year magnitude may damage future urban development. Damages to other developments which are likely to increase as population increases were projected proportionally. Estimates of flood damages are shown in Table 6.3.

FORESTRY

Present day management of the study area's conifer and oak-woodland chaparral forest types is aimed at satisfying the ever increasing recreation demands for these limited high elevation lands. These areas are now used to provide a forest atmosphere for recreationists with the desired degrees of protection against wildfires. Management emphasis has shifted from the production and sale of sawlogs to recreation with the sale of timber products as a salvage operation. The present forest management emphasis is not expected to undergo any significant changes in the future, and timber production and sales are expected to remain relatively constant throughout the evaluation period.

The future condition of fuels in wilderness, primitive, and natural areas would be one of an increasing accumulation of litter and of dead and down forest debris. Under increasing levels of fuel buildup, large devestating fires could result.

TABLE 6.2 - ESTIMATED ACRES OF CROPS IN THE SANTA CRUZ AND SAN PEDRO STUDY AREAS IN 1970 AND SPECIFIED PROJECTIONS WITHOUT PLANNED ACTION IN THE SAN PEDRO STUDY AREA

Commodity	San Pedro Study Area 1/							Santa Cruz Study Area
		Projections w/o Pl. Action			Percent, 1970=100			
	1970 2/	1980	2000	2020	1980	2000	2020	1970 3/
Cotton, upland	9,201	8,552	9,621	9,963	93	104	108	94,870
Cotton, Am.-Pima	-	-	-	-	-	-	-	8,049
Barley	4,327	4,610	4.314	4,314	106	100	100	38,151
Sorghum grain, Single	70,278	80,116	84,952	83,932	114	121	119	31,169
Wheat	12,894	11,933	12,886	13,134	92	100	102	20,824
Safflower	-	-	-	-	-	-	-	2,250
Alfalfa hay	7,978	9,285	10,231	10,231	116	128	128	9,797
Vegetables, Single (incl. potatoes)	1,773	1,832	2.074	2,431	103	117	137	10,508
Other crops	15,570	14,999	16,836	17,385	96	108	112	32,212
Total	122,021	131,327	140,914	141,390	108	115	116	247,830

1/ Does not include 3,700 acres of crops in Pima and Pinal counties in the San Pedro Basin.
2/ 1968-70 average for most crops.
3/ Includes 3,700 acres of crops in Pima and Pinal counties in the San Pedro Basin.

FISH AND WILDLIFE

The future without condition for fish and wildlife components for the San Pedro study area is based on a projection of recent historical trends. The overall condition and productivity of the habitat is expected to remain relatively constant or to experience a slight decline. This "status quo" condition can be considered to be a significant decline in light of projected human population increases and the associated increase in need for the quality of life experiences associated with fish and wildlife. Projections were not made for the Santa Cruz study area.

EXISTING PROGRAMS AND PROJECTS

Specific information on the effects of Charleston Dam, the only part of the Bureau of Reclamation's Central Arizona Project that is in the San Pedro study area, is not available at this time. Furthermore, it does not appear that this structure will be built in the foreseeable future. For these reasons, Charleston Dam is not included in the future without conditions.

It is assumed that all other authorized projects in the San Pedro study area will be constructed as planned, and their effects are included in the projected future without conditions. Existing programs in the San Pedro study area are assumed to be operational throughout the projection periods, and their effects are also reflected in the future without conditions for all of the affected second level components (Table 3.9). Effects of ongoing programs within the Santa Cruz study area were not analyzed.

SPECIFIC DESCRIPTION OF FUTURE WITHOUT CONDITIONS

This section quantifies the conditions expected to occur in the future. Table 6.3 lists each of second level components and preferences shown in Chapter 3, Table 3.9. The table displays the specific future without conditions that relate to each of these components for the San Pedro study area and the present conditions for the Santa Cruz study area.

TABLE 6.3 - FUTURE WITHOUT CONDITION - SANTA CRUZ-SAN PEDRO RIVER BASIN

Second Level Component From Table 3.9 1/	Unit	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
NATIONAL ECONOMIC DEVELOPMENT						
1. (Floodwater, erosion, and sediment damages)						
Damages Reduced 2/						
Agricultural Damage-Avg. Ann.	Dollars	0	0	0	0	0
Nonagricultural Damage-Avg. Ann.	Dollars	183,000	207,000	284,000	418,000	0
2. (a) (Crop production) 3/						
Net Return	Dollars	3,241,000	4,452,000	6,482,000	9,501,000	12,217,000
(b) (Livestock forage production)						
Production	AUM	783,000	863,000	1,039,000	1,251,000	612,000
Value of Production	Dollars	2,741,000	3,021,000	3,637,000	4,379,000	2,142,000
3. (Water-based recreation) 4/						
Supply	Activity					
Picnicking	Occasions	620,900	620,900	620,900	620,900	2,687,900
Camping	"	181,400	181,400	181,400	181,400	809,300
Lake Swimming	"	0	0	0	0	26,000
Boating	"	6,200	6,200	6,200	6,200	41,800
Water Skiing	"	0	0	0	0	9,400
ENVIRONMENTAL QUALITY						
1. (Fishery habitat and esthetics)						
Lake Habitat 5/	Surface Ac.	150	150	135	115	0
Pond Habitat	Surface Ac.	1,830	1,750	1,600	1,480	0
Stream Habitat	Stream Mi.	0	0	0	0	0

TABLE 6.3 - FUTURE WITHOUT CONDITION - SANTA CRUZ-SAN PEDRO RIVER BASIN
(Cont'd)

Second Level Component From Table 3.9 1/	Unit	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
ENVIRONMENTAL QUALITY (CONT'D)						
2. (a) (Wildlife oriented management techneques) 5/						
Wildlife Oriented Grazing Lands	Acres	200,000	200,000	200,000	200,000	270,000
Forestland - Silviculture and Controlled Burning Techneques Practiced	Acres	1,500	3,450	7,350	11,250	1,000
Cropland Acres Producing Food and Cover for Wildlife	Acres	6	21	51	81	36
(b) (Wildlife water developments) 5/						
Additional Water Developments Installed	Number	0	140	450	750	0
(c) (Restoration of rangeland and forestland habitat) 5/						
Restored Area	Acres	13,000	13,000	39,000	50,000	0
(d) (Restoration of abandoned irrigated land) 6/						
Restored Area	Acres	0	0	3,000	9,000	0
(e) (Multiple use planning) 5/						
Area With Adequate Multiple Use Planning	Acres	0	0	0	0	0

TABLE 6.3 - FUTURE WITHOUT CONDITION - SANTA CRUZ-SAN PEDRO RIVER BASIN
(Cont'd)

Second Level Component From Table 3.9 1/	Unit	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
ENVIRONMENTAL QUALITY (CONT'D)						
2. (f)(Unique biotic inhabitants) 7/ Preserved or Improved Habitat for:						
1. Antelope	Acres	0	36,000	36,000	36,000	0
2. Arizona Black Tail Prairie Dog	Acres	0	0	0	0	-
3. Masked Bobwhite Quail	Acres	0	0	0	0	0
4. Botteri's Sparrow	Acres	0	50,000	50,000	50,000	-
3. (a)(Riparian communities) 5/ Riparian Communities Maintained	Acres	0	0	0	0	0
(b)(Restore riparian communities Area Restored or Improved	Acres	0	0	0	0	0
4. (a)(Expand wetland) 5/ Wetland Area Expanded	Acres	0	0	0	0	0
(b)(Encourage wetlands) 5/ Ponds with Wetland Facilities	Number	0	0	0	0	0
or Wetland Management	Surface Ac.	0	0	0	0	0
5. (Unique biotic areas) 5/ Areas Preserved and Protected	Number	0	0	0	0	0

TABLE 6.3 - FUTURE WITHOUT CONDITION - SANTA CRUZ-SAN PEDRO RIVER BASIN
(Cont'd)

Second Level Component From Table 3.9 1/	Unit	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
ENVIRONMENTAL QUALITY (CONT'D)						
6. (Restricted use areas) 7/ Established Areas of Natural Beauty	Acres	68,000	74,000	74,000	74,000	58,000
7. (Erosion exhibit areas) 5/ Exhibit Areas Established	Acres	0	0	0	0	0
8. (Fuel buildup) Areas Protected Against Fuel Buildup	Acres	0	0	0	0	0
9. (Archeological and historical) 5/ Areas Protected	Number	12	12	12	12	12
10. (a) (Critical erosion areas) 5/ Vegetation Managed and Structures Installed on Critical Areas	Acres	0	0	0	0	0
Sediment Yield Reduced	AF/Year	0	0	0	0	0
(b) (Streambank protection) 5/ Streambank Protected	Miles	0	0	0	0	0
Sediment Yield Reduced	AF/Year	0	0	0	0	0
(c) (Grazing land erosion control) 5/ Erosion Control Practices Installed	Acres	3,263,000	3,314,000	3,416,000	3,518,000	3,820,000
Erosion Reduced	AF/Year	0	60	295	530	0

TABLE 6.3 - FUTURE WITHOUT CONDITION - SANTA CRUZ-SAN PEDRO RIVER BASIN
(Cont'd)

Second Level Component From Table 3.9 1/	Unit	San Pedro				Santa Cruz
		Time Period				
		1970	1980	2000	2020	Present
ENVIRONMENTAL QUALITY (CONT'D)						
11. (a) (Solid waste disposal) 8/ Disposal Facilities Provided	Number	0	9	17	17	0
(b) (Dump cleanup) Dumps Cleaned Up	Number	0	0	0	0	0

1/ See Table 3.9 for the complete statement of the second level components (preferences).
2/ Projection based on project effectiveness and future values of protected properties.
3/ Projection based on expected yields by time frame and continued application of land treatment practices.
4/ Supply of water based recreation is not expected to increase.
5/ Projections based on historical trend.
6/ Projections based on estimate of natural recovery.
7/ Projections based on current proposals.
8/ Projections based on assumption that existing statutes will be complied with.

CHAPTER 7

NEEDS

The net (without plan) needs for each of the specific study objectives described in Chapter 3 are shown in Table 7.1. The values shown for the San Pedro study area are essentially a subtraction of values in Chapter 6 from values in Chapter 4. Both present and future needs are shown. The values reflect accomplishments from on-going programs.

The values for the Santa Cruz study area are present needs only. No projections have been made.

The needs are expressed at two levels, National Economic Development (NED) and Environmental Quality (EQ). The NED needs reflect development of water and land resources that result in terms of increased production of goods and services. The environmental needs reflect the achievement of environmental conditions which the general public considers acceptable at the current time and preferences expected to prevail in the future.

TABLE 7.1 - NEEDS

SANTA CRUZ-SAN PEDRO RIVER BASINS

Primary Objective	Second Level Component From Table 3.9 1/	Units	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
National Economic Development	1. Floodwater, Erosion, and Sediment Damages						
	Agricultural Damages	Dollars 2/	762,800	889,000	1,061,000	1,241,000	1,484,700
	Nonagricultural Damages	Dollars 2/	435,900	488,800	658,300	944,500	709,000
	2(a) Crop Production						
	Net Return	Dollars	0	422,800	1,483,400	1,463,400	1,443,600
	2(b) Livestock Forage Production						
	Production	AUM	0	127,000	361,000	558,000	1,145,000
	Value of Production	Dollars	0	444,000	1,263,000	1,953,000	4,007,500

1/ See Table 3.9 for a full statement of the component need.

2/ Average annual damages.

TABLE 7.1 - NEEDS

SANTA CRUZ-SAN PEDRO RIVER BASINS

(Continued)

Primary Objective	Second Level Component From Table 3.9 1/	Units	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
National Economic Development (Cont'd)	3. Water-based Recreation						
	Picnicking	Activity Occasions	224,700	326,200	588,300	825,100	1,555,900
	Camping		0	21,000	77,000	127,600	217,100
	Lake Swimming		378,000	423,400	540,600	646,500	924,000
	Boating		132,800	149,500	192,600	231,500	354,400
	Water skiing		61,200	68,500	87,500	104,600	125,600
Environmental Quality	1. Fishery Habitat and Esthetics Protection Needed						
	Lake Habitat	Sur. Ac.	0	0	15,000	35,000	580,000
	Pond Habitat	Sur. Ac.	0	80,000	230,000	350,000	1,690,000
	Streams	Mi.	115,000	115,000	115,000	115,000	70,000

1/ Also shown in Erosion and Sediment Item EQ 10(b).

TABLE 7.1 - NEEDS

SANTA CRUZ-SAN PEDRO RIVER BASINS

(Continued)

Primary Objective	Second Level Component From Table 3.9 1/	Units	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
Environmental Quality (Cont'd)	2(a) Wildlife Oriented Management Techniques						
	Grazing Lands	Acres	2,967,000	2,967,000	2,967,000	2,967,000	4,808,000
	Forestlands	Acres	76,500	74,550	70,650	66,750	51,000
	Cropland	Acres	1,694	1,679	1,649	1,620	4,164
	2(b) Wildlife Water Developments	No.	1,267	1,117	817	517	1,500
	2(c) Restoration of Rangeland and Forestland Habitat	Acres	50,000	37,000	11,000	0	55,000
	2(d) Restoration of Abandoned Irrigated Land	Acres	19,000	19,000	16,000	10,000	34,000
	2(e) Multiple-Use Planning						
	Area Needing Multiple-Use Planning	Acres	61,000	62,000	64,000	65,000	124,000

TABLE 7.1 - NEEDS

SANTA CRUZ-SAN PEDRO RIVER BASINS

(Continued)

Primary Objective	Second Level Component From Table 3.9 1/	Units	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Time Period Present
Environmental Quality (Cont'd)	2(f) Unique Biotic Inhabitants						
	Antelope	Acres	1,936,000	1,900,000	1,900,000	1,900,000	1,157,000
	Arizona Black-tailed Prairie Dog	Acres	1,936,000	1,936,000	1,936,000	1,936,000	0
	Masked Bobwhite Quail	Acres	1,936,000	1,936,000	1,936,000	1,936,000	1,157,000
	Botteri's Sparrow and Others	Acres	1,936,000	1,886,000	1,886,000	1,886,000	0
	3(a) Riparian Communities Areas Needing Preservation	Acres	35,000	35,000	35,000	35,000	43,000
	3(b) Restore Riparian Vegetation	Acres	17,500	17,500	17,500	17,500	21,500
	4(a) Expand Wetlands	Acres	100	100	100	100	100
	4(b) Encourage Wetlands	Number	350	480	740	1,000	430
		Sur. Ac.	365	500	772	1,043	448
	5 Unique Biotic Areas	Number	3	3	3	3	4

TABLE 7.1 - NEEDS

SANTA CRUZ-SAN PEDRO RIVER BASINS

(Continued)

Primary Objective	Second Level Component From Table 3.9 1/		Units	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
Environmental Quality (Cont'd)	6.	Restricted Use Areas	Acres	0	4,000	27,000	52,000	10,000
	7.	Erosion Exhibit Areas	Acres	40	40	40	40	10
	8.	Fuel Buildup	Acres	58,000	58,000	58,000	58,000	5,000
	9.	Archeological and Historic Sites	No. of Sites	70	70	70	70	109
	10(a)	Critical Erosion Areas Areas Needing Treatment	Acres	192,000	192,000	192,000	192,000	7,500
		Average Reduction in Sediment Yield	AF/Yr.	335	335	335	335	8
	10(b)	Streambank Protection Treatment Needed	Miles	115	115	115	115	75
		Average Reduction in Sediment Yield	AF/Yr.	35	35	35	35	25

TABLE 7.1 - NEEDS

SANTA CRUZ-SAN PEDRO RIVER BASINS

(Continued)

Primary Objective	Second Level Component From Table 3.9 1/	Units	San Pedro Time Period 1970	1980	2000	2020	Santa Cruz Present
Environmental Quality (Cont'd)	10(c) Grazing Land Erosion Control Area Needing Treatment	Acres	499,000	448,000	346,000	244.000	522,000
	Average Reduction in Erosion	AF/Year	1,410	1,350	1,115	880	570
	11(a) Solid Waste Disposal	Number of Communities	17	8	0	0	18
	11(b) Dump Cleanup	Acres	160	180	200	220	400

CHAPTER 8

ALTERNATIVE PLANS

INTRODUCTION

The alternative plans in this report consist of the National Economic Development alternative and the Environmental Quality alternative. Each alternative for the San Pedro study area is for the early action program, essentially the time period from the present to the year 2000. The alternative plans for the Santa Cruz study area only consider present needs. Other alternatives or long range plans were not developed because the Arizona Water Commission is developing a detailed State Water Plan and the regional councils of government within the Arizona state planning districts are developing plans for the solution of problems locally. This study has provided and will continue to provide data for such detailed planning efforts.

The plan alternatives in this chapter require an acceleration of existing programs. The measures and cost of the plans are over and above the ongoing programs. This acceleration relates to existing state and federal agencies and programs and involves several areas of resources and efforts. These include:

1. Public information - Increased communication of natural resource needs, problems, and possible solutions is essential. The public, young and old, must have more information and understanding of resource needs and problems if society is to speed up solution to problems. Demonstration projects, technical assistance from trained and experienced people, education of primary, secondary, and adult students are examples needing emphasis.

2. Assistance and services from well trained and experienced agency personnel - The application of practices and measures to solve natural resource problems requires people who know how to do the job effectively. Private landowners and landusers need additional assistance. Some agencies need additional technical personnel.

3. Funding for application and cost sharing - The programs must be funded after society understands the problems, requests assistance or demands action.

NATIONAL ECONOMIC DEVELOPMENT (NED) ALTERNATIVE -PLAN A

The NED Alternative, Plan A, is a plan to increase the efficiency in the use of soil, water, and other resources used to produce crops at the OBERS level of production and livestock within that level. It also

includes flood protection plans which are economically feasible and plans to develop areas for recreation where practical. Items designed to improve environmental quality, which do not detract from the NED, are included in this alternative.

Land and water resources are adequate to produce the output of goods and services included in Plan A. Ground water available in the San Pedro study area will support the projected level of agricultural production and municipal and industrial use many years beyond the early action program included in the plan. Flood damage problems exist but control is too costly to include in the plan in most cases. The potential for water-based recreation and for development of wetlands or fisheries is limited. There are possibilities for improving wildlife habitat on lands grazed by livestock, used for cropland, and on forest lands.

The following discussion, by second level components, identifies the specific actions in the NED plan. (Also see Table 8.1.)

NED-1 (Floodwater, erosion, & sediment damages) - The St. David, Willcox East, Willcox West, Black Diamond, Rucker Canyon, and Pomerene watersheds in the San Pedro study area were studies for feasibility under the Watershed Protection and Flood Prevention Act, Public Law 566. The St. David Watershed is the only one where studies indicate a project could be developed with a favorable cost benefit ratio (See Project Site Map). The Town of St. David and irrigated croplands can be protected from flooding. This proposed project includes a floodwater retarding structure, a diversion, and a waterway.

The Picacho No. 1, Picacho No. 2, Marana, West Branch of the Santa Cruz River, Cactus Forest, and Airport Wash watersheds were studied in the Santa Cruz Basin. The West Branch of the Santa Cruz River and Cactus Forest watershed are feasible under present conditions (See Project Site Map).

The potential project on the West Branch of the Santa Cruz River Watershed would provide flood protection to urban areas in Tucson. The potential project consists of a floodway.

The potential Cactus Forest Project would protect irrigated cropland and irrigation and drainage canals in the San Carlos Irrigation Project, a portion of the towns of Coolidge and Randolph and the Central Arizona Project Salt-Gila aquaduct from floodwaters. It consists of three floodwater retarding structures, four diversions, and four floodways.

NED-2(a)(Crop production) - The resource management system for irrigated cropland consists of measures applied to the land and water resources and the methods of managing these resources (Table 8.2). Proper application and management of these measures will reduce the quantity of water used to produce crops, maintain and improve soil condition, reduce soil erosion, and control soil salts. Increases in the quantity and quality of crops will result.

TABLE 8.1

PLAN A - NATIONAL ECONOMIC DEVELOPMENT
SAN PEDRO-SANTA CRUZ STUDY AREAS

Primary Objectives - NED			San Pedro Area	Santa Cruz Area
			Early Action Plan Provides (year 2000)	Plan A Provides satisfaction of most
Second Level Component	Plan Elements	Unit	Plan A Provides	present needs
NED 1. (Flood water, erosion and sediment damage.)	Provide watershed protection to urban and agricultural lands.		Protection to the town of St. David from a 100-year storm	Protection to the urban area of Tucson in the West Branch of the Santa Cruz Watershed and protection to urban and protection to urban and agricultural lands in the Cactus Forest Watershed.
	Agricultural damages	$	4,100	151,100 with 1,333,600 need remaining
	Nonagricultural damages	$	115,000	139,500 with 569,500 need remaining
NED 2a. (Crop production)	Install Resource Management System (Conservation Land Treatment) on irrigated cropland.	$	Annual net returns increase by $1,483,400 to a total of $7,965,000.	Average annual net returns increased by $ 1,443,600 from $12,217,000 to $13,660,600
		$		
		Ac.	100,000	264,000
NED 2b. (Beef production	Install grazing land resource management grazing lands.	$	Increase in average annual value of production by $1,263,000 to a total	Increase in average annual value of production by $4,007,500.
NED 3. (Water based recreation)	Develop recreation areas.		San Pedro Mesquite Bosque as a camping and natural area and Leslie Canyon as a camping and boating area.	
		Rec. Activity occasions	Picnicking 121,300	0 with 1,555,900 need remaining
			Camping 71,700	0 " 217,100 " "
			Lake swim 33,500	0 " 924,000 " "
			Boating 10,400	0 " 354,400 " "
			Water skiing -0-	0 " 125,600 " "

1/ See Table 3.9 for complete statement of the second level component (Preferences).

TABLE 8.2

ELEMENTS OF THE IRRIGATED CROPLAND RESOURCE MANAGEMENT SYSTEM

Item	Units	San Pedro Study Area (projected-30 yrs)	Santa Cruz Study Area (Present needs)
Ditch and canal lining and piping	Mi.	918	1,934
Field earthen ditches	Mi.	345	190
Water measuring devices and Water control structures	No.	3,100	9,600
Irrigation land leveling	Ac.	80,000	201,000
Irrigation system design			
furrows, borders	Ac.	80,000	201,000
sprinkler, bubbler, drip	Ac.	20,000	21,000
Field shelterbelts - trees and shrubs	Mi.	272	870
Irrigation overnight storage reservoirs	No.	135	--
Irrigation water management	Ac.	100,000	222,000
Conservation cropping system	Ac.	100,000	264,000
Crop residue use	Ac.	100,000	264,000
Mulching	Ac.	2,800	11,000
Minimum tillage (also reduces use of energy)	Ac.	59,000	107,000
Critical area treatment	Ac.	29,000	7,500
Toxic salt reduction in the soil	Ac.	6,000	38,000
Conservation Planning	Ac.	100,000	88,000

TABLE 8.3

APPROXIMATE CHANGE IN INPUTS AND RESPONSE IN CROP YIELD
AS A RESULT OF APPLYING THE CROPLAND RESOURCE MANAGEMENT SYSTEM

Item	Unit	San Pedro Study Area - Change 1/	Santa Cruz Study Area - Change 2/
Average Annual Cost of Resource Management System	$/acre	21 increase	12 to 33 increase
Water Use and Pumping Requirement 3/ (varies by crop and method of irrigation)	%	5 to 23 decrease	4 to 25 decrease
Fertilizer Use (varies by crop)	%	1 to 8 decrease	1 to 8 decrease
Labor for Irrigation	%	19 increase	25 increase
Seedbed Preparation 3/ - minimum tillage (cotton, small grains and sorghum crops)	%	15 to 41 decrease	20 to 55 decrease
Average Yield Increases (varies by crop and location)	%	18 increase	14 to 20 increase

1/ Change from present conditions by applying 75 percent of Resource Management System Elements.
2/ Change from present conditions with 100 percent of most present needs satisfied by applying Resource Management System.
3/ Also reduces consumption of energy.

A resource management system is made up of a particular combination of treatment measures, each of which contributes a specific, yet often overlapping contribution to the solution of a problem. Each irrigated field has certain problems that can be solved by an appropriate resource management system.

It will not be feasible to apply all the land treatment practices outlined within a short period of time due to the number and quantity of practices involved, the amount of technical assistance which could reasonably be provided, and the ability of farmers to provide their part of the capital required to apply the practices. As a result it was estimated that 75 percent of the remaining resource management system measures needed would be applied during the early actions program in the San Pedro study area. All present resource needs are included in the plans for the Santa Cruz study area.

With these practices applied, crop yields would be increased and inputs modified as indicated in Table 8.3. It is estimated that projected crop yields for the year 2000 would increase 18 percent with application of 75 percent of the remaining resource management system measures needed.

Inputs of water and fertilizer and seedbed preparation costs would be reduced while irrigation labor costs would increase.

With increases in crop yields shown in Table 8.3, the projected yields of major crops, with 75 percent of land treatment planned action, would increase as compared to the base year (Table 8.4).

TABLE 8.4 - CROP YIELD PROJECTIONS WITH PLANNED ACTION DURING THE EARLY ACTION PROGRAM - SAN PEDRO STUDY AREA

Crop	Base Year Index	End Early Action Program Index
Cotton, upland	100	148
Barley	100	140
Sorghum grain	100	139
Wheat	100	141
Alfalfa	100	132
Vegetables	100	134

These yield projections were obtained by increasing the projected increases in yields without planned action given in Chapter 6 by the percentages given in Table 8.3. For example, the yield of sorghum grain is projected to increase 33 percent by the year 2000 without planned action (Table 6.2). Increasing the 33 percent by 18 percent gives 38.94 percent, or 39 percent rounded, with planned action.

Projections were also made in the San Pedro study area to determine the maximum production that could be obtained with the available water resources. Should the need for agricultural production increase beyond projected future levels, it would be within the capabilities of the study area to increase production an additional 18 percent, on the average. The increase yields in the Santa Cruz Basin would range from 14 percent in Santa Cruz County to about 20 percent in Pinal County.

NED-2(b)(Livestock forage production) - The resource management system for grazing lands (Table 8.5) consists of measures to improve the production of livestock forage, reduce soil erosion, reduce sediment yield and improve the distribution of reliable water. Abandoned cropland and abandoned subdivisions are included as grazing lands.

The application of the resource management system will also make significant contributions to the satisfaction of several environmental quality components.

NED-3 (Water-based recreation) - There are two potential water-based recreation developments in the San Pedro study area. These are Leslie Canyon and the San Pedro Mesquite Bosque. The Leslie Canyon development would be located in Cochise County and would consist of constructing a dam in Leslie Canyon, impounding about 100 surface acres of water, and developing a recreation complex. Facilities provided would include a 45 unit campground, 30 picnic tables, swimming beach, a boat ramp, and about .5 miles of trail.

The San Pedro Mesquite Bosque is located along the banks of the San Pedro River in Cochise and Pima counties. Development would be limited to a camping area of 45 units, (35 for trailers and 10 for tent camping). About 1200 acres of mesquite bosque would be purchased; and trails would be developed for hiking, bird watching, nature study, and other similar activities.

Display of Accounts

The following tables display the beneficial and adverse effects of the NED alternative. This display system is divided into four accounts; 1. National Economic Development (Tables 8.6 and 8.7), 2. Environmental Quality (Tables 8.8 and 8.9), 3. Regional Development (Tables 8.10 and 8.11), and 4. Social Well-Being (Tables 8.12 and 8.13). The effects of the alternative are displayed in each of these accounts.

TABLE 8.5

ELEMENTS OF THE GRAZING LANDS RESOURCE MANAGEMENT SYSTEM

Item	Unit	San Pedro Study Area	Santa Cruz Study Area
Water facilities (wells & tanks)	No.	470	1,800
(ponds)	No.	200	395
Range seeding	Ac.	71,000	119,000
Brush management	Ac.	123,000	320,000
Mechanical erosion control	Ac.	62,000	82,000
Management measures			
proper grazing use	Ac.	1,114,000	4,115,000
grazing management systems	Ac.	1,114,000	4,115,000
Conservation Planning	Ac.	1,114,000	4,115,000

TABLE 8.6

PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE

National Economic Development Account

SAN PEDRO STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/	Components	Measure of Effects (Avg. Annual) 1/
Beneficial effects:		Adverse effects:	
A. The value to users of increased output of goods and services.		A. The value of resources required for a plan:	
1. Flood Prevention	$ 119,100	1. Single purpose floodwater retarding structures, floodways, diversions, recreation structure and basic facilities.	
2. Recreation	$ 374,900	Project Installation	$ 266,200
3. Resource Management Systems	$5,911,800	Operation, Maintenance and Replacement	$ 107,400
B. The value of output resulting from external economics.		2. Resource Management Systems.	
1. Indirect activities associated with increased net returns from resource management systems.	$ 726,900	Project Installation	$2,279,400
		Operation, Maintenance and Replacement	$1,504,900
		3. Project Administration	$ 17,000
TOTAL BENEFICIAL EFFECTS	$7,132,700	TOTAL ADVERSE EFFECTS	$4,174,900
		NET BENEFICIAL EFFECTS	$2,957,800

1/ 100 years at 6-1/8 percent interest.

TABLE 8.7
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
National Economic Development Account
SANTA CRUZ STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/	Components	Measure of Effects (Avg. Annual) 1/
Beneficial effects:		Adverse effects:	
A. The value to users of increased output of goods and services.		A. The value of resources required for a plan:	
1. Flood Prevention	$ 787,300	1. Single purpose floodwater retarding structures, diversions, and channel modification.	
2. Resource Management Systems	$18,330,700	Project Installation	$ 497,600
		Operation, Maintenance and Replacement	$ 27,800
B. The value of output resulting from external economics.		2. Resource Management Systems.	
1. Indirect activities associated with increased net returns from resource management systems and flood prevention	$ 3,936,600	Project Installation	$ 9,346,300
		Operation, Maintenance and Replacement	$ 5,524,900
		3. Project Administration	$ 31,000
TOTAL BENEFICIAL EFFECTS	$23,054,600	TOTAL ADVERSE EFFECTS	$15,427,600
		NET BENEFICIAL EFFECTS	$ 7,627,000

1/ 100 years at 6 1/8 percent interest.

TABLE 8.8
SAN PEDRO STUDY AREA
NED Alternative Plan A

EQ ACCOUNT

Component	Beneficial and adverse effects:
A. Areas of natural beauty	1. Visual impact of the increase of grass, forb and small shrub vegetation on about 450,000 acres of grazing lands.
	2. Visual impact of the removal of woody plants (mostly pinon-juniper and chaparral) on about 123,000 acres of grazing lands.
	3. Visual change through the control of soil erosion on about 224,000 acres of grazing and recreation lands.
	4. Visual increase of water surface by about 200 new stock ponds (about 300 surface acres) that contrast with arid and semi-arid conditions.
	5. Quiet, remote living conditions of the rural area will be disturbed by an increase of 207,900 visitor days by recreationists.
	6. Dikes and flood control structures will interrupt a portion of the view of Dragoon Mountains from the Town of St. David.
	7. Visual change as 16,000 acres of abandoned croplands and some abandoned subdivision lands return to native vegetation.
	8. Visual change on areas where natural fire is not suppressed or prescribed burning practices are implemented.
	9. Loss of about one-half mile of free flowing stream and fish habitat as a result of constructing Leslie Canyon Dam and 100-acre lake.
	10. Remove about 15 acres of riparian type vegetation at the proposed site of Leslie Canyon Dam and Lake.
	11. Modify about 40 acres native vegetation to accommodate recreation facilities near Leslie Canyon Lake.

TABLE 8.8 (Continued)

	12. More uniform growth and vigorous growing crops contrasted by 272 miles of shelterbelts and associated bird and wildlife on well kept farms will be a change from the present visual conditions.
	13. Preserve, on public lands, 1,200 acres of mesquite bosque as a natural and wildlife area and provide trails for humans to enjoy the natural resources.
	14. Modify about 10 acres of riparian vegetation to accommodate recreation facilities at the Mesquite Bosque recreation area.
B. Quality considerations of water, land and air resources	1. Reduce soil erosion by about 480 acre-feet per year on about 40,000 acres of cropland and 224,000 acres of grazing lands to protect the soil and productive capacity of the land for present and future generations.
	2. Increase the kinds, amount and vigor of vegetation to improve soil protection and vegetation on about 1,114,000 acres grazing land and 95,000 acres of cropląnds.
	3. Increase distribution of 670 small water developments (about 300 surface acres) with each serving one or more sections of grazing land.
	4. Reduce sediment moving down the San Pedro River that contributes to flat broad channel bottoms and barren sand bars, by about 240 acre-feet per year.
	5. Increase crop residue and mulch on the soil surface and plowed under later to improve soil condition on about 46,000 acres of irrigated cropland.
	6. Leach salt from soil root zone of crops on approximately 2,100 acres of cropland.
	7. Reduce evaporation of irrigation water and increase crop yields by planting about 272 (1000 acres) miles of shelterbelts at the end of and along irrigated fields.
	8. Reduce airborne dust caused by slight to moderate wind erosion on about 224,000 acres of grazing lands and about 40,000 acres of irrigated cropland.

TABLE 8.8 (Continued)

9. Return about 16,000 acres of abandoned cropland and some abandoned subdivisions to native vegetation.

10. Provide flood control on 420 acres of agricultural cropland and urban land.

11. Provide about 207,900 visitor days of recreation in Leslie Canyon and Mesquite Bosque.

12. Create a lake of about 100 surface acres -- Leslie Canyon.

13. Lose about one-half mile live stream - Leslie Canyon.

14. Modify about 50 acres natural vegetation to accommodate recreation facilities - Leslie Canyon and Mesquite Bosque.

15. Preserve about 1,200 acres natural and wildlife area - Mesquite Bosque.

16. Increased soil erosion may occur for relatively short time periods during construction of two flood control structures, two miles concrete drainway at St. David, 65,000 acres of land leveling, 800 miles of ditch and canal lining, small erosion control structures on about 62,000 acres, 123,000 acres of brush management, 470 wells and tanks, 200 stock ponds, recreation facilities, etc.

C. Biological resources and selected ecosystems

1. Increased kind and amount of vegetation for livestock will also benefit wildlife on about 1,114,000 acres.

(Note: Livestock grazing programs generally benefit wildlife by improving vegetation, however, the program to maximize output of goods and services may not provide permanent, total or year long food, cover, water and space required for all wildlife species present or potentially present.)

2. Increase distribution of permanent water facilities for livestock that will be usable for land wildlife species and waterfowl on about 300 surface acres of water at 200 new locations.

TABLE 8.8 (Continued)

3. Increase seasonal water at 470 locations of new wells and tanks on grazing lands.

4. Increase permanent cover and food for some wildlife species in 272 miles (about 1,000 acres) of shelterbelts at the end of and along irrigated cropland fields.

5. Generally reduce wildlife habitat value on about 75,000 acres by clearing (pinon, juniper, & chaparral) in large blocks to increase forage for livestock.

(Note: Brush management may be accomplished without this loss if present methods are changed - loss in habitat occurs when edge effect is reduced and all tree and shrub cover is removed.

6. Increase crop residue and mulch on cropland soil surface that will provide food for some wildlife for longer time periods.

7. Lose one-half mile of live stream and aquatic habitat - Leslie Canyon.

8. Create 100 surface acre water body - Leslie Canyon.

9. Lose about 15 acres of riparian type vegetation - Leslie Canyon.

10. Preserve 1,200 acre wildlife habitat area - Mesquite Bosque.

11. Modify about 40 acres natural vegetation - Leslie Canyon and Mesquite Bosque recreation facilities.

D. Irreversible or irretrievable commitments

1. Commitment of land and water to manmade structures such as 670 water facilities, erosion control structures, floodwater retarding structures, access roads, etc.

2. Loss of 50 acres of riparian vegetation in Leslie Canyon above and under the dam to be constructed for recreation.

3. Commitment of about 210 acres of land to Leslie Canyon dam, water area and recreation development.

4. Commitment of 1,200 acres to natural Mesquite Bosque along the San Pedro River.

TABLE 8.9
SANTA CRUZ STUDY AREA
NED Alternative Plan A

EQ ACCOUNT

Component		Beneficial and adverse effects:
A.	Areas of natural beauty	1. Visual impact of the increase of grass, forb and small shrub vegetation on about 850,000 acres of grazing lands.
		2. Visual impact of the removal of woody plants (mostly pinon-juniper, chaparral, and mesquite) on about 320,000 acres of grazing lands.
		3. Visual change through the control of soil erosion on about 119,000 acres of lands with high moderate and severe erosion by grass seeding and mechanical erosion control. In addition erosion will be reduced and vegetation increased on about 403,000 acres through grazing management measures.
		4. Visual increase of water surface by about 395 new stock ponds (about 600 surface acres) that contrast with arid and semi-arid conditions.
		5. Quiet remote living conditions will be disturbed by increase in population and increased demand for use of natural resources.
		6. Flood retarding, channel and floodway structures will change the local landscape near the towns of Coolidge and Randolph and near Tucson.
		7. Visual change as 34,000 acres of abandoned croplands and some abandoned subdivision lands return to native vegetation.
		8. Prevent fuel buildup on about 5,000 acres in two natural areas.
		9. More uniform growth and vigorous growing crops contrasted by 870 miles of shelterbelts and associated bird and wildlife on well kept farms will be a change from the present visual conditions.

TABLE 8.9 (Continued)

B.	Quality considerations of water, land and air resources	1. Reduce soil erosion by about 400 acre-feet per year on about 522,000 acres of grazing lands to protect the soil and productive capacity of the land for present and future generations.
		2. Increase the kind, amount and vigor of vegetation to improve soil protection and vegetation on about 4,115,000 acres grazing land and 264,000 acres of croplands.
		3. Increase distribution of 2,195 small water developments (about 600 surface acres) with each serving one or more sections of grazing land.
		4. Reduce sediment moving down the Green's Wash by about eight acre-feet per year.
		5. Increase crop residue and mulch on the soil surface and plowed under later to improve soil condition on about 140,000 acres of irrigated cropland.
		6. Reduce evaporation of irrigation water and increase crop yields by planting about 870 miles (4,200 acres) of shelterbelts at the end of and along irrigated fields.
		7. Reduce airborne dust caused by slight to moderate wind erosion on about 280,000 acres of grazing lands and about 80,000 acres of irrigated cropland.
		8. Return about 34,000 acres of abandoned croplands and some abandoned subdivisions to native vegetation.
		9. Provide flood control on about 500 acres of urban land along the Santa Cruz River near Tucson and about 7,000 acres of cropland in the Cactus Forest Watershed.
		10. Increased soil erosion may occur for relatively short time periods during construction of flood control structures, land leveling, ditch and canal lining, small erosion control structures, bursh removal, wells and tanks, ponds, etc.

TABLE 8.9 (Continued)

C.	Biological resources and selected ecosystems	1. Increased kind and amount of vegetation for livestock will also benefit wildlife on about 4,115,000 acres. (Note: Livestock grazing programs generally benefit wildlife by improving vegetation, however, the program to maximize output of goods and services may not provide permanent, total or year long food, cover, water and space required for all wildlife species present or potentially present.) 2. Increase distribution of permanent watering facilities for livestock that will be usable for land wildlife species and waterfowl (about 600 surface acres of water) at 395 new locations. 3. Increase seasonal water at 1,800 locations of new wells and tanks on grazing lands. 4. Increase permanent cover and food for some wildlife species in 870 miles (about 4,200 acres) of shelterbelts at the end of and along irrigated cropland fields. 5. Generally reduce wildlife habitat value on about 160,000 acres by clearing (pinon-juniper, chaparral, and mesquite) in large blocks to increase forage for livestock. (Note: Brush management may be accomplished without this loss if present methods are changed - loss in habitat occurs when edge effect is reduced and all tree and shrub cover is removed.) 6. Increase crop residue and mulch on cropland soil surface that will provide food for some wildlife for longer time periods.
D.	Irreversible or irretrievable commitments	1. Commitment of land and water to manmade structures such as water facilities, erosion control structures, floodwater retarding structures, access roads, etc.

TABLE 8.10
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account
SAN PEDRO STUDY AREA

Components	Measure of Effects: San Pedro Study Area (Avg. Annual)	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Beneficial effects:		
A. The value of increased output of goods and services to users residing in the region.		
1. Flood prevention	$ 119,100	$ --
2. Recreation	356,200	18,700
3. Resource management systems	5,911,800	--
B. Additional net income accruing to the region from project installation and from other economic activities induced by operation of the plan.		

Components	Measure of Effects: San Pedro Study Area (Avg. Annual)	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Adverse effects:		
A. The value of resources contributed from within the region to achieve the outputs.		
1. Single purpose floodwater retarding structure, floodways, diversion, recreation structure, and basic facilities.		
Project installation	$ 93,500	$ 172,700
OM&R	107,400	0
2. Resource management systems		
Project installation	929,900	1,349,500
OM&R	1,456,400	48,500 2/

TABLE 8.10
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measure of Effects: San Pedro Study Area (Avg. Annual)	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Beneficial effects:		
1. Increased net profit stemming from construction of the plan, to firms located in the region.	22,400	-22,400
2. Additional wages and salaries accruing to the region throughout the life of the plan.		
(a) Recreation sector	10,400	-10,400
(b) Project OM&R	568,200	-568,200
C. The value of output resulting from external economics accruing within the region.		
1. Resource management systems	318,400	408,500
TOTAL BENEFICIAL EFFECTS	$7,306,500	-$173,800

Components	Measure of Effects: San Pedro Study Area (Avg. Annual)	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Adverse effects:		
3. Project Administration	2,300	14,700
TOTAL ADVERSE EFFECTS	$2,589,500	$1,585,400
NET BENEFICIAL EFFECTS	$4,717,000	-$1,759,200

1/ 100 years at 6-1/8 percent interest.
2/ Technical assistance on replacing practices.

TABLE 8.10
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measures of Effects: San Pedro Study Area	Measures of Effects: Rest of Nation
Employment: Beneficial Effects:		
A. Increase in number and type of jobs.		
1. Agricultural employment	-17.2 annual man-years of agricultural jobs	-
2. Employment in construction of the plan	286.4 man-years skilled jobs; 59.3 man-years semi-skilled jobs	-286.4 man-years skilled jobs
3. Employment in OM&R of the plan	3 full-time skilled jobs; 70 part-time skilled jobs; 6 full time semi-skilled jobs; 23 part-time semi-skilled jobs	-3 full-time skilled jobs
4. Indirect and induced employment from increased expenditure within the region.	11 full-time semi-skilled jobs.	-

Components	Measures of Effects: San Pedro Study Area	Measures of Effects: Rest of Nation
Employment: Adverse Effects:		
A. Decrease in number and and type of jobs.		
1. Loss in agricultural employment associated with plan take area	-	-
2. Loss in indirect and induced employment associated with plan take area.	-	-

TABLE 8.10
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measures of Effects: San Pedro Study Area	Measures of Effects: Rest of Nation
Employment:		
TOTAL BENEFICIAL EFFECTS	Loss of 17.2 annual man-years of agricultural jobs. Gain of 286.4 man-years skilled jobs; 59.3 man-years semi-skilled jobs; 3 full time skilled jobs; 17 full-time semi-skilled jobs; 70 part-time skilled jobs; and 23 part-time semi-skilled jobs	Loss of 286.4 man-years skilled jobs and 3 full-time skilled jobs

Components	Measures of Effects: San Pedro Study Area	Measures of Effects: Rest of Nation
Employment:		
TOTAL ADVERSE EFFECTS	-	-
NET BENEFICIAL EFFECTS	Loss of 17.2 annual man-years of agricultural jobs. Gain of 286.4 man-years skilled jobs; 59.3 man-years semi-skilled jobs; 17 full time semi-skilled jobs; 70 part-time skilled jobs; and 23 part-time semi-skilled jobs	Loss of 286.4 man-years skilled jobs and 3 full-time skilled jobs

TABLE 8.10
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measures of Effects: San Pedro Study Area	Rest of Nation
Population Distribution		
Beneficial Effects	Gain of 3 full time skilled jobs, 17 full time semi-skilled jobs, 70 part time skilled jobs, and 23 part time semi-skilled jobs during the life of the plan; and 345.7 man-years of employment during construction of the plan. This is within an area that has experienced a 12.5 percent rise in population over the past 10 years.	
Adverse Effects	Loss of 17.2 man-years of agricultural employment.	Reduce growth potential in the rest of the nation by 3 full time employees throughout the life of the plan; and 286.4 man-years of employment during the installation period.
Regional Economic Base and Stability		
Beneficial Effects	Gain of 20 permanent full time, 93 permanent part time, and 345.7 man-years of medium to high income employment in an area where per capita income is 11 percent below the national average (1970).	
Adverse Effects	Loss of 17.2 annual man-years of low to medium income agricultural jobs.	

TABLE 8.11
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account
SANTA CRUZ STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/ San Pedro Study Area	Rest of Nation
INCOME		
Beneficial effects:		
A. The value of increased output of goods and services to users residing in the region.		
1. Flood prevention	$ 290,600	$ 496,700
2. Resource management systems	$18,330,700	-
Adverse effects:		
A. The value of resources contributed from within the region to achieve the outputs.		
1. Single purpose floodwater retarding structures, diversions, and channel modification.		
Project installation	$ 170,800	$ 326,800
OM&R	$ 27,800	-
2. Resource management systems.		
Project installation	$ 5,133,300	$ 4,213,000
OM&R	$ 5,142,000	$ 382,900 2/
3. Project administration	$ 3,900	$ 27,100

TABLE 8.11
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measure of Effects: San Pedro Study Area (Avg. Annual) 1/	Measure of Effects: Rest of Nation (Avg. Annual) 1/	Components	Measure of Effects: San Pedro Study Area (Avg. Annual) 1/	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME			INCOME		
Beneficial effects:			Adverse effects:		
B. Additional net income accruing to the region from project installation and from other economic activities induced by operation of the plan.					
1. Increased net profit stemming from construction of the plan, to firms located in the region.	$ 115,300	$ -115,300			
2. Additional wages and salaries accruing to the region throughout the life of the plan.					
(a) Project OM&R	$ 1,906,500	$ -1,906,500			

TABLE 8.11
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/ San Pedro Study Area	Rest of Nation	Components	Measure of Effects (Avg. Annual) 1/ San Pedro Study Area	Rest of Nation
INCOME			INCOME		
Beneficial effects:			Adverse effects:		
C. The value of output resulting from external economics accruing within the region.					
1. Resource management systems and flood prevention.	$ 3,134,200	$ 802,400			
TOTAL BENEFICIAL EFFECTS	$23,777,300	$ -722,700	TOTAL ADVERSE EFFECTS	$10,477,800	$ 4,949,800
			NET BENEFICIAL EFFECTS	$13,299,500	$-5,672,500

1/ 100 years a 6-1/8 percent interest rate.
2/ Technical assistance or replacing practices.

TABLE 8.11
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Employment: Beneficial Effects:		
A. Increase in number and type of jobs		
1. Agricultural employment	56.1 annual man-years of agricultural jobs	-
2. Employment in construction of the plan	35 annual man-years of skilled jobs during construction period; 1429.1 man-years skilled jobs; 295.4 man-years semi-skilled jobs	-35 annual man-years of skilled jobs during construction period; -1429.1 man-years skilled jobs
3. Employment in OM&R of the plan	24 full-time skilled jobs; 246 part-time skilled jobs; 40 part-time semi-skilled jobs	-24 full-time skilled jobs
4. Indirect and induced employment from increased within the region	127 full-time semi-skilled jobs	-

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Employment: Adverse Effects:		
A. Decrease in number and type of jobs		
1. Loss in agricultural employment associated with plan take area	-	-
2. Loss in indirect and induced employment associated with plan take area	-	-

TABLE 8.11
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Employment:		
Continued		
TOTAL BENEFICIAL EFFECTS	56.1 annual man-years of agricultural jobs; 35 annual man-years of skilled jobs during construction period; 1429.1 man-years skilled jobs; 295.4 man-years semi-skilled jobs; 24 full-time skilled jobs; 246 part-time skilled jobs; 40 part-time semi-skilled jobs; and 127 full-time semi-skilled jobs	-35 annual man-years of skilled jobs during construction period; -1429.1 man-years skilled jobs; and -24 full-time skilled jobs

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Employment:		
Continued		
TOTAL ADVERSE EFFECTS	-	-
NET BENEFICIAL EFFECTS	56.1 annual man-years of agricultural jobs; 35 annual man-years of skilled jobs during construction period; 1429.1 man-years skilled jobs; 295.4 man-years semi-skilled jobs; 24 full-time skilled jobs; 246 part-time skilled jobs; 40 part-time semi-skilled jobs; and 127 full-time semi-skilled jobs	-35 annual man-years of skilled jobs during construction period; -1429.1 man-years skilled jobs; and -24 full-time skilled jobs

TABLE 8.11
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Population Distribution		
Beneficial Effects	Gain of 24 permanent full time skilled jobs; 35 annual full time skilled jobs during construction period; 127 permanent full time semi-skilled jobs; 286 permanent part time jobs; 56.1 annual man-years of agricultural jobs and 1,724.5 man-years of construction jobs during installation period. This is within an area that has experienced an 18.6 percent increase in population during the period 1970-1975.	--
Adverse Effects	--	Reduce growth potential in the rest of the nation by 24 permanent skilled employees, 35 annual skilled employees during the construction period, and 1429.1 man-years of construction employees during installation period.
Regional Economic Base and Stability		
Beneficial Effects	Gain of 151 permanent full time; 286 permanent part time; 35 temporary full time jobs; 56.1 annual man-years of agricultural jobs and 1724.5 man-years of construction employment. This is in an area where per capita income is 9.8 percent below the national average.	
Adverse Effects	--	--

TABLE 8.12
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
SOCIAL WELL-BEING ACCOUNT
SAN PEDRO STUDY AREA

Components	Measures of Effects
Beneficial and adverse effects	
A. Real income distribution	1. Create 113 low to high income permanent, full time and part time jobs for area residents.
	2. Create regional income benefit distribution of $7,306,500 by income class as follows:

Income class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Benefits in Class
Less than 3,000	12.6	17.8
3,000-10,000	49.3	47.0
More than 10,000	38.1	35.2

3. Local costs to be borne by region total $2,589,500 with distribution by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Contributions in Class
Less than 3,000	12.6	17.8
3,000-10,000	49.3	47.0
More than 10,000	38.1	36.2

B. Life, health and safety	1. Provide one percent level of flood protection to the town of St. David.
C. Recreational opportunities	1. Creates opportunities for 207,900 recreation days primarily for residents of the region.

TABLE 8.13
PLAN A - NATIONAL ECONOMIC DEVELOPMENT ALTERNATIVE
SOCIAL WELL-BEING ACCOUNT
SANTA CRUZ STUDY AREA

Components	Measures of Effects
Beneficial and adverse effects	
A. Real income distribution	1. Create 493.1 low to high income permanent, full time and part time jobs for area residents.
	2. Create regional income benefit distribution of $23,777,300 by income class as follows:

Income class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Benefits in Class
Less than 3,000	19.1	19.1
3,000-10,000	42.7	42.7
More than 10,000	38.2	38.2

3. Local costs to be borne by region total $10,477,800 with distribution by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Contributions in Class
Less than 3,000	19.1	19.1
3,000-10,000	42.7	42.7
More than 10,000	38.2	38.2

B. Life, health and safety

1. Provide one percent level of flood protection to the West Branch Santa Cruz River in Tucson.

ENVIRONMENTAL QUALITY (EQ) ALTERNATIVE - PLAN B

This alternative considers the environmental quality aspects of natural resources and conditions. While esthetic values, wildlife habitat, archeological values, and other natural resources are emphasized in this alternative, items that contribute to national economic development and do not detract from the environmental quality objectives are included (See Table 8.16).

The plan provides for increasing natural vegetation, reducing soil erosion and sediment yield, improving the value of habitat for wildlife, and improving esthetic quality. (See the Project Site Map for locations of some of the Plan B features.) The U.S. Department of Agriculture (USDA) programs coordinated with the public desires, private landuser activities, and other agency programs assist in accomplishing this accelerated program. Programs of other than USDA agencies are capable of protecting archeological values, reintroducing wildlife species, researching wildlife habitat needs, preserving wilderness areas, etc.

The resource management systems as described in the NED alternative for grazing lands and croplands are also a part of the EQ alternative plan. See components 2a and 2b in Table 8.1. A summary of measures in the EQ resource management system are in Tables 8.14 and 8.15.

In addition to the NED resource management system are specific items added to emphasize environmental quality. The grazing land management system is expanded as follows:

1. Restrict livestock grazing use to 40 percent of the annual growth of native vegetation instead of 50 percent as in the NED.

2. Design brush management and clearing to increase edge effect, leave riparian plant species, leave trees every fourth mile (depending on the site), and leave trees on thin soils and on slopes over 15 percent.

3. Fence stock ponds to include the dam and ten or more acres above and around the pond and exclude livestock. Limit the area where livestock may drink at the pond or provide tank downstream from the pond. Leave all the shoreline of the pond, or as much as possible, undisturbed. The area below watering tanks will be fenced to avoid mud holes and to increase the area of ungrazed vegetation.

4. Include plants important to wildlife and esthetics in range reseeding according to the potential of the site.

5. Include wildlife as a user in all grazing management systems.

TABLE 8.14 - Elements of the Grazing Land Resource Management System

Items	Units	San Pedro	Santa Cruz
Proper grazing use (Livestock use restricted to 40 percent of annual forage growth)	Ac	1,114,000	4,115,000
Grazing management systems (Includes wildlife as a landuser)	Ac	1,114,000	4,115,000
Brush management (Protect riparian and improve wildlife habitat value)	Ac	123,000	320,000
Range seeding (Includes forbs and shrubs)	Ac	71,000	119,000
Water facilities 1/	No	670	1,800
Area restricted to livestock	Ac	6,700	18,000
Wetland improved	Ac	50	134
Mechanical treatment for erosion control	Ac	62,000	82,000
Improved habitat for wildlife species (Such as antelope, masked bobwhite quail, black tailed prairie dog, etc.)	Ac	1,114,000	1,157,000 (Antelope & quail)

1/ Also improves water quality

TABLE 8.15 - Elements of the Cropland Land Resource Management System

Items	Units	San Pedro	Santa Cruz
All measures in the NED plan, Table 8.1, plus:			
Plant trees and shrubs within cropland area	Ac	2,000	5,000
Provide water year long for wildlife	Ac	1,114,000	4,000,000
Restore abandoned croplands to native vegetation	Ac	16,000	34,000
Plant and leave unharvested cereal grain gaps in and near the tree and shrub plantings	Ac	130	300

The following EQ items are added to emphasize environmental quality in the cropland portion of the resource management system:

1. Plant trees and shrubs on areas not used for crop production.

2. Plant cereal grains adjacent to these trees and shrubs. This may involve an unharvested strip of grain crop along the side of a field.

3. Return abandoned cropland to its original native vegetation - grassland, woodland, or riparian-type.

4. Maintain yearlong water for wildlife.

5. Maintain existing riparian vegetation within or adjacent to the cropland area by irrigating two, three or more times a year.

The EQ alternative plan is outlined on Table 8.16.

This section briefly discusses the kind of treatment planned for each EQ component.

EQ-1 (Fishery habitat and esthetics) - The resource management system will reduce sediment and erosion in live streams and lakes. Stream channel modification will be used only where fish habitat will not be destroyed. Pumping of ground water from new areas should be controlled, and no additional land will be developed for irrigated cropland.

EQ-2(a)(Wildlife oriented management techniques) - The amount of annual forage growth harvested by livestock is reduced to 40 percent. Apply proper grazing use to all livestock grazing lands. Apply new standards to brush management and include wildlife as a user of grazing lands in all resource management systems. Wildlife productivity on forestlands will be increased through vegetative plantings on burns and cut over areas, thinning of conifer trees, control of human intrusion, and multiple-use planning. Small grain crops will be planted in and around shelterbelts and be available to wildlife.

EQ-2(b)(Wildlife water developments) - Wildlife watering facilities will be improved, and additional facilities will be provided. More surface water offers a contrast in an otherwise arid or semi-arid landscape. Water will be maintained in ponds and tanks year long.

EQ-2(c)(Restoration of rangeland and forestland habitat) - Range seeding and improved livestock management is planned on overused lands. Wildlife habitat and esthetic quality will improve as the kinds and amount of native vegetation increase.

EQ-2(d)(Restoration of abandoned irrigated land) - Restore native vegetation to abandoned cropland through reseeding, replanting, restricted use, and irrigation as necessary.

EQ-2(e)(Multiple use planning) - Multiple-use planning techniques will insure against improper conversion of rangeland, forestland, and cropland.

EQ-2(f)(Unique biotic inhabitants) - The resource management system planned will restore habitat of several wildlife species such as the antelope, Arizona blacktailed prairie dog, masked bobwhite quail, and Botteri's sparrow. Other agency programs are necessary for research to determine if all habitat requirements are met and to reintroduce such species to their original range.

EQ-3(a)(Riparian communities) - The plan for measures that involve change in type of vegetation, such as brush management and seeding, will include diverse plant species and those important to wildlife. Plant species and seeds used should be native to the location.

EQ-3(b)(Restore riparian communities) - Some abandoned cropland, abandoned subdivisions, and riparian vegetation in poor condition will be restored to native riparian or riparian-type vegetation in the grazing land management system.

EQ-4(a)(Expand wetlands) - The Arizona Game and Fish Department has planned and partially implemented the improvements and expansion of wetlands within the Willcox Playa. This program is expected to continue.

EQ-4(b)(Encourage wetlands) - It is planned that livestock ponds and other water areas will be fenced to exclude livestock from other than designated drinking areas. Wetland vegetation will increase around the undisturbed shorelines.

EQ-5 (Unique biotic areas) - The approach is to determine areas that are unique and in private ownership, convert these areas to public ownership through land transfer or purchase, study and research to determine kind and intensity of management necessary, and implement the management plan to perpetuate the resources.

EQ-6 (Restricted use areas) - The 27,000 acres proposed for restricted use by the year 2000 are 20,000 acres high on the east slope of the Santa Catalina Mountains overlooking the San Pedro Valley and 7,000 acres of semi-desert grassland and oak woodland in the Whetstone Mountains. These are, in addition to the existing 68,000 acres of wilderness, primitive and natural areas in the Chiricahua and Galiuro Mountains and in Aravaipa Canyon and an anticipated 6,000 acres expected to be included in the wilderness system in the Chiricahua Mountains by the U.S. Forest Service.

In the Santa Cruz Basin are 10,000 acres of oak woodland-chaparral high in the Santa Rita Mountains proposed for restricted use. This acreage is in addition to an existing 5,000 acres in the Butterfly Peak and Santa Catalina Natural Areas in the Santa Catalina Mountains.

EQ-7 (Erosion exhibit areas) - It is proposed that about 30 acres in the San Pedro study area be used to exhibit natural erosion processes and man's influence in erosion. About 10 acres are needed in each of three vegetative zones (desert, grassland, and oak woodland-chaparral).

Preferably all exhibits would be located near Interstate Highway 10 to promote maximum use. The desert exhibit should be located in the San Pedro Valley where erosion classes 1, 2, 3, and 4 can be exhibited (Erosion Classification Map at the back of the report). The Benson vicinity has good opportunities. The grassland exhibit should be located near Whetstone where erosion classes 3 and 4 can be shown. The oak woodland-chaparral exhibit should be located in the Little Dragoon Mountains where erosion classes 4 and 5 occur. Similar exhibits would be used in the Santa Cruz Basin south of Picacho Peak along the Santa Cruz River.

EQ-8 (Fuel buildup) - There are 58,000 acres within the San Pedro study area in the Galiuro and Chiricahua Wildernesses and Aravaipa Canyon natural area that are planned for a fire management program of controlled natural fire and prescribed burning. There are 5,000 acres in the Santa Cruz study area in the Santa Catalina and Butterfly Peak natural areas planned under the same program.

EQ-9 (Archeological and historical) - It is proposed that 46 historic and archeologic sites in the San Pedro study area and 109 sites in the Santa Cruz study area be provided with adequate means for restoration, excavation, stabilization, and/or protection. Archeological and historical resources will be protected or recovered before major projects are constructed. Vandalism will continue to be a problem.

EQ-10(a)(Critical erosion areas) - Diversion and sediment storage structures are planned along the San Pedro River, Aravaipa Creek, and Green's Wash. These structures are to intercept runoff from critically eroding areas and reduce the sediment entering the river system. Management of the vegetation is included in the resource management system.

EQ-10(b)(Streambank protection) - Streambank protection measures will be installed to reduce erosion and sediment in the major streams and rivers. The structures will be designed to improve fish habitat where live streams are involved.

EQ-10(c)(Grazing land erosion control) - The resource management system for grazing lands will reduce soil erosion by the reseeding of barren areas where there is a potential for good vegetation and through better management of use that increases the amount and vigor of vegetation.

EQ-11(a)(Solid waste disposal) - This plan assumes that present laws will be enforced and the problem will be alleviated.

EQ-11(b)(Dump cleanup) - The problem of dumping trash will continue.

TABLE 8.16
PLAN B - ENVIRONMENTAL QUALITY
SANTA CRUZ-SAN PEDRO RIVER BASINS

Primary Objective - EQ			San Pedro Study Area	Santa Cruz Study Area
			Plan B - Early Action through year 2000	Plan B Provides
Second Level Component	Plan Elements	Unit	Plan B Provides	
EQ 1. (Fishery habitat and esthetics)	Reduce sediment yield by resource management system above streams.			
	Lake habitat saved	Ac	0	580
	Pond habitat saved	Ac	50	1,690
	Streams protected	Miles	50	70
EQ 2(a). (Wildlife oriented management)	Install resource management systems to improve the kind and amount of vegetation important to wildlife and esthetics on grazing lands, forested lands and irrigated croplands.			
	Grazing lands	Ac	1,114,000	4,808,000
	Forest lands	Ac	50,000	51,000
	Croplands	Ac	1,300	4,164
EQ 2(b). (Wildlife water developments)	Install and improve wildlife watering facilities on grazing and croplands.	No	670	1,500
EQ 2(c). (Restoration of rangeland and forestland habitat)	Reseed and protect from overuse, historically overgrazed lands. These lands cannot be restored without reseeding and deferred use.	Ac	11,000	55,000

1/ See Table 3.9 for complete statement of the second level component (Preferences).

TABLE 8.16
PLAN B - ENVIRONMENTAL QUALITY
SANTA CRUZ-SAN PEDRO RIVER BASINS
(Continued)

Primary Objective - EQ			San Pedro Study Area	Santa Cruz Study Area
			Plan B - Early Action through year 2000	Plan B Provides
Second Level Component	Plan Elements	Unit	Plan B Provides	
EQ 2(d). (Restoration of abandoned irrigated land)	Abandoned cropland will be reseeded, protected or otherwise returned to native vegetation. Some irrigation and deferred use will be practiced.	Ac	16,000	34,000
EQ 2(e). (Multiple-use planning to guard against improper land conversion to urban and utility uses)	Resource management systems will determine proper land use and provide protection. Insure all natural resources are available to meet needs of subdivisions and utilities.			
	Multiple-use planning	Ac	30,000	124,000
EQ 2(f). (Unique biotic inhabitants)	Resource management systems on grazing lands will improve habitat. Research and reintroduction of species is additional.			
	Antelope	Ac	1,114,000	1,157,000
	Arizona Black-tailed Prairie Dog	Ac	1,114,000	--
	Masked Bobwhite Quail	Ac	1,114,000	1,157,000
	Botteri's Sparrow and others	Ac	1,114,000	--

TABLE 8.16
PLAN B - ENVIRONMENTAL QUALITY
SANTA CRUZ-SAN PEDRO RIVER BASINS
(Continued)

Primary Objective - EQ			San Pedro Study Area	Santa Cruz Study Area
			Plan B - Early Action through year 2000	Plan B Provides
Second Level Component	Plan Elements	Unit	Plan ■ Provides	
EQ 3(a). (Riparian communities)	Resource management systems will not allow removal of riparian vegetation and will improve existing riparian vegetation along streams and drainways.			
	Area protected	Ac	35,000	43,000
EQ 3(b). (Restore riparian vegetation)	Abandoned cropland will be returned to riparian vegetation if the land was originally in riparian. Change in abandoned to riparian, grassland, etc. types.	Ac	17,500	21,500
EQ 4(a). (Expand wetland)	Increase size of wetland area by pumping water when needed and encouraging natural vegetation.	Ac	Willcox Playa 100	Bog Hole 100
EQ 4(b). (Encourage wetlands)	Areas in ponds, above ponds, and below wells and tanks will be fenced to restrict livestock to encourage as much wetland along shorelines and adjoining areas as possible.	No Ac	670 50	430 30

TABLE 8.16
PLAN B - ENVIRONMENTAL QUALITY
SANTA CRUZ-SAN PEDRO RIVER BASINS
(Continued)

Primary Objective - EQ Second Level Component	Plan Elements	Unit	San Pedro Study Area Plan B - Early Action through year 2000 Plan B Provides	Santa Cruz Study Area Plan B Provides
EQ 5. (Unique biotic areas)	Determine unique areas and privately owned, transfer to public ownerhsip by purchase if necessary, develop management plan and protect to perpetuate these resources.	No. of Areas	Aravaipa, Ramsey and Carr Canyons 3	Parker and Gardner Canyons, Patagonia-Sonoita Creek and Blue Haven 4
EQ 6. (Restricted use)	Establish and protect from overuse wilderness and natural areas by fencing and managing.		Chiricahua Mountains 27,000	Santa Rita Mountains area 10,000
EQ 7. (Erosion exhibit areas)	Assist the public understand natural and manmade erosion processes by selecting sites and providing exhibits.	Ac	San Pedro Valley - Benson vicinity 30	Lower Santa Cruz Valley vicinity of Picacho Peak 10
EQ 8. (Natural fuel buildup)	Control unnatural fuel buildup in wilderness primitive and natural areas through prescribed natural fire and prescribed burning.	Ac	Galiuro and Chiricahua Wilderness areas; Aravaipa Canyon primitive area; privately owned Aravaipa Canyon natural area. 58,000	Santa Catalina and Butterfly Peak Natural Areas 5,000
EQ 9. (Archeological and historical sites)	Investigation and protection or recovery will be made during construction of projects. Programs other than USDA will preserve these areas as programs and funding are available.	No. of Sites	46	109 Additional needs may develop

TABLE 8.16
PLAN B - ENVIRONMENTAL QUALITY
SANTA CRUZ-SAN PEDRO RIVER BASINS
(Continued)

Primary Objective - EQ Second Level Component	Plan Elements	Unit	San Pedro Study Area Plan B - Early Action through year 2000 Plan B Provides	Santa Cruz Study Area Plan B Provides
EQ 10(a). (Critical erosion areas)	Sediment control structures are planned between the foothills and the river or main drainway to contain sediment.		San Pedro and Aravaipa Valleys	Picacho Peak and Green's Wash area
	Critical erosion areas	Ac	128,000	7,500
	Detention structures	No	255	--
	Reduction in sediment yield	AF/yr	200 (reduced)	.8 1/
EQ 10(b). (Streambank protection)	Streambank protection measures to be installed only where fish habitat can be maintained or improved.		115 miles along San Pedro River, Aravaipa Creek, and Whitewater Draw	Along Santa Cruz River, Alter Wash, Sopori Wash, McClelland Creek, Santa Rosa Wash and Green's Wash
	Area treated	Mi	69	75
	Reduction sediment yield	AF/yr	20	25
EQ 10(c). (Erosion control on grazing lands)	Grazing land resource management systems to reduce moderate erosion.			
	Treatment planned	Ac	224,000	522,000
	Average reduction to erosion	AF/yr	470 1/	400
EQ 11(a). (Solid waste disposal)	(See Chapter 11)	No. of Comm.	-0-	-0-
EQ 11(b). (Clean up dumps)	(See Chapter 7)	Ac	200	400

Display of Accounts

The following display system shows the beneficial and adverse effects of the EQ alternative. This display system is divided into four tables for each study area. 1. National Economic Development Tables 8.17 and 8.18, 2. Environmental Quality Tables 8.19 and 8.20, 3. Regional Development Tables 8.21 and 8.22, and 4. Social Well-Being Tables 8.23 and 8.24. The effects of the alternative are displayed in each of these tables. Tables 8.25 and 8.26 contain a summary comparison, by study area, of Plans A and B.

TABLE 8.17
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
National Economic Development Account
SAN PEDRO STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/
Beneficial effects:	
A. The value to users of increased output of goods and services.	
1. Recreation	$ 145,100
2. Resource Management Systems	$5,659,300
B. The value of output resulting from external economies:	
1. Indirect activities associated with increased net returns from resource management systems	$ 416,500
Adverse effects:	
A. The value of resources required for a plan:	
1. Recreation Facilities	
Project installation	$ 48,300
OM&R	$ 35,000
2. Resource Management Systems	
Project installation	$2,299,900
3. Project Administration	$ 1,000
4. Areas of natural beauty	
Project Installation	$ 2,800
OM&R	$ 10,000
5. Protect, preserve, or restore 16 archeological and historical sites.	
Project Installation	$ 184,200
6. Critical area stabilization	
Project Installation	$ 257,900
OM&R	$ 80,000

TABLE 8.17
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
National Economic Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/	Components	Measure of Effects (Avg. Annual) 1/
		7. Expand wetland	
		Project Installation	$ 15,400
		8. Prevent fuel buildup	
		Project Installation	$ 41,800
		9. Streambank protection	
		Project Installation	$ 83,400
		OM&R	13,100
		10. Plantings for esthetics and wildlife	
		Project Installation	$ 18,900
		OM&R	$ 46,000
		11. Preserve riparian vegetation	
		Project Installation	$ 429,900
		12. Clean up dumps	
		Project Installation	$ 3,700
TOTAL BENEFICIAL EFFECTS:	$6,220,900	TOTAL ADVERSE EFFECTS:	$5,077,900
		NET BENEFICIAL EFFECTS	$1,143,000

1/ 100 years at 6 1/8 percent interest.

TABLE 8.18
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
National Economic Development Account
SANTA CRUZ STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/	Components	Measure of Effects (Avg. Annual) 1/
Beneficial effects:		Adverse effects:	
A. The value to users of increased output of goods and services.		A. The value of resources required for a plan:	
1. Resource management systems	$17,529,200	1. Resource management systems	
		Project Installation	$ 9,413,600
		OM&R	$ 5,530,400
		2. Plantings for esthetics and wildlife	
B. The value of output resulting from external economies.		Project Installation	$ 47,300
		OM&R	$ 115,000
		3. Preserve riparian vegetation	
1. Indirect activities associated with increased net returns from resource management systems.	$ 2,918,700	Project Installation	$ 1,000
		4. Expand wetland	
		Project Installation	$ 528,100
		5. Areas of natural beauty	
		Project Installation	$ 1,000
		OM&R	$ 10,000
		6. Protect, preserve or restore 109 archeological and historical sites	
		Project Installation	$ 522,000
TOTAL BENEFICIAL EFFECTS:	$20,447,900		

TABLE 8.18
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
National Economic Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/	Components	Measure of Effects (Avg. Annual) 1/
Beneficial effects:		Adverse effects:	
		7. Critical area stabilization	
		Project Installation	$ 14,100
		OM&R	11,500
		8. Streambank protection	
		Project Installation	$ 87,500
		OM&R	14,300
		9. Clean up dumps	
		Project Installation	7,400
		10. Prevent fuel buildup	
		Project Installation	3,100
		TOTAL ADVERSE EFFECTS	$16,320,700
		NET BENEFICIAL EFFECTS	$ 4,127,200

1/ 100 years at 6-1/8 percent interest.

TABLE 8.19
SAN PEDRO STUDY AREA
Environmental Quality - Plan B

ENVIRONMENTAL QUALITY ACCOUNT

Component	Measure of Effects
A. Areas of natural beauty	1. Visual change as native vegetation will increase on 1,114,000 acres of grazing lands.
	2. Reduction of woody plants in areas now dominated by trees to more open areas of grass, forbs and shrubs interspersed with trees on about 123,000 acres of grazing lands.
	3. Visual change from overused grazing lands with moderate soil erosion to vegetated and protected grazing lands, about 224,000 acres.
	4. Visual increase of water surface by about 200 new stock ponds that contrast with the arid and semi-arid climatic conditions.
	5. Increase of native vegetation, on about 6,700 acres, around 670 fenced stock ponds and areas around tanks.
	6. Quiet remote living conditions will be interrupted by an additional 96,750 recreationists visitor days.
	7. Visual change as 16,000 acres of abandoned croplands and some abandoned subdivision lands are returned to native vegetation.
	8. Prevent fuel buildup on 58,000 acres of wilderness lands.
	9. Modify about 10 acres of native vegetation to accommodate recreation facilities - Mesquite Bosque.
	10. More uniform and vigorous growing crops interspersed with 3,000 acres of trees and shrubs will be a change from present visual conditions.
	11. Preserve, on public lands, 1,200 acres of riparian Mesquite Bosque as a natural and wildlife area accessible for recreationists to study and enjoy.

TABLE 8.19 (Continued)

	12. Preserve and protect about 68,000 acres with unique and biotic significance in Aravaipa, Carr and Ramsey Canyons.
	13. Establish 27,000 acres of natural beauty for restricted use.
	14. Prevent exploitation of archeological and historical sites.
B. Quality Considerations of water, land, and air resources	1. Reduce soil erosion by about 480 acre-feet per year on about 40,000 acres of cropland and 224,000 acres of grazing lands.
	2. The vegetation will contain more diverse kinds of plants with better plant vigor on the 1,100,000 acres of grazing lands and 95,000 acres of cropland.
	3. Increase uniform distribution of 670 small water facilities (about 130 acres surface water) for land wildlife and waterfowl.
	4. Reduction of sediment in natural drainways by about 240 acre-feet per year.
	5. Increase crop residue and mulch on soil surface of about 46,000 acres of cropland.
	6. Remove salt from soil root zone of crops to allow better growth of plants on 2,100 acres.
	7. Addition of about 2,000 acres of trees, shrubs and 300 acres unharvested cereal grains of permanent wildlife habitat interspersed in cropland area.
	8. Reduce airborne dust by reducing wind erosion on about 40,000 acres of cropland and 224,000 acres of grazing land.
	9. Re-establish native vegetation on 16,000 acres abaondoned cropland by accelerating natural plant succession with reseeding, management of livestock and irrigation where necessary.
	10. Provide 96,750 visitor days recreation - Mesquite Bosque.
	11. Modify about 10 acres natural vegetation in recreation area - Mesquite Bosque.

TABLE 8.19 (Continued)

		12. Preserve 1,200 acres natural and wildlife area - Mesquite Bosque.
		13. Increase soil erosion for short time periods during construction of measures in resource management systems.
		14. Preserve unique areas Aravaipa, Carr and Ramsey Canyons - 58,000 acres.
		15. Establish natural areas with restricted use on forest lands - 27,000 acres.
		16. Protect archeological and historical sites.
C.	Biological resources and selected ecosystems	1. Increase wildlife habitat value on 1,114,000 acres of grazing lands by increased vegetation, more plant diversity, water yearlong and better management of use.
		2. Restoration of wildlife habitat for antelope, masked bobwhite quail, black-tailed prairie dog and other species such as Botteri's sparrow on 1,114,000 acres. This includes vegetative portion and water availability only. Other habitat requirements may need to be researched before re-establishments of these species will be totally successful.
		3. Increased distribution of permanent, yearlong water at 200 ponds with about 300 acres of surface water.
		4. Increase permanent yearlong water facilities at 470 new wells and tanks.
		5. Increase permanent cover and food for wildlife in 272 miles (about 1,000 acres) of shelterbelts and about 2,000 acres of other tree and shrub plants with about 130 acres of unharvested cereal grain interspersed on cropland.
		6. Increase the value of wildlife habitat by improved methods of brush management by leaving trees interspersed with open areas of grass, forbs and shrubs on about 123,000 acres.
		7. Increase wildlife food for longer time periods by leaving crop residue and mulching on the soil surface - about 46,000 acres cropland.

TABLE 8.19 (Continued)

	8. Preserve about 1,200 acres of riparian vegetation and wildlife habitat area - Mesquite Bosque.
	9. Modify about 10 acres of natural vegetation for recreation area - Mesquite Bosque.
	10. Increase wetland along shoreline of fenced permanent ponds by about 50 acres.
	11. Improve watershed conditions above about 69 miles of live streams.
	12. Improve riparian habitat on 17,500 acres along drainways, 11,000 acres replanted range, 6,700 acres around fenced watering facilities and 2,000 acres tree plantings on abandoned cropland to be available for greater numbers of wildlife species now present in the area.
	13. Preserve and protect about 58,000 acres of unique biotic significance in Aravaipa, Carr and Ramsey Canyons.
	14. Establish areas of natural beauty under restricted use that will be habitat available for increasing populations of wildlife on about 27,000 acres.
	15. Increase wildlife values on 64,000 acres of grazing lands by applying better multiple-use planning techniques. This area is in addition to most of the above acreages but overlaps the first item.
	16. Maintain a more diverse composition of understory plants useable by wildlife on areas where fuel buildup is controlled.
D. Irreversible or irretrievable commitments	1. Commitment of land, water, and monetary resources to manmade structures such as: land leveling, ditch lining, water control and erosion control structures, access roads and trails, water developments, etc.
	2. Commitment of 1,200 acres to natural and wildlife area - Mesquite Bosque.
	3. Commitment of land, sites, structures, monetary and other resources to protect archeological and historical values.
	4. Commitment of land to 100-acre wetland area - Willcox Playa.

TABLE 8,20
SANTA CRUZ STUDY AREA
Environmental Quality - Plan B

ENVIRONMENTAL QUALITY ACCOUNT

Component	Measure of Effects
A. Areas of natural beauty	1. Visual change as native vegetation will increase on 4,115,000 acres of grazing lands.
	2. Reduction of woody plants in areas now dominated by trees to more open areas of grass, forbs and shrubs interspersed with trees on about 320,000 acres of grazing lands.
	3. Visual change from overused grazing lands with moderate soil erosion to vegetated and protected grazing lands, about 522,000.
	4. Visual increase of water surface by about 395 new stock ponds (about 600 surface acres) that contrast with arid and semi-arid climatic conditions.
	5. Increase of native vegetation, on about 22,000 acres, around 2,195 fenced stock ponds and areas around stock tanks.
	6. Quiet remote living conditions will be interrupted by an increase in population and increased demand for use of natural resources.
	7. Visual change as 34,000 acres of abandoned croplands and some abandoned subdivision lands are returned to native vegetation.
	8. Prevent fuel buildup on 5,000 acres of natural areas.
	9. More uniform and vigorous growing crops interspersed with 4,200 acres of trees and shrubs will be a change from present visual conditions.
	10. Preserve and protect areas of unique and biotic significance in Parker and Gardner Canyons, Patagonia-Sonoita Creek and Blue Haven.
	11. Establish 10,000 acres of natural beauty in restricted use.
	12. Protect archeological and historical sites.

TABLE 8.20 (Continued)

B.	Quality considerations of water, land, and air resources	1. Reduce soil erosion by about 400 acre-feet per year on about 522,000 acres of grazing lands to protect the soil and productive capacity of the land for present and future generations.
		2. The vegetation will contain a more diverse number of kinds of plants with better plan vigor on the 4,115,000 acres of grazing lands and 264,000 acres of cropland.
		3. Increase uniform distribution of 2,195 small water facilities for land wildlife and waterfowl.
		4. Reduction of sediment in natural drainways by about 152 acre-feet per year.
		5. Increase crop residue and mulch on soil surface of all cropland.
		6. Addition of about 5,000 acres of trees, shrubs and unharvested cereal grains for permanent wildlife habitat interspersed in cropland area.
		7. Reduce airborne dust by reducing wind erosion on about 80,000 acres of cropland and 280,000 acres of grazing land.
		8. Re-establish native vegetation on 34,000 acres of abandoned cropland by accelerating natural plant succession with reseeding, management of livestock and irrigation where necessary.
		9. Increase soil erosion for short time periods during construction of measures in resource management systems. Preserve and protect unique areas - Parker and Gardner Canyons, Patagonia-Sonoita Creek and Blue Haven.
		10. Establish natural areas with restricted use on forest lands - 10,000 acres.
		11. Protect 109 archeological and historical sites.
C.	Biological resources and selected ecosystems	1. Increased wildlife habitat value on 4,115,000 acres of grazing lands by increased vegetation, more plant diversity, yearlong water and better management.

TABLE 8.20 (Continued)

2. Restoriation of wildlife habitat for antelope and masked bobwhite quail, and other species on 1,200,000 acres. This includes vegetative portion and water availability only. Other habitat requirements may need to be researched before re-establishment of these species will be totally successful.

3. Increased distribution of permanent, yearlong water at 395 ponds with about 600 acres of surface water.

4. Increase permanent yearlong water facilities at 1,800 new wells and tanks.

5. Increase permanent cover and food for wildlife in 870 miles (about 4,200 acres) of shelterbelts and about 600 acres of other tree and shrub plants with about 200 acres of unharvested cereal grain interspersed on cropland.

6. Increase the value of wildlife habitat by improved methods of brush management and by leaving trees interspersed with open areas of grass, forbs and shrubs and leaving riparian vegetation on about 320,000 acres.

7. Increase availability of wildlife food for longer time periods by leaving crop residue and mulching on the soil surface - about 100,000 acres of cropland.

8. Increase wetland along shoreline of fenced permanent ponds by about 150 acres.

9. Improve watershed conditions above about 70 miles of live streams.

10. Improve riparian habitat on 43,000 acres along drainways, 21,000 acres within fenced watering facilities and 600 acres of tree plantings on abandoned cropland for use by greater numbers of wildlife.

11. Preserve and protect areas of unique biotic significance in Parker and Gardner Canyons, Patagonia-Sonoita Creek and Blue Haven.

12. Establish areas of natural beauty with restricted use that will be available habitat for increasing populations of wildlife on about 10,000 acres.

TABLE 8.20 (Continued)

		13. Increase wildlife values on 124,000 acres of grazing lands by applying better multiple use planning techniques. This area is in addition to most of the above average acreages but overlaps the first item.
		14. Maintain a more diverse composition of understory plants useable by wildlife on areas where fuel buildup is controlled.
D.	Irreversible or irretrievable commitments	1. Commitment of land, water and monetary resources to manmade structures such as: land leveling, ditch lining, water control and erosion control structures, access roads and trails, water developments, etc.
		2. Commitment of land, sites, structures, monetary and other resources to protect archeological and historical values.
		3. Commitment of land to 100-acre wetland area - Bog Hole.

TABLE 8.21
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account
SAN PEDRO STUDY AREA

Components	Measure of Effects: San Pedro Study Area (Avg. Annual) 1/	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Beneficial effects:		
A. The value of increased output of goods and services to users residing in the region.		
1. Recreation	$ 137,800	$ 7,300
2. Resource management systems	5,659,300	-
B. Additional net income accruing to the region from project installation and from other economic activities induced by operation of the plan.		

Components	Measure of Effects: San Pedro Study Area (Avg. Annual) 1/	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Adverse effects:		
A. The value of resources contributed from within the region to achieve the outputs.		
1. Single purpose recreation facilities.		
Project Installation	$ 24,200	$ 24,100
OM&R	35,000	-
2. Resource management systems.		
Project Installations	$ 950,400	$1,349,500
OM&R	$ 1,458,100	$ 48,500
3. Project administration	$ 300	$ 700
4. Areas of natural beauty		
Project installations	$ -	$ 2,800
OM&R	$ -	$ 10,000

TABLE 8.21
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/ San Pedro Study Area	Rest of Nation
INCOME		
Beneficial effects:		
B. 1. Increased net profit, stemming from construction of the plan, to firms located in the region.	$ 26,400	$ -26,400
2. Additional wages and salaries accruing to the region throughout the life of the plan.		
(a) Recreation sector	$ 5,300	$ -5,300
(b) Project OM&R	$573,200	$-573,200

Components	Measure of Effects (Avg. Annual) 1/ San Pedro Study Area	Rest of Nation
INCOME		
Adverse effects:		
5. Protect, preserve or restore 16 archeological and historical sites.	$ -	$ 184,200
6. Critical area stabilization.		
Project Installation	$ 61,400	$ 196,500
OM&R	$ 80,000	-
7. Expand wetland		
Project Installation	$ -	$ 15,400
8. Prevent fuel buildup		
Project Installation	$ -	$ 41,800
9. Streambank Protection		
Project Installation	$ 19,800	$ 63,600
OM&R	$ 13,100	-

TABLE 8.21
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measure of Effects: San Pedro Study Area (Avg. Annual) 1/	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Beneficial effects:		
C. The value of output resulting from external economies accruing within the region.		
1. Resource management systems	$ 318,400	$ 98,100
TOTAL BENEFICIAL EFFECTS:	$6,720,400	$ -499,500

Components	Measure of Effects: San Pedro Study Area (Avg. Annual) 1/	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Adverse effects:		
10. Plantings for esthetics and wildlife.		
Project Installation	$ 4,500	$ 14,400
OM&R	$ 42,000	$ 4,000 2/
11. Preserve riparian vegetation.		
Project Installation	$ -	$ 429,900
12. Clean up dumps		
Project Installation	$ -	$ 3,700
TOTAL ADVERSE EFFECTS:	$2,688,800	$ 2,389,100
NET BENEFICIAL EFFECTS:	$4,031,600	$-2,888,600

1/ 100 years at 6-1/8 percent interest rate.
2/ Technical assistance on replacing practices.

TABLE 8.21
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measures of Effects: San Pedro Study Area	Measures of Effects: Rest of Nation
Employment: Beneficial Effects:		
A. Increase in number and type of jobs.		
1. Agricultural employment	-17.2 annual man-years of agricultural jobs	-
2. Employment in construction of the plan	361.3 man-years skilled jobs; 75.1 man-years semi-skilled jobs; 43.8 man-years unskilled jobs	-361.3 man-years skilled jobs
3. Employment in OM&R of the plan	3 full-time skilled jobs; 2 full-time semi-skilled jobs; 72 part-time skilled jobs; 23 part-time semi-skilled jobs	-3 full-time skilled jobs
4. Indirect and induced employment from increased expenditures within the region	5 full-time semi-skilled jobs	

Components	Measures of Effects: San Pedro Study Area	Measures of Effects: Rest of Nation
Employment: Adverse Effects:		
A. Decrease in number and and type of jobs.		
1. Loss in agricultural employment associated with plan take area	-	-
2. Loss in indirect and induced employment associated with plan take area	-	-

TABLE 8.21
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measures of Effects		Components	Measures of Effects	
	San Pedro Study Area	Rest of Nation		San Pedro Study Area	Rest of Nation
Employment:			Employment:		
Continued			Continued		
TOTAL BENEFICIAL EFFECTS	Loss of 17.2 annual man-years of agricultural jobs. Gain of 361.3 man-years skilled jobs; 75.1 man-years semi-skilled jobs; 43.8 man-years unskilled jobs; 3 full-time skilled jobs 7 full-time semi-skilled jobs; 72 part-time skilled jobs; and 23 part-time semi-skilled jobs	Loss 361.3 man-years skilled jobs and 3 full-time skilled jobs	TOTAL ADVERSE EFFECTS	-	-
			NET BENEFICIAL EFFECTS	Loss 17.2 annual man-years of agricultural jobs. Gain of 361.3 man-years skilled jobs; 75.1 man-years semi-skilled jobs; 43.8 man-years unskilled jobs; 3 full-time skilled jobs; 7 full-time semi-skilled jobs; 72 part-time skilled jobs; and 23 part-time semi-skilled jobs	Loss 361.3 man-years skilled jobs and 3 full-time skilled jobs

TABLE 8.21
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SAN PEDRO STUDY AREA

Components	Measures of Effects	
	San Pedro Study Area	Rest of Nation
Population Distribution		
Beneficial Effects	Gain of 3 full time skilled, 7 full time semi-skilled, 72 part time skilled, and 23 part time semi-skilled permanent jobs during the life of the plan; and 480.2 man-years of employment during construction of the plan. This is within an area that has experienced a 12.5 percent rise in population over the past 10 years.	
Adverse Effects	Loss of 17.2 annual man-years of agricultural jobs.	Reduce growth potential in the rest of the nation by 3 full time employees throughout the life of the plan; and 361.3 man-years of employment during installation period.
Regional Economic Base and Stability		
Benefical Effects	Gain of 10 permanent full-time, 95 permanent part-time, and 480.2 man-years of low to high income jobs in an area where per capita income is 11 percent below the national average (1970).	
Adverse Effects	Loss of 17.2 annual man-years of low to medium income agricultural jobs.	

TABLE 8.22
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account
SANTA CRUZ STUDY AREA

Components	Measure of Effects: Santa Cruz Study Area (Avg. Annual) 1/	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Beneficial effects:		
A. The values of increased output of goods and services to users residing in the region.		
1. Resource management systems.	$17,529,200	-
B. Additional net income accruing to the region from installation of the plan and from other economic activities induced by operation of the plan.		
1. Increased net profit stemming from construction of the plan to firms located in the region	$ 116,900	$ -116,900

Components	Measure of Effects: Santa Cruz Study Area (Avg. Annual) 1/	Measure of Effects: Rest of Nation (Avg. Annual) 1/
INCOME		
Adverse effects:		
A. The value of resources contributed from within the region to achieve the outputs.		
1. Resource management systems.		
Project Installation	$5,200,600	$4,213,000
OM&R	$5,147,500	$ 382,900 2/
2. Plantings for esthetics and wildlife		
Project Installation	$ 11,400	$ 35,900
OM&R	$ 105,000	$ 10,000 2/
3. Preserve riparian vegetation		
Project Installation	$ -	$ 528,100
4. Expand wetland		
Project Installation	$ -	$ 15,400
5. Areas of natural beauty		
Project Installation	$ -	$ 1,000
OM&R	$ -	$ 10,000

TABLE 8.22
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measure of Effects (Avg. Annual) 1/ Santa Cruz Study Area	Rest of Nation
INCOME		
Beneficial effects:		
2. Additional wages and salaries accruing to the region throughout the life of the plan.		
(a) Project OM&R	$ 1,950,200	$-1,950,200
C. The value of output resulting from economies accruing within the region.		
1. Resource management systems	$ 2,839,500	$ 79,200
TOTAL BENEFICIAL EFFECTS	$22,435,800	$-1,987,900

Components	Measure of Effects (Avg. Annual) 1/ Santa Cruz Study Area	Rest of Nation
INCOME		
Adverse effects:		
6. Protect, preserve or restore 109 archeological and historic sites	$ -	$ 522,000
7. Critical area stabilization		
Project Installation	$ 3,600	$ 10,500
OM&R	$ 11,500	-
8. Streambank protection		
Project Installation	$ 21,900	$ 65,600
OM&R	$ 14,300	-
9. Clean up dumps	-	$ 7,400
10. Prevent fuel buildup		
Project Installation	$ -	$ 3,100
TOTAL ADVERSE EFFECTS	$10,515,800	$ 5,804,900
NET BENEFICIAL EFFECTS	$11,920,000	$-7,792,800

1/ 100 years at 6-1/8 percent interest rate.
2/ Technical assistance on replacing practices.

TABLE 8.22
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Employment: Beneficial Effects:		
A. Increase in number and type of jobs		
1. Agricultural employment	56.1 annual man-years of agricultural jobs	-
2. Employment in construction of the plan	35 annual man-years of skilled jobs during construction period; 1508.1 man-years skilled jobs; 322.9 man-years semi-skilled jobs; and 12.2 man-years unskilled jobs	-35 annual man-years of skilled jobs during construction period; -1508.1 man-years skilled jobs
3. Employment in OM&R of the plan	24 full-time skilled jobs; 247 part-time skilled jobs; and 58 part-time semi-skilled jobs	-24 full-time skilled jobs
4. Indirect and induced employment from increased expenditures in the region	114 full-time semi-skilled jobs	-

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Employment: Adverse Effects:		
A. Decrease in number and type of jobs		
1. Loss in agricultural employment associated with plan take area	-	-
2. Loss in indirect and induced employment associated with plan take area	-	-

TABLE 8.22
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Employment:		
Continued		
TOTAL BENEFICIAL EFFECTS	56.1 annual man-years of agricultural jobs; 35 annual man-years of skilled jobs during the construction period; 1508.1 man-years skilled jobs; 322.9 man-years semi-skilled jobs; 12.2 man-years unskilled jobs; 24 full-time skilled jobs; 114 full-time semi-skilled jobs; 247 part-time skilled jobs; and 58 part-time semi-skilled jobs	-35 annual man-years of skilled jobs during the construction period; -24 full-time skilled jobs; and -1508.1 man-years skilled jobs

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Employment:		
Continued		
TOTAL ADVERSE EFFECTS	-	-
NET BENEFICIAL EFFECTS	56.1 annual man-years of agricultural jobs; 35 annual man-years of skilled employment during the construction period; 1508.1 man-years skilled jobs; 322.9 man-years semi-skilled jobs; 12.2 man-years unskilled jobs; 24 full-time skilled jobs; 114 full-time semi-skilled jobs; 247 part-time skilled jobs; and 58 part-time semi-skilled jobs	-35 annual man-years of of skilled jobs during the construction period; -24 full-time skilled jobs; and -1508.1 man-years skilled jobs

TABLE 8.22
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
Regional Development Account (Cont'd)
SANTA CRUZ STUDY AREA

Components	Measures of Effects: Santa Cruz Study Area	Measures of Effects: Rest of Nation
Population Distribution		
Beneficial Effects	Gain of 24 permanent full time skilled jobs; 56.1 annual man years of agricultural jobs; 247 part time skilled jobs; 58 part time semi-skilled jobs; 114 full time semi-skilled jobs; 35 annual skilled jobs during the construction period; and 1,843.2 man years of construction jobs during the installation period. This is within an area that has experienced an 18.6 percent increase in population during the period 1970-1975.	--
Adverse Effects	--	Reduce growth potential in the rest of the nation by 24 permanent full time skilled employees, 35 annual skilled employees during the construction period; and 1508.1 man-years of construction employees during installation period.
Regional Economic Base and Stability		
Beneficial Effects	Gain of 138 permanent full time; 56.1 annual man years of agricultural jobs; 302 permanent part time; 35 temporary full time jobs; and 1843.2 man years of construction employment. This is an area where per capita income is 9.8 percent below the national average.	
Adverse Effects	--	--

TABLE 8.23
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
SOCIAL WELL-BEING ACCOUNT
SAN PEDRO STUDY AREA

Components	Measures of Effects
Beneficial and adverse effects	
A. Real income distribution	1. Create 105 low to medium income permanent, full time and part time jobs for area residents.
	2. Create regional income benefit distribution of $6,720,400 by income class as follows:

Income class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Benefits in Class
Less than 3,000	12.6	18.5
3,000-10,000	49.3	46.6
More than 10,000	38.1	34.9

3. Local costs to be borne by region total $2,688,800 with distribution by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Contributions in Class
Less than 3,000	12.6	18.1
3,000-10,000	49.3	46.9
More than 10,000	38.1	-5.0

B. Life, health and safety	1. 0
C. Recreational opportunities	1. Creates opportunities for 96,750 recreation days primarily for residents of the region.

TABLE 8.24
PLAN B - ENVIRONMENTAL QUALITY ALTERNATIVE
SOCIAL WELL-BEING ACCOUNT
SANTA CRUZ STUDY AREA

Components	Measures of Effects
Beneficial and adverse effects	
A. Real income distribution	1. Create 499.1 low to high income permanent, full time and part time jobs for area residents.
	2. Create regional income benefit distribution of $22,435,800 by income class as follows:

Income class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Benefits in Class
Less than 3,000	19.1	19.1
3,000-10,000	42.7	42.7
More than 10,000	38.2	38.2

3. Local costs to be borne by region total $10,515,800 with distribution by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Contributions in Class
Less than 3,000	19.1	19.1
3,000-10,000	42.7	42.7
More than 10,000	38.2	38.2

TABLE 8.25 - SUMMARY COMPARISON BETWEEN PLAN A AND PLAN B
SAN PEDRO STUDY AREA

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
National Economic Development			
Beneficial Effects	$7,132,700	$6,220,900	$ -911,800
Adverse Effects	4,174,900	5,077,900	+903,000
Net Beneficial Effects	2,957,800	1,143,000	-1,814,800
Environmental Quality			
A. Areas of natural beauty	1. Increase in grass, forb and shrub vegetation or about 450,000 acres of grazing lands - 50 percent used by livestock each year.	Greater increase in vegetation on about 1,114,000 acres with 40 percent used by livestock each year.	+664,000 acres
	2. Removal of trees and replaced by livestock forage plant species on about 123,000 acres.	Same 123,000 acres with grass, forbs and shrubs, interspersed with trees that provide greater variety of vegetation on the landscape.	+ better balance of vegetation on the landscape and better wildlife habitat.
	3. Reduce soil erosion on 224,000 acres that removes scars on the landscape.	Provides more protection against soil erosion with more vegetation and less use by livestock.	+ more scars removed and better soil protection.

TABLE 8.25 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	4. Addition of about 200 stock ponds with open water surfaces contrasted to arid and semi-arid landscape.	200 stock ponds fenced with 2,000 acres riparian vegetation.	+2,000 acres riparian vegetation
	5. Interrupts quiet and remote living conditions by 209,900 recreation visitor days.	same except less visitor days (96,750)	-111,150 visitor days of recreation
	6. Flood control structures will interrupt view of Dragoon Mountains from town of St. David.	None	No restrictions
	7. Abandoned croplands (16,000 acres) and some abandoned subdivision lands return to native vegetation.	Same except process is accelerated.	+ acceleration
	8. Lose about one-half mile free flowing stream - Leslie Canyon.	None	- the loss
	9. Lose about 15 acres riparian type vegetation - Leslie Canyon.	None	- the loss

TABLE 8.25 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	10. Modify about 40 acres native vegetation - recreation facilities - Leslie Canyon.	None	- the loss
	11. Contrast with trees added to cropland landscape on about 1,000 acres in 272 miles of shelterbelts.	Same with additional 2,000 acres of trees and 130 acres cereal grains for wildlife food.	+ 2,000 acres trees and 130 acres wildlife
	12. None	Preserve 68,000 acre areas of unique and biotic significance.	+ 3 areas
	13. None	Establish restricted use on areas of natural beauty.	+ areas managed for their natural beauty
	14. None	Prevent exploitation archeological sites.	+ protection
B. Quality considerations of water, land and air resources.	1. Increase distribution of 670 (some seasonal) water facilities on grazing lands.	Same plus provide water at tanks yearlong.	+ water for wildlife yearlong
	2. Reduce evaporation of irrigation water and increase crop yield with 272 miles shelterbelts.	Same plus addition of 2,000 acres of trees and 130 acres of cereal grains left for wildlife.	+2,000 acres trees and 130 acres wildlife food.

TABLE 8.25 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	3. Return about 16,000 acres abandoned cropland and some abandoned subdivision land to native vegetation.	Same but accelerated	+ acceleration
	4. Provide flood control on 420 acres.	None	- 420 acres flood protection
	5. Provide 207,900 recreation days.	Provide 96,750 recreation days.	- 111,150 recreation days.
	6. Create 100-acre lake - Leslie Canyon.	None	- 100-acre lake
	7. Lose about one-half mile stream - Leslie Canyon	None	- the loss
	8. Modify about 50 acres natural vegetation - recreation facilities Leslie Canyon and Mesquite Bosque.	Modify 10 acres - Mesquite Bosque	- modification 40 acres
	9. None	Preserve unique areas.	+ preserve
	10. None	Establish natural areas.	+ natural areas
	11. None	Protect exploitation of archeological areas.	+ protection

TABLE 8.25 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
C. Biological resources	1. Increase diversity and amount of vegetation on 1,114,000 acres of grazing lands.	Same with less vegetation grazed by livestock.	+ 10 percent additional forage for other uses.
	2. Increase permanent water at 200 new locations (about 300 acres of water).	Same with addition of 2,000 acres riparian vegetation within fenced ponds.	+ 2,000 acres vegetation and better water quality.
	3. Increase seasonal water at 470 new locations.	Yearlong water at 470 well and tank locations.	+ yearlong water
	4. Increase permanent wildlife habitat in 272 miles shelterbelts.	Same with additional 2,000 acres trees and shrubs and 130 acres unharvested cereal grains.	+ 2,000 acres trees and 130 acres wildlife food.
	5. Generally reduce wildlife habitat values on 123,000 acres that would be cleared of pinon, juniper, etc.	Increase wildlife values same area.	+ increased wildlife values on 123,000 acres native vegetation.
	6. Lose one-half mile of live stream and aquatic habitat - Leslie Canyon.	None	- loss
	7. Create 100 surface-acre water body - Leslie Canyon.	None	- loss

TABLE 8.25 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	8. Lose about 15 acres riparian type vegetation - Leslie Canyon.	None	- loss
	9. Modify about 40 acres natural vegetation - Leslie Canyon and Mesquite Bosque recreation area.	Modify 10 acres - Mesquite Bosque	- loss 30 acres
	10. None	Increase wetland at stock ponds about 50 acres.	+ 50 acres wetland
	11. None	Improve watershed conditions above about 115 miles live streams.	+ improved watersheds above 115 miles live streams.
	12. None	Improve riparian 17,500 acres along drainways, 11,000 acres replanted rangeland 6,700 acres at stockponds, and 2,000 acres replanted abandoned cropland.	+ about 37,200 acres riparian.
	13. None	Preserve unique biotic area.	+ these areas

TABLE 8.25 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	14. None	Establish areas natural beauty.	+ these areas
	15. None	Better multiple use planning on about 64,000 acres.	+ better multiple use planning
D. Irreversible or irretrievable commitments	1. Commitment land, water and monetary resources to manmade structures.	Commitment land, water and monetary resources to manmade structures.	- flood control structures
	2. Loss of 50 acres riparian - Leslie Canyon.	None	- Loss
	3. Commitment 210 acres to dam, water area and recreation - Leslie Canyon.	None	- 210 acres Leslie Canyon
	4. None	Commit land, sites, structures to protect sites.	+ protect archeological sites.
Regional Development			
A. Income:			
Beneficial Effects	$7,306,500	$6,720,400	$ -586,100
Adverse Effects	2,589,500	2,688,800	+ 99,300
Net Beneficial Effects	4,717,000	4,031,600	-685,400

TABLE 8.25 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
B. Employment:			
Employment for project construction	286.4 man-years skilled jobs 59.3 man-years semi-skilled jobs	261.3 man-years skilled jobs 75.1 man-years semi-skilled jobs 48.3 man-years unskilled jobs	+74.9 man-years skilled jobs +15.8 man-years semi-skilled jobs +48.3 man-years unskilled jobs
Employment in project OM&R	6 full time semi-skilled jobs 70 part time skilled jobs	2 full time semi-skilled jobs 72 part time skilled jobs	-4 full time semi-skilled jobs +2 part time skilled jobs
Indirect and induced employment	11 full time semi-skilled jobs	5 full time semi-skilled jobs	-6 full time semi-skilled jobs
Social Well-Being			
B. Life, health and safety	Provides flood protection to the town of St. David.	-0-	Does not provide flood protection for the town of St. David.
C. Recreation opportunities	Created opportunities for 207,900 recreation days primarily for residents of the region.	Creates opportunities for 96,750 recreation days primarily for residents of the region.	- 111,150 recreation days

TABLE 8.26 - SUMMARY COMPARISON BETWEEN PLAN A AND PLAN B
SANTA CRUZ STUDY AREA

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
National Economic Development			
Beneficial Effects	$23,054,600	$20,447,900	$-2,606,700
Adverse Effects	$15,427,600	$16,320,700	$+ 893,100
Net Beneficial Effects	$ 7,627,000	4,127,200	$-3,499,800
Environmental Quality			
A. Areas of natural beauty	1. Visual impact on 850,000 acres by increase of grass forbs and shrubs.	Same on 4,115,000 acres	+3,265,000 acres
	2. Removal of trees on about 320,000 acres of grazing lands	Reduction of trees to open areas interspersed with trees on about 320,000 acres	+better wildlife and esthetic values
	3. Moderate soil erosion reduced on about 119,000 acres.	Action will reduce moderate soil erosion on about 522,000 acres.	+403,000 acres
	4. ----	Increase in about 22,000 acres native vegetation around fenced water facilities.	+22,000 acres
	5. Flood control structures will change the landscape near the towns of Coolidge Randolph and Tucson.	----	-flood control

TABLE 8.26 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	6. ----	Protect areas of unique and biotic significance	+3 acres
	7. ----	Establish 10,000 acres of natural beauty by restricted use.	+10,000 acres natural beauty
	8. ----	Protect archeological and historical sites.	+better protection of the resource
B. Quality considerations of water, land and air resources	1. Improved vegetation on about 4,115,000 acres of grazing lands and about 264,000 acres of croplands.	Same	+better protection for native vegetation since livestock use is limited to 40 percent of annual forage growth.
	2. Increase distribution of livestock water.	Same distribution with fenced area and restricted use by livestock.	+improved vegetation on about 22,000 acres and better water quality for livestock and wildlife.
	3. Reduce sediment moving down Green's Wash by about 8 acre-feet per year.	Reduce sediment moving down natural drainways by about 152 acre-feet per year.	+Reduction of 144 acre-feet of sediment.
	4. Increase crop residues on about 140,000 acres of cropland.	Increase residues on all cropland, about 264,000 acres.	+124,000 acres with increased crop residue

TABLE 8.26 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	5. ----	Additional trees and shrubs for wildlife and esthetics on about 5000 acres within the cropland area.	+5000 acres trees and shrubs
	6. Return 34,000 acres of abandoned cropland to native vegetation.	Same plus irrigation if needed to speed the revegetating.	+better natural vegetation.
	7. Flood control on about 7,500 acres along the Santa Cruz River near Tucson and in the Cactus Forest Watershed.	----	-Flood control 7,500 acres
	8. ----	Establish natural areas, 10,000 acres	+10,000 acres natural area
	9. ----	Protect 109 archeological and historical sites.	+protection
C. Biological resources and selected ecosystems	1. Increased kind and amount of vegetation will improve wildlife habitat on about 4,115,000 acres.	Additional vegetation, yearlong water and better land management.	+additional wildlife and esthetic values.
	2. Restoration of some wildlife habitat for antelope and masked bobwhite quail.	Additional improvement of habitat for these species, yearlong water and better land management on about 1,200,000 acres.	+habitat for requirements for wildlife on 1,200,000 acres.

TABLE 8.26 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	3. Increased seasonal water at 1,800 locations.	Permanent water at these locations.	+permanent water for wildlife
	4. ----	Additional 600 acres of tree and shrub plantings and about 200 acres of feed grains for wildlife within cropland area.	+600 acres habitat and 200 acres food supply for wildlife.
	5. Generally reduce wildlife habitat values on about 160,000 acres of brushland.	Improve value of wildlife habitat on about 320,000 acres of land during brush management.	+improved habitat on about 320,000 acres.
	6. ----	Increase wetland along shoreline of stock ponds by 150 acres.	+increase wetlands by 150 acres.
	7. Improve watershed conditions above about 70 miles of live streams.	Additional protection	+additional protection of live stream watersheds.
	8. ----	Additional protection 43,000 acres riparian vegetative type, 21,000 acres around fenced water facilities and 600 acres of tree planting on abandoned croplands.	+additional wildlife habitat 43,000 acres-improved, 21,600 acres-increased.

TABLE 8.26 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
	9. ----	Protect unique biotic areas -- Parker and Gardner Canyons, Patagonia-Sonoita Creek and Blue Haven.	
	10. ----	Establish areas of natural beauty under restricted use - about 10,000 acres.	+10,000 acres natural beauty areas.
	11. ----	Maintain a more diverse composition of understory plants in areas where fuel buildup is controlled.	+better plant composition
D. Irreversible or irretrievable commitments	1. ----	Commitment of land to 109 archeological and historical sites and 100-acre wetland area at Bog Hole.	+commitment of 109 sites plus 100 acres wetland.
Regional Development			
A. Income:			
Beneficial Effects	$23,777,300	$22,435,800	$-1,341,500
Adverse Effects	$10,477,800	$10,515,800	$+ 38,000
Net Beneficial Effects	$13,299,500	$11,920,000	$-1,379,500

TABLE 8.26 - Continued

Account	Plan A National Economic Development	Plan B Environmental Quality	Differences (Plan B minus Plan A)
B. Employment:			
Employment for project construction.	1429.1 man years skilled jobs	1508.1 man years skilled jobs	+79 man years skilled jobs
	--	12.2 man years unskilled jobs	+12.2 man years unskilled jobs
	295.4 man years semi-skilled jobs	322.9 man years semi-skilled jobs	+27.5 man years semi-skilled jobs
Employment in project OM&R	40 permanent part time semi-skilled jobs	58 permanent part time semi-skilled jobs	+18 permanent part time semi-skilled jobs
	246 permanent part time skilled jobs	247 permanent part time skilled jobs	+1 permanent part time skilled jobs
Indirect and induced employment	127 full time semi-skilled jobs	114 full time semi-skilled jobs	-13 full time semi-skilled jobs
Social Well-Being			
B. Life, Health, and Safety	Provide one percent level of flood protection to the urban areas of the West Branch Santa Cruz River in Tucson.	--	Loss of flood protection to urban areas of West Branch Santa Cruz River in Tucson.

SUMMARY OF SIGNIFICANT ENVIRONMENTAL IMPACTS

This section presents a brief summary of the combined socio-economic and other environmental effects that were set forth in the displays of effects for Plans A and B.

Economic and Social

The most significant beneficial and adverse effects would be caused by application of the planned resource management systems. These effects apply to both plans and would be basin-wide. Certain other planned projects such as recreational developments and flood prevention would cause only significant local impact.

Adverse effects would involve costs to install, operate, maintain, and replace various elements of the proposed projects.

Beneficial effects would include the enhancement of other social and employment opportunities in the basin and the economic values that would be directly or indirectly derived by plan implementation.

Specific details and comparison of effects have been shown in Tables 8.6, 8.7, 8.8, 8.9, 8.10, 8.11, 8.12, and 8.13 for NED-Plan A; and Tables 8.17, 8.18, 8.19, 8.20, 8.21, 8.22, 8.23, and 8.24 for EQ-Plan B. Summary comparisons between Plans A and B, by study area, are shown in Tables 8.25 and 8.26.

Other Environmental Effects

National Economic Development - Plan A

The most significant environmental impacts on both the Santa Cruz and the San Pedro study areas would be caused by the application of the planned resource management systems. Implementation of the land treatment portion of the management systems would result in a general overall enhancement of the visual quality of the areas by vegetative manipulation aimed primarily at increasing forage for range production of livestock. Additionally, the installation of more livestock waters throughout both areas would have a significant effect. Associated with implementation of the vegetative program would be a significant reduction in wind and water erosion now occurring in sparsely vegetated areas. Local, but otherwise insignificant, impacts could be expected from the installation of certain recreation developments and flood prevention projects.

Some adverse effects that could be expected from implementation of this plan would be general loss of certain types of fish and wildlife habitat through construction and vetetative manipulation, increased noise and air pollution during construction and application of certain projects and measures; and a general increase in traffic and, perhaps, population in certain areas.

Beneficial effects would accrue primarily from the increased vegetation cover and would include reduction of air-borne dust pollution; reduction of sheet, rill and gully erosion and consequent sediment pollution of water; general increase in common wildlife habitat and some seasonal waterfowl habitat; and an overall improvement in the visual quality of both study areas.

The specific elements of resource management systems for Plan A were shown in Tables 8.2 and 8.5. The detailed effects of this alternative in each study area are listed in Tables 8.6 through 8.13. Tables 8.25 and 8.26 present a summary comparison between this plan and Alternative Plan B.

Environmental Quality - Plan B

Alternative Plan B would provide for intensified vegetative measures and reduction in structural type activities with the exception of livestock waters and irrigated cropland measures. Vegetative programs would be accomplished with the aim of improving all of the wildlife habitat in both areas and to better balance the esthetic quality of the vegetation of the basin. Erosion and sedimentation would be reduced to a greater extent than under Alternative A. The environmental impacts would be almost entirely beneficial with adverse effects coming primarily from an increase in traffic (albeit less than with Plan A) by users of recreational and esthetic areas and, perhaps, some increase in population.

The additional elements of the Plan B resource management systems were shown in Tables 8.14 and 8.15. The detailed effects on each study area were listed in Tables 8.17 through 8.24. Tables 8.25 and 8.26 present a summary comparison between this plan and Alternative Plan A.

CHAPTER 9

OPPORTUNITIES FOR USDA PROGRAMS, DEVELOPMENT AND IMPACT

INTRODUCTION

This study identifies two alternative courses of action, one that tends to optimize national economic development (NED) and one that tends to emphasize environmental quality (EQ). Neither a recommended nor a preferred plan was developed. Consequently, this chapter discusses the opportunities and impacts of USDA programs that could be used to satisfy, or make contributions toward the satisfaction of the various second level components.

USDA PROGRAMS

Table 9.1 lists the components of the NED and EQ alternatives for which USDA programs or actions could be used to help satisfy the need. The table also points out the local interest, financial capabilities, any legal or institutional constraints that might limit development, and the degree to which that component could be satisfied with USDA assistance. This data is presented for the San Pedro study area and the Santa Cruz study area.

The NED alternatives, as outlined in Chapter 8, are all USDA programs. However, implementation of these alternatives would require the active support of natural resource conservation districts and other units of state and local government. If fully implemented, the combined impacts of these alternatives, monetary and environmental, would be identical to those shown in Tables 8.6 through 8.13 in Chapter 8 and are not repeated here.

The USDA opportunities in the EQ alternatives, as outlined in Chapter 8, would also require the active support of natural resource conservation districts and other units of state and local government. If the USDA opportunities of the EQ alternatives are fully implemented, the combined impact of these alternatives, monetary and environmental, would be similar to those shown in Tables 8.17 through 8.24 in Chapter 8. However, since the impacts of USDA programs are not identical with the total planned action, it is necessary to make the following changes to the EQ plans, by account and study area, to determine the impacts of USDA action.

NED Account - EQ Plans

For the San Pedro study area, under "Adverse Effects", Table 8.17, it is necessary to delete items numbered 5, 7, and 12 to determine the effects of potential USDA actions. These items were not considered to involve significant USDA inputs and are concerned with historical and archeo-

logical sites, wetland expansion, and dump cleanup. When data was collected, the Arizona Game and Fish Department had sufficient resources to carry out the wetland expansion and consequently did not feel the need for assistance. However, cost sharing through the RC&D program could be made available if needed. Deletion of these three items will lower "TOTAL ADVERSE EFFECTS" to $4.874,600 and raise "NET BENEFICIAL EFFECTS" to $1,346,300.

Items 4, 6, and 9 under "Adverse Effects", Table 8.18, for the Santa Cruz study area should also be deleted. These items are identical to those discussed above for the San Pedro Study area. Deletion of these three items will lower "TOTAL ADVERSE EFFECTS" to $15,775,900 and raise "NET BENEFICIAL EFFECTS" to $4,672,000.

Income

For the San Pedro study area, under "ADVERSE EFFECTS" delete items numbered 5, 7, and 12. This would lower "TOTAL ADVERSE EFFECTS" for the rest of the nation to $2,185,800 and "NET BENEFICIAL EFFECTS" for the rest of the nation to $2,685,300.

For the Santa Cruz study area, under "Adverse Effects" delete items numbered 4, 6, and 9. This will lower "TOTAL ADVERSE EFFECTS" for the rest of the nation to $5,260,100 and "NET BENEFICIAL EFFECTS" for the rest of nation to $7,248,000.

Employment

Reduce employment opportunities by 4 man-years skilled and 4.6 man-years semi-skilled for the San Pedro study area and 12 man-years skilled and 9.2 man-years semi-skilled for the Santa Cruz study area. Also, reduce man-years of skilled employment lost in the rest of nation columns by 4 for the San Pedro study area and 12 for the Santa Cruz study area.

Population Distribution

Reduce construction employment by 8.6 man-years for the San Pedro study area and by 21.2 man-years for the Santa Cruz study area. Also reduce lost growth potential for the rest of nation by 4 man-years of construction employment for the Santa Cruz study area.

Regional Economic Base and Stability

Reduce man-years of construction employment by 8.6 for the San Pedro study area and by 21.2 for the Santa Cruz study area.

Social Well Being Account - EQ Plans

Tables 8.23 and 8.24 would be unchanged.

TABLE 9.1 - USDA PROGRAMS TO IMPLEMENT THE PLANS

Plan	Second Level Component 1/	USDA Agency, Program and Authority	Project, Measure or Action	Local Interest	Financial Capabilities	Legal or Institutional Constraints	Percent of Need Satisfied 2/
NED	NED-1	Soil Conservation Service, Watershed Program, Pl-566, 83rd Congress, as amended	San Pedro Study Area:				San Pedro Study Area = 7
			St. David Watershed	High	Adequate	None	Santa Cruz Study Area = 13
			Santa Cruz Study Area:				
			West Branch Santa Cruz River Watershed	High	Adequate	None	
			Cactus Forest Watershed	High	Inadequate	None	
NED	NED-2(a) & (b)	Soil Conservation Service, Conservation Operations Program, Pl-46, 74th Congress	Accelerated planning and application of resource management systems on irrigated croplands and grazing lands.	High	Adequate	Historic use patterns	San Pedro Study Area = 100 Santa Cruz Study Area = 100
NED	NED-3	Soil Conservation Service, Resource Conservation and Development Program, PL-74-46; PL-91-343; PL-87-703; PL-92-419	Leslie Canyon recreation lake and basic facilities.	High	Adequate	Water rights and environmental concerns limit potential.	San Pedro Study Area = 14 Santa Cruz Study Area = 0
			San Pedro Mesquite Bosque, recreation basic facilities	Low to Moderate	Adequate	None	
NED	EQ-1	SCS, Conservation Operations Program, PL-46, 74th Congress	Accelerated planning and application of resource management systems on irrigated croplands and grazing lands.	High	Adequate	Historic use patterns	San Pedro Study Area Lake Habitat Saved = 0 Pond Habitat Saved = 24 Stream Habitat Maintained = 17 Santa Cruz Study Area Lake Habitat Saved = 70 Pond Habitat Saved = 70 Stream Habitat Maintained = 29

TABLE 9.1 - USDA PROGRAMS TO IMPLEMENT THE PLANS (Continued)

Plan	Second Level Component 1/	USDA Agency, Program and Authority	Project, Measure or Action	Local Interest	Financial Capabilities	Legal or Institutional Constraints	Percent of Need Satisfied 2/
NED	EQ-2(c) & (f)	SCS, Conservation Operations Program, PL-46, 74th Congress	Accelerate planning and application of resource management systems on irrigated croplands and grazing lands.	High	Adequate	2(c)Historic use patterns 2(f)None	San Pedro Study Area 2(c) = 100 2(f)Antelope Habitat = 59 Prairie Dog Habitat = 57 Quail Habitat = 57 Bottari's Sparrow Habitat = 59 Santa Cruz Study Area 2(c) = 100 2(f)Antelope Habitat = 90 Quail Habitat =90
EQ	NED-2(a) & (b)	SCS, Conservation Operations Program, PL-46, 74th Congress	Accelerate planning and application of resource management systems on irrigated lands and grazing lands with emphasis on environmental quality.	Moderate	Adequate	Historic use patterns	San Pedro Study Area = 91 Santa Cruz Study Area = 85
EQ	NED-3	SCS, Resource Conservation & Development Project Measures, PL-74-46; PL-91-343; PL-87-703; PL-92-419	San Pedro Mesquite Bosque, recreation basic facilities	Low to Moderate	Adequate	None	San Pedro Study Area = 7 Santa Cruz Study Area = 0
EQ	EQ-1	SCS, Conservation Operations Program, PL-46, 74th Congress	Accelerate planning and application of resource management systems on irrigated lands and grazing lands with emphasis on environmental quality.	Moderate	Adequate	Historic use patterns	San Pedro Study Area Lake Habitat Saved = 0 Pond Habitat Saved = 24 Stream Habitat Maintained = 44

TABLE 9.1 - USDA PROGRAMS TO IMPLEMENT THE PLANS (Continued)

Plan	Second Level Component 1/	USDA Agency, Program and Authority	Project, Measure or Action	Local Interest	Financial Capabilities	Legal or Institutional Constraints	Percent of Need Satisfied 2/
							Santa Cruz Study Area Lake Habitat Saved = 70 Pond Habitat Saved = 70 Stream Habitat Maintained = 70
EQ	EQ-2(a), (b), (c), (d) & (f)	SCS, Conservation Operations Program, PL-46, 74th Congress	Accelerate planning and application of resource management systems on irrigated croplands and grazing lands, with emphasis on environmental quality.	Moderate	Adequate	Historic use patterns	San Pedro Study Area 2(a)Grazing lands = 38 Forest lands = 71 Cropland = 100 2(b) = 82 2(c) = 100 2(d) = 100 2(f)Antelope = 59 Prairie Dog = 57 Quail = 57 Sparrow = 59 Santa Cruz Study Area 2(a)Grazing lands = 100 Forest lands = 100 Cropland = 100 2(b) = 100 2(c) = 100 2(d) = 100 2(f)Antelope = 90 Quail = 90
EQ	EQ-3(a) & (b)	SCS, Conservation Operations Program, PL-46, 74th Congress; US Forest Service, Multiple Use-Sustained	Accelerate planning and application of resource management systems with emphasis on protection and improvement of riparian communities and acquire	Moderate	Adequate	Historic use patterns	San Pedro Study Area 3(a) = 100 3(b) = 100 Santa Cruz Study Area 3(a) = 100 3(b) = 100

TABLE 9.1 - USDA PROGRAMS TO IMPLEMENT THE PLANS (Continued)

Plan	Second Level Component 1/	USDA Agency, Program and Authority	Project, Measure or Action	Local Interest	Financial Capabilities	Legal or Institutional Constraints	Percent of Need Satisfied 2/
		and the Fish & Wildlife Coordination Act of March 10, 1934, as amended, Land and Water Conservation Fund Act of 1964.	lands growing riparian vegetation.				
EQ	EQ-4(b)	SCS, Conservation Operations Program, PL-46, 74th Congress	Accelerate planning and application of resource management systems on irrigated croplands and grazing lands, with emphasis on environmental quality.	Low to Moderate	Adequate	Historic use patterns	San Pedro Study Area = 90 Santa Cruz Study Area = 90
EQ	EQ-5	US Forest Service, Land Exchange Program, Land Exchange Act of March 20, 1922	Acquire and protect areas of unique biotic significance.	Moderate		None	San Pedro Study Area = 100 Santa Cruz Study Area = 100
EQ	EQ-6	US Forest Service, Wilderness Program, Wilderness Act of September 3, 1964	Acquire private lands and designate them as wilderness areas	Moderate		None	San Pedro Study Area = 100 Santa Cruz Study Area = 100
EQ	EQ-7	SCS, Conservation Operations Program, PL-46, 74th Congress	In cooperation with natural resource conservation districts, identify and exhibit various forms of accelerated erosion.	Moderate	Adequate	None	San Pedro Study Area = 75 Santa Cruz Study Area = 100
EQ	EQ-8	US Forest Service, Wilderness Program, Wilderness Act of September 3, 1964	Prevent fuel buildup on wilderness areas	High		Clean Air Act	San Pedro Study Area = 100 Santa Cruz Study Area = 100

TABLE 9.1 - USDA PROGRAMS TO IMPLEMENT THE PLANS (Continued)

Plan	Second Level Component 1/	USDA Agency, Program and Authority	Project, Measure or Action	Local Interest	Financial Capabilities	Legal or Institutional Constraints	Percent of Need Satisfied 2/
EQ	EQ-10(a) & (b)	San Pedro Study Area: SCS, Resource Conservation & Development Project Measures, PL-74-46; PL-91-343; PL-87-703; PL-92-418	Critical area treatment	Low	Inadequate	Historic use patterns & concept of downstream water users.	San Pedro Study Area = 60 Santa Cruz Study Area = 100
		Santa Cruz Study Area: SCS, Conservation Operations Program, PL-46, 74th Congress	Streambank stabilization	Low	Inadequate	None	San Pedro Study Area = 60 Santa Cruz Study Area = 100
	EQ-10(c)	SCS Conservation Operations Program, PL-46, 74th Congress	Accelerate planning and application of resource management systems, with emphasis on environmental quality.	Moderate	Adequate	Historic use patterns, & concept of downstream water users.	San Pedro Study Area = 45 Santa Cruz Study Area = 70
EQ and NED	All Components As Applicable	Farmers Home Administration, Loan Programs (Consolidated Farm and Rural Development Act).	Assure adequate availability of funds for project development loans, if needed.				
		Cooperative Extension Service - Information Program (Smith-Lever Act of 1914).	Timely dissemination of information concerning proposed programs and expected results.				

TABLE 9.1 - USDA PROGRAMS TO IMPLEMENT THE PLANS (Continued)

Plan	Second Level Component 1/	USDA Agency, Program and Authority	Project, Measure or Action	Local Interest	Financial Capabilities	Legal or Institutional Constraints	Percent of Need Satisfied 2/
		Agricultural Stabilization and Conservation Service, Agricultural Conservation Program (Soil Conservation and Domestic Allotment Act of February 29, 1936).	Assure adequate availability of cost-sharing funds for the proposed program.	-	-	-	-

1/ See Chapter 3, Table 3.9 for second level component (preference).
2/ Percent of projected need, year 2000, for the San Pedro Study Area and the present need for the Santa Cruz Basin.

CHAPTER 10

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

INTRODUCTION

Chapter 8 presented two plans, titled National Economic Development (Plan A) and Environmental Quality (Plan B), to solve the problems identified in the Santa Cruz-San Pedro River Basins. The opportunities of USDA programs to satisfy these plans and the impacts of the programs are discussed in Chapter 9. The percent of total need that can be satisfied by USDA programs is shown in the last column of Table 9.1. As shown, USDA programs cannot completely satisfy all of the needs.

There are other (non-USDA) programs that would help implement Plans A and B and also contribute to satisfying the total needs. These programs are shown in Table 10.1. The table also shows when special coordination between agencies and between programs is needed.

Regardless of the programs utilized, there are physical, financial, legal, and institutional constraints against completely satisfying all of the needs in the basin. Recommended new programs or criteria (including legal and institutional) are presented in the following section.

RECOMMENDED NEW PROGRAMS OR CRITERIA

Following are those comments, suggestions, and recommendations related to changes needed to satisfy the remaining needs (see Table 9.1) in the Santa Cruz-San Pedro River Basins.

This material is grouped into subject matter categories (e.g., Flood Prevention) instead of by second-level components of the objectives. Many of the recommendations apply to more than one second-level component.

The recommendations should not be considered an endorsement by either the U. S. Department of Agriculture or Arizona Water Commission.

Flood Prevention
(NED-1)

1. Section 73, Title 1 of the U. S. Water Resource Development Act of 1974 (Public Law 93-251) authorizes federal cost-sharing for non-structural measures for flood prevention. It is recommended that additional funds be made available to allow further effectiveness in the installation of structural and non-structural measures.

2. Arizona has a state program to assist local agencies in bearing the non-federal costs for flood prevention projects. The costs include land, easements and rights-of-way, utility and road relocations, etc. An increased funding level is needed to assist local agencies.

3. Arizona has an existing statute authorizing donation of State Trust lands for flood control projects to the extent that other State Trust lands are benefited. The constitutionality of this act has been questioned.

   The donation of State Trust lands would assist local agencies in obtaining needed rights-of-way for flood prevention projects. This may require an Arizona constitutional amendment.

Land and Water Resources and Use
(NED-2; EQ-1, 2, 3, 4, 10)

1. Procedures are needed to control the unwise conversion of irrigated lands to other uses, thereby slowing urban sprawl, preserving prime and unique farmlands, and retaining open space.

2. Additional federal and state financing and assistance for installation of land treatment measures is needed.

3. State legislation is needed to establish and adequately fund a revolving fund within the State Land Department for treatment and improvement of State Trust lands.

4. State legislation and adequate funding are needed to enact a program that would provide for acquisition and retention of lands for open space.

5. State legislation is needed to establish an irrigation well metering and monitoring program.

Water-Based Recreation
(NED-3)

1. Legislation or a state constitutional amendment is needed to allow the donation of State Trust lands for water-based recreation projects.

2. The Santa Cruz-San Pedro River Basins have a critical shortage of water-based recreation. A comprehensive feasibility study of potential impoundment sites is needed to identify those sites where existing programs may be utilized to alleviate this shortage. The programs include the Arizona Outdoor Recreation Coordination Commission's State Lake Improvement Fund and the Arizona Game and Fish Department's Water Conservation and Development Fund. The study must include an examination of water rights.

Biological Resources
(EQ-1, 2, 3, 4, 5)

1. Elimination of federal cost-sharing assistance under the Agricultural Conservation Program for practices such as channel clearance would reduce the rate of destruction of riparian vegetation.

2. Increased funds to Arizona State Land Department and Arizona Commission of Agriculture and Horticulture for enforcement of statutes would help protect vegetation.

3. Increased federal and state funding is needed for fish and wildlife research, particularly research for the re-establishment of unique biotic species.

4. Economic incentives are needed to encourage private landowners to make their land more beneficial to wildlife.

5. There is a need for State Trust lands with special and/or unique fish and wildlife values to be managed accordingly. Any transfer of such land should be based on the fish and wildlife values rather than maximum dollar return.

Natural Areas
(EQ-6)

Federal and state financial assistance is needed for purchase of areas of special and/or unique scenic and biotic significance.

Erosion and Sedimentation
(EQ-1, 7, & 10)

1. There is a need for state legislation and stronger local codes with enforcement to reduce erosion and sediment produced from road, utility corridor, and other construction, particularly in isolated subdivisions.

2. Modifications are needed in cost sharing under the Agricultural Conservation Program and other programs to put wildlife and erosion control practices on at least an equal basis with production type practices.

Historic, Archeologic, and Unique Scenic and Geologic Sites
(EQ-9)

Acquisition of historical and archeological sites is dependent upon federal grants-in-aid on a matching basis. The property involved must also be on the National Register of Historic Places.

1. State legislation and adequate funding are needed for acquisition of historical, archeological, and unique scenic and geologic sites and for enforcement of statutes.

2. Tax preferences or other economic incentives to private landowners are needed to encourage the protection of sites located on private land.

Solid Wastes
(EQ-10)

1. State legislation that would impose a container tax or similar economic sanction is needed to prevent littering.

2. Stricter law enforcement at all levels of government is needed to enforce existing statutes against littering.

TABLE 10.1 - OTHER PROGRAMS AND COORDINATION NEEDED

Plan	Second Level Component From Table 3.9	Agency(s)	Programs and/or Authorities	Project, Measure or Action	Special Coordination Needed
A	NED-1 (Floodwater, erosion, and sediment damages)	Corps of Engineers	Water Resource Development Programs as authorized by the 1936 Flood Control Act and Amendments	San Pedro City of Willcox Santa Cruz Greens Wash Diversion Middle Gila Channel Improvement	
		U.S.Bureau of Reclamation	Public Law 90-537 (Central Arizona Project)	Santa Cruz Salt-Gila Aqueduct	Coordinate flood prevention features with other federal, state, and local agencies to obtain optimization of all flood prevention benefits, particularly off-site benefits.
		City of Tucson	On-going flood prevention program	Structural measures for localized flood problems	
		Cities and Counties	Arizona House Bill 2027 (Flood Plain Management Act of 1975)	Flood plain regulations	
		Flood Insurance Administration, Corps of Engineers, U.S. Geologic Survey, Arizona State Land Dept., and Local Agencies	Flood Insurance Program (U.S. Flood Disaster Protection Act of 1973)	Flood Insurance Studies and Flood Plain Management Programs	

TABLE 10.1 - OTHER PROGRAMS AND COORDINATION NEEDED (Continued)

Plan	Second Level Component From Table 3.9	Agency(s)	Programs and/or Authorities	Project, Measure or Action	Special Coordination Needed
A	NED-1, NED-3 (Multi-purpose flood prevention and recreation)	U.S.Bureau of Reclamation	Public Law 90-537 (Central Arizona Project)	San Pedro Charleston Dam Santa Cruz Buttes Dam	
			Public Law 89-561 (Feasibility studies)	Santa Cruz Nogales Dam	International treaty with Mexico required.
	NED-2(a) (Crop production)	U.S.Bureau of Reclamation	Public Law 90-537 (Central Arizona Project)	San Pedro Charleston Dam	Possible improvements in the irrigation water distribution systems for the St. David Irrigation District and Pomerene Water Users Association are contingent upon actual project facilities at the authorized upstream Charleston Dam. Close coordination between USBR and these organizations is required.
				Santa Cruz Salt-Gila Aqueduct and facilities for distribution of irrigation water.	Central Arizona Project authorizations require lining of main canals that receive project waters. Close coordination is required between all federal agencies that have programs that may assist in this undertaking and between local water using agencies of the Central Arizona Water Conservation District.

TABLE 10.1 - OTHER PROGRAMS AND COORDINATION NEEDED (Continued)

Plan	Second Level Component From Table 3.9	Agency(s)	Programs and/or Authroities	Project, Measure or Action	Special Coordination Needed
A		Indian Tribes and U.S.Bureau of Indian Affairs	On-going programs for land treatment on irrigated lands		
	NED-2(b) (Beef production)	U.S.Bureau of Land Management, Arizona State Land Department, Indian Tribes, and U.S.Bureau of Indian Affairs	Grazing land management programs		
	NED-3 (Water-based recreation)	U.S.Bureau of Outdoor Recreation	Public Law 88-578 (Federal Land & Water Conservation Fund)		
		Arizona Outdoor Recreation Coordination Commission	Arizona State Lake Improvement Fund (SLIP)	Santa Cruz Ajo Detention Basin (Pima County)	
		Corps of Engineers	Section 77 of the 1974 Water Resource Development Act	Silverbell Parks (City of Tucson)	
		Cities and Counties	Local programs		
		Arizona Game & Fish Department	Arizona Water Conservation & Development Fund	Santa Cruz Twin Peaks Reservoir (In litigation over downstream water rights)	

TABLE 10.1 - OTHER PROGRAMS AND COORDINATION NEEDED (Continued)

Plan	Second Level Component From Table 3.9	Agency(s)	Programs and/or Authorities	Project, Measure or Action	Special Coordination Needed
B	EQ-1 (Fishery habitat & esthetics)	U.S.Bureau of Land Management & Arizona State Land Department	On-going programs to reduce erosion and sediment yield		
	EQ-2(a) (Wildlife oriented management)	U.S.Bureau of Land Management & Arizona State Land Department	On-going programs that contribute to improvement of wildlife habitat		
	EQ-2(b) (Wildlife water development)	Arizona Game & Fish Dept., Arizona Wildlife Federation, and other organizations	Existing program for the construction of wildlife watering facilities		
		U.S.Bureau of Land Management and Arizona State Land Department	On-going programs for stockpond development		
	EQ-2(c) (Restoration of rangeland and forestland habitat)	U.S.Bureau of Land Management, Arizona State Land Department, Indian Tribes, and U.S.Bureau of Indian Affairs	Resource management programs for proper grazing use		

TABLE 10.1 - OTHER PROGRAMS AND COORDINATION NEEDED (Continued)

Plan	Second Level Component From Table 3.9	Agency(s)	Programs and/or Authorities	Project, Measure or Action	Special Coordination Needed
B	EQ-2(f) (Unique biotic inhabitants)	Arizona Game & Fish Department	On-going research and other programs for the re-establishment of unique biotic species		
	EQ-4(a) (Expand wetlands)	Arizona Game & Fish Department	On-going wetland program	San Pedro Willcox Playa Santa Cruz Bog Hole	
	EQ-4(b) (Encourage wetlands)	U.S.Bureau of Land Management and Arizona State Land Department	Resource management programs		
	EQ-9 (Archeological and Historic Sites)	Office of Arizona State Historical Preservation Officer, National Park Service, and all land administering agencies	Antiquity Programs		
		Arizona State Museum	Permit program for State Trust lands		

TABLE 10.1 - OTHER PROGRAMS AND COORDINATION NEEDED (Continued)

Plan	Second Level Component From Table 3.9	Agency(s)	Programs and/or Authorities	Project, Measure or Action	Special Coordination Needed
B	EQ-10(a)(b)(c) (Critical erosion areas; streambank protection; erosion control on grazing lands)	U.S.Bureau of Land Management, Arizona State Land Department, Indian Tribes & U.S.Bureau of Indian Affairs	Resource management programs		Coordination is needed with downstream water-users to insure compatibility between treatment measures applied and desires of downstream users to maintain watershed runoff.
	EQ-11(b) (Clean up dumps)	Arizona State Department of Health Services	Technical Assistance		
		All land administering agencies and local governmental agencies	On-going regulatory and cleanup programs		

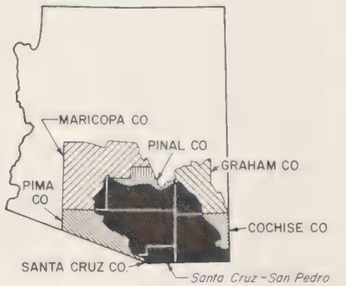
MAPS

SANTA CRUZ - SAN PEDRO RIVER BASINS
ARIZONA

SEPTEMBER 1977

10 0 10 20 MILES

SCALE 1:1,000,000



LOCATION MAP

SANTA CRUZ STUDY AREA

SAN PEDRO STUDY AREA

MEXICO

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:500,000 series.
Thematic detail compiled by state staff.
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OR 1977

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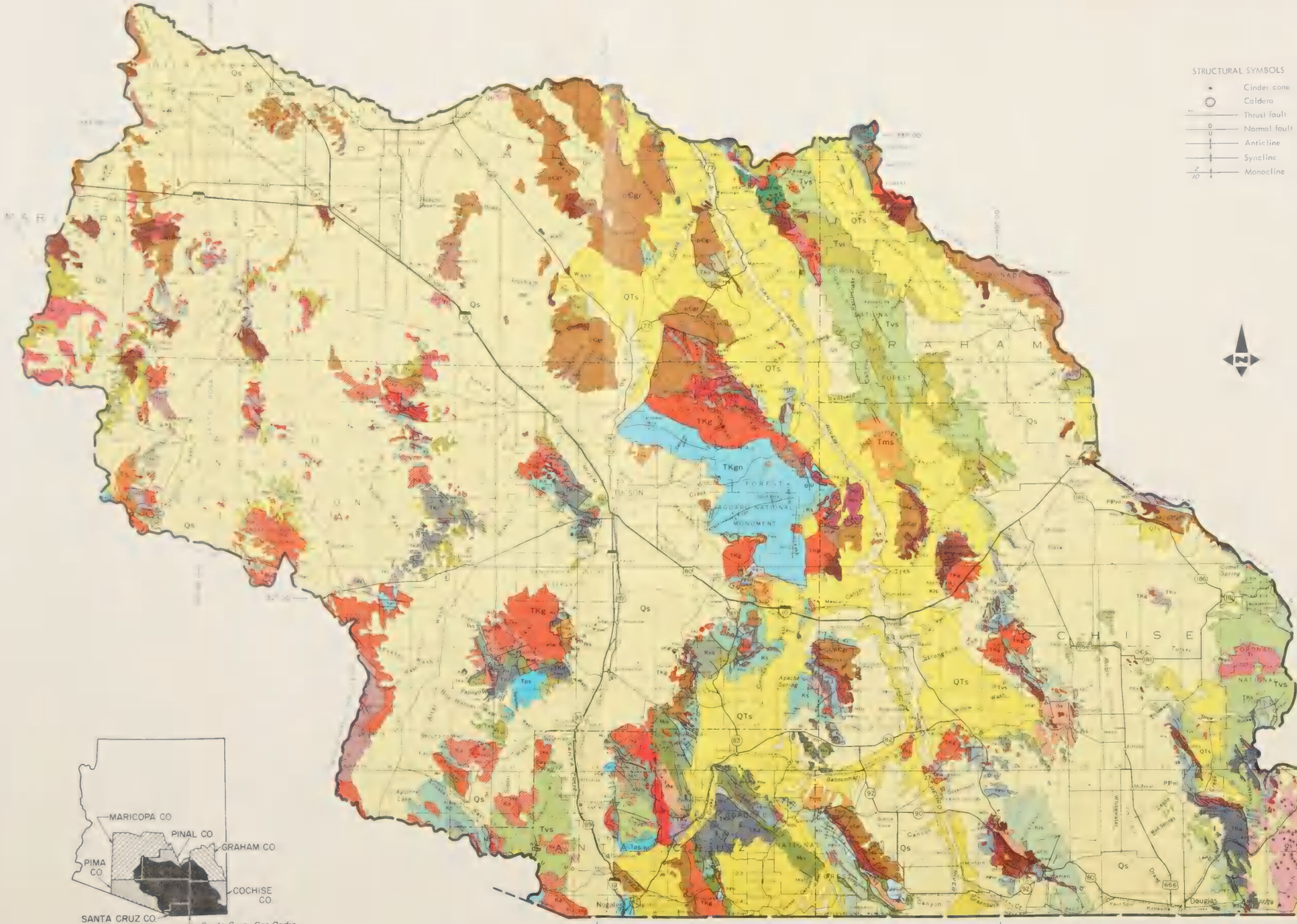

STRUCTURAL SYMBOLS

- Cinder cone
- Caldera
- Thrust fault
- Normal fault (D / U)
- Anticline
- Syncline
- Monocline (D / 10)

LEGEND

Qs	Quaternary sedimentary deposits
Qb	Quaternary volcanic rocks
QTs	Tertiary - Quaternary sedimentary rocks
QTb	Tertiary - Quaternary volcanic rocks
QTI	Tertiary - Quaternary dikes and plugs
Tms, Ts	Tertiary sedimentary rocks
Tv, Tvs, Tvi	Tertiary volcanic rocks
Ti	Tertiary dikes, sills and plugs
Tps	Tertiary sedimentary deposits
TKs	Cretaceous - Tertiary sedimentary rocks
TKv, TKa, TKr	Cretaceous - Tertiary volcanic rocks
TKg, TKi	Cretaceous - Tertiary intrusive rocks
TKsc, TKgn	Cretaceous - Tertiary metamorphic rocks
Kus	Upper Cretaceous sedimentary rocks
Ks, Kv, Kg, Kvs	Cretaceous sedimentary and volcanic rocks
Kls	Lower Cretaceous sedimentary rocks
Mzgr	Mesozoic granite to quartz diorite
Mzv	Mesozoic volcanic rocks
JTrg	Triassic - Jurassic intrusive rocks
PIPn	Pennsylvanian-Permian sedimentary rocks (Naco Group undivided
Pnu	Upper formations of Naco Group
PIPnl	Lower formations of Naco Group
Pzs	Paleozoic sedimentary rocks undivided
Mus	Devonian and Mississippian sedimentary rocks
Ocs	Cambrian and Ordovician sedimentary rocks
pCs	Younger Precambrian sedimentary and volcanic rocks
p-Y db	Younger Precambrian diabase
p-Y qt	Younger Precambrian quartzite
pCgr	Older Precambrian intrusive rocks
pCs, pCgn	Older Precambrian metamorphosed sedimentary and volcanic rocks

SEE DETAILED LEGEND ON REVERSE

Source:
Geologic Map of Arizona by Eldred D. Wilson and Richard T. Moore, Arizona Bureau of Mines and John R. Cooper, U.S. Geological Survey, 1969

LOCATION MAP

GEOLOGY
SANTA CRUZ - SAN PEDRO RIVER BASINS
ARIZONA

JULY 1974

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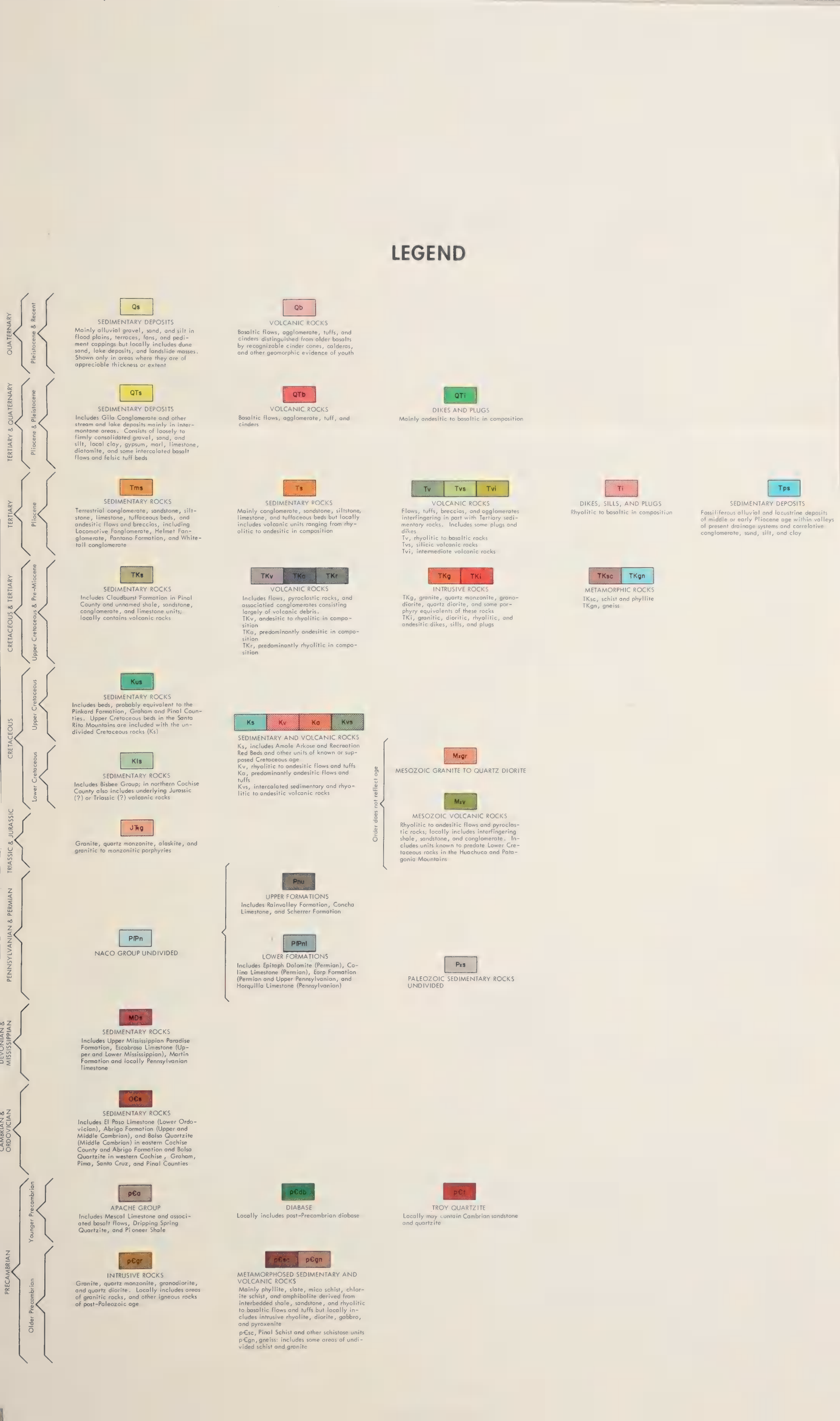
SCALE 1:1,000,000

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-23185-3

LEGEND


QUATERNARY
Pleistocene & Recent
Qs
SEDIMENTARY DEPOSITS
Mainly alluvial gravel, sand, and silt in flood plains, terraces, fans, and pediment cappings but locally includes dune sand, lake deposits, and landslide masses. Shown only in areas where they are of appreciable thickness or extent
Qb
VOLCANIC ROCKS
Basaltic flows, agglomerate, tuffs, and cinders distinguished from older basalts by recognizable cinder cones, calderas, and other geomorphic evidence of youth
TERTIARY & QUATERNARY
Pliocene & Pleistocene
QTs
SEDIMENTARY DEPOSITS
Includes Gila Conglomerate and other stream and lake deposits mainly in intermontane areas. Consists of loosely to firmly consolidated gravel, sand, and silt, local clay, gypsum, marl, limestone, diatomite, and some intercalated basalt flows and felsic tuff beds
QTb
VOLCANIC ROCKS
Basaltic flows, agglomerate, tuff, and cinders
QTi
DIKES AND PLUGS
Mainly andesitic to basaltic in composition
TERTIARY
Pliocene
Tms
SEDIMENTARY ROCKS
Terrestrial conglomerate, sandstone, siltstone, limestone, tuffaceous beds, and andesitic flows and breccias, including Locomotive Fanglomerate, Helmet Fanglomerate, Pantano Formation, and Whitetail conglomerate
Ts
SEDIMENTARY ROCKS
Mainly conglomerate, sandstone, siltstone, limestone, and tuffaceous beds but locally includes volcanic units ranging from rhyolitic to andesitic in composition
Tv
Tvs
Tvi
VOLCANIC ROCKS
Flows, tuffs, breccias, and agglomerates interfingering in part with Tertiary sedimentary rocks. Includes some plugs and dikes
Tv, rhyolitic to basaltic rocks
Tvs, silicic volcanic rocks
Tvi, intermediate volcanic rocks
Ti
DIKES, SILLS, AND PLUGS
Rhyolitic to basaltic in composition
Tps
SEDIMENTARY DEPOSITS
Fossiliferous alluvial and lacustrine deposits of middle or early Pliocene age within valleys of present drainage systems and correlative conglomerate, sand, silt, and clay
CRETACEOUS & TERTIARY
Upper Cretaceous & Pre-Miocene
TKs
SEDIMENTARY ROCKS
Includes Cloudburst Formation in Pinal County and unnamed shale, sandstone, conglomerate, and limestone units; locally contains volcanic rocks
TKv
TKa
TKr
VOLCANIC ROCKS
Includes flows, pyroclastic rocks, and associated conglomerates consisting largely of volcanic debris.
TKv, andesitic to rhyolitic in composition
TKa, predominantly andesitic in composition
TKr, predominantly rhyolitic in composition
TKg
TKi
INTRUSIVE ROCKS
TKg, granite, quartz monzonite, granodiorite, quartz diorite, and some porphyry equivalents of these rocks
TKi, granitic, dioritic, rhyolitic, and andesitic dikes, sills, and plugs
TKsc
TKgn
METAMORPHIC ROCKS
TKsc, schist and phyllite
TKgn, gneiss
CRETACEOUS
Upper Cretaceous
Kus
SEDIMENTARY ROCKS
Includes beds, probably equivalent to the Pinkard Formation, Graham and Pinal Counties. Upper Cretaceous beds in the Santa Rita Mountains are included with the undivided Cretaceous rocks (Ks)
Ks
Kv
Ka
Kvs
SEDIMENTARY AND VOLCANIC ROCKS
Ks, includes Amole Arkose and Recreation Red Beds and other units of known or supposed Cretaceous age
Kv, rhyolitic to andesitic flows and tuffs
Ka, predominantly andesitic flows and tuffs
Kvs, intercalated sedimentary and rhyolitic to andesitic volcanic rocks
Lower Cretaceous
Kls
SEDIMENTARY ROCKS
Includes Bisbee Group; in northern Cochise County also includes underlying Jurassic (?) or Triassic (?) volcanic rocks
Order does not reflect age
Mzgr
MESOZOIC GRANITE TO QUARTZ DIORITE
Mzv
MESOZOIC VOLCANIC ROCKS
Rhyolitic to andesitic flows and pyroclastic rocks; locally includes interfingering shale, sandstone, and conglomerate. Includes units known to predate Lower Cretaceous rocks in the Huachuca and Patagonia Mountains
TRIASSIC & JURASSIC
JTrg
Granite, quartz monzonite, alaskite, and granitic to monzonitic porphyries
PENNSYLVANIAN & PERMIAN
Pnu
UPPER FORMATIONS
Includes Rainvalley Formation, Concha Limestone, and Scherrer Formation
PPn
NACO GROUP UNDIVIDED
PPnl
LOWER FORMATIONS
Includes Epitaph Dolomite (Permian), Colina Limestone (Permian), Earp Formation (Permian and Upper Pennsylvanian, and Horquilla Limestone (Pennsylvanian)
Pzs
PALEOZOIC SEDIMENTARY ROCKS UNDIVIDED
DEVONIAN & MISSISSIPPIAN
MDs
SEDIMENTARY ROCKS
Includes Upper Mississippian Paradise Formation, Escabrosa Limestone (Upper and Lower Mississippian), Martin Formation and locally Pennsylvanian limestone
CAMBRIAN & ORDOVICIAN
OCs
SEDIMENTARY ROCKS
Includes El Paso Limestone (Lower Ordovician), Abrigo Formation (Upper and Middle Cambrian), and Bolsa Quartzite (Middle Cambrian) in eastern Cochise County and Abrigo Formation and Bolsa Quartzite in western Cochise, Graham, Pima, Santa Cruz, and Pinal Counties
PRECAMBRIAN
Younger Precambrian
pЄa
APACHE GROUP
Includes Mescal Limestone and associated basalt flows, Dripping Spring Quartzite, and Pioneer Shale
pЄdb
DIABASE
Locally includes post-Precambrian diabase
pЄt
TROY QUARTZITE
Locally may contain Cambrian sandstone and quartzite
Older Precambrian
pЄgr
INTRUSIVE ROCKS
Granite, quartz monzonite, granodiorite, and quartz diorite. Locally includes areas of granitic rocks, and other igneous rocks of post-Paleozoic age
pЄsc
pЄgn
METAMORPHOSED SEDIMENTARY AND VOLCANIC ROCKS
Mainly phyllite, slate, mica schist, chlorite schist, and amphibolite derived from interbedded shale, sandstone, and rhyolitic to basaltic flows and tuffs but locally includes intrusive rhyolite, diorite, gabbro, and pyroxenite
pЄsc, Pinal Schist and other schistose units
pЄgn, gneiss: includes some areas of undivided schist and granite

DEPTH TO WATER, 1970
SANTA CRUZ - SAN PEDRO RIVER BASINS
ARIZONA

JULY 1974

10 0 10 20 MILES

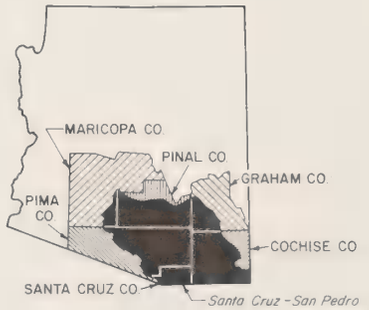
SCALE 1:1,000,000

BY
ARIZONA WATER COMMISSION
AND
U.S. DEPARTMENT OF AGRICULTURE

Sources:

The data shown for the Santa Cruz Basin, excluding Aguirre and Santa Rosa Valleys, are from Map Showing Depth to Water in Wells in the Tucson Area, Arizona, 1972 and Map Showing Depth to Water in Wells in the Phoenix Area, Arizona, 1972, Geological Survey, United States Department of the Interior

Data shown for the remaining areas are interpretations of published and unpublished Geological Survey (U.S.D.I.) data and ground water model analyses conducted by the Soil Conservation Service (U.S.D.A.) and the Arizona Water Commission.



LOCATION MAP

LEGEND

- 0-100 Feet
- 100-200 Feet
- 200-300 Feet
- 300-400 Feet
- 400-500 Feet
- 500-600 Feet
- 600-700 Feet
- Below 700 Feet
- Areas With Ground Water Not Analyzed
- Rock Outcrop or Insufficient Data

Note Lines dashed where data are limited

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-23185-6

WATER LEVEL CHANGE, 1940-1970
AND EARTH FISSURE ZONES
SANTA CRUZ - SAN PEDRO RIVER BASINS
ARIZONA

JUNE 1974

10 0 10 20 MILES
SCALE 1:1,000,000

BY
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AND
U.S. DEPARTMENT OF AGRICULTURE

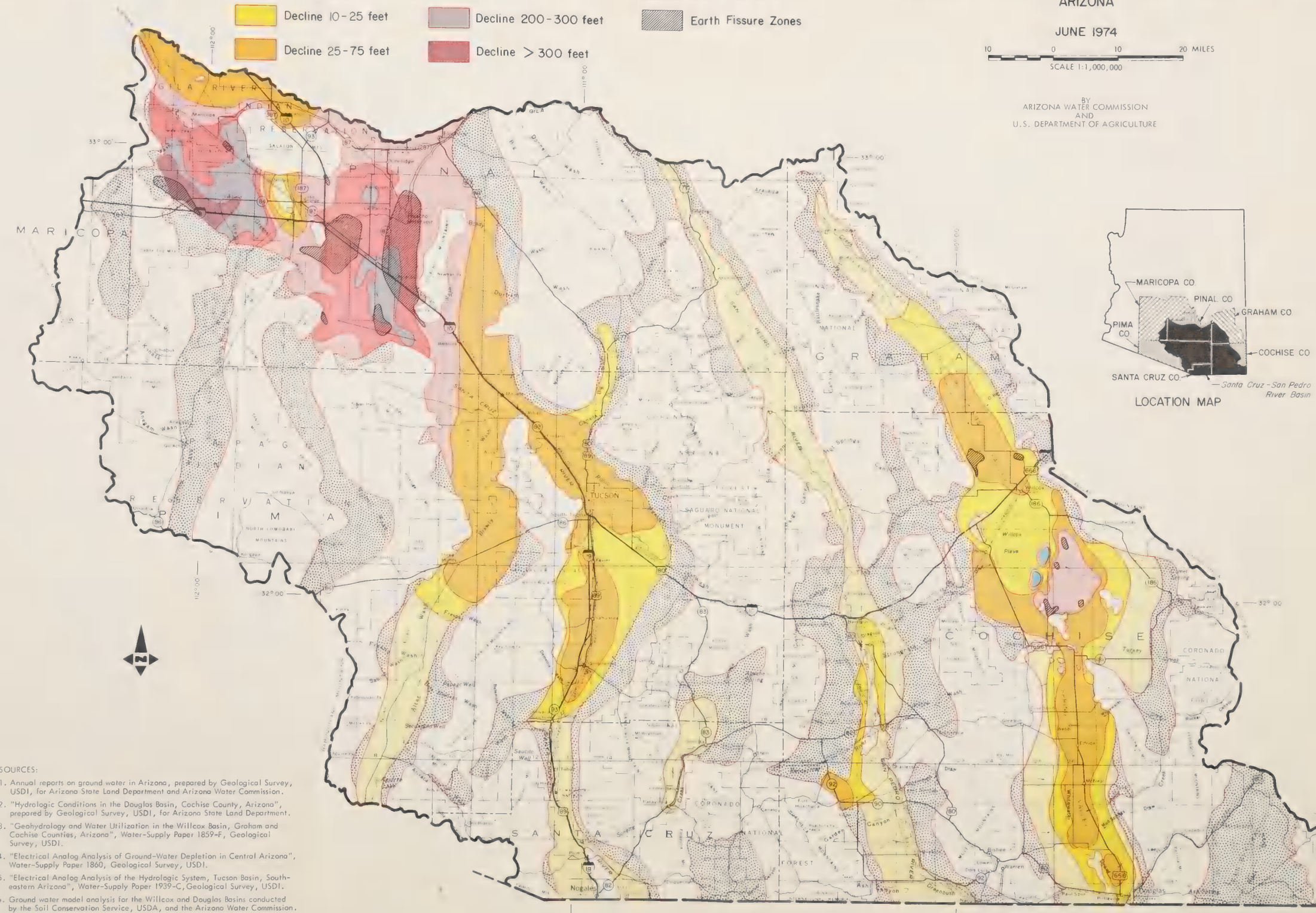
LEGEND

APPROXIMATE CHANGE IN WATER LEVEL IN ALLUVIAL DEPOSITS

- Rise 0-25 feet
- Decline < 10 feet
- Decline 10-25 feet
- Decline 25-75 feet
- Decline 75-125 feet
- Decline 125-200 feet
- Decline 200-300 feet
- Decline > 300 feet

OTHER AREAS

- Areas with ground water not analyzed
- Rock outcrop or insufficient data
- Earth Fissure Zones



LOCATION MAP

SOURCES:

1. Annual reports on ground water in Arizona, prepared by Geological Survey, USDI, for Arizona State Land Department and Arizona Water Commission.
2. "Hydrologic Conditions in the Douglas Basin, Cochise County, Arizona", prepared by Geological Survey, USDI, for Arizona State Land Department.
3. "Geohydrology and Water Utilization in the Willcox Basin, Graham and Cochise Counties, Arizona", Water-Supply Paper 1859-F, Geological Survey, USDI.
4. "Electrical Analog Analysis of Ground-Water Depletion in Central Arizona", Water-Supply Paper 1860, Geological Survey, USDI.
5. "Electrical Analog Analysis of the Hydrologic System, Tucson Basin, Southeastern Arizona", Water-Supply Paper 1939-C, Geological Survey, USDI.
6. Ground water model analysis for the Willcox and Douglas Basins conducted by the Soil Conservation Service, USDA, and the Arizona Water Commission.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1974

MEXICO

M7-EN-23185-4

WELL WATER IRRIGATION CLASSIFICATION
SANTA CRUZ - SAN PEDRO RIVER BASINS
ARIZONA

JULY 1974

10 0 10 20 MILES

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ARIZONA WATER COMMISSION
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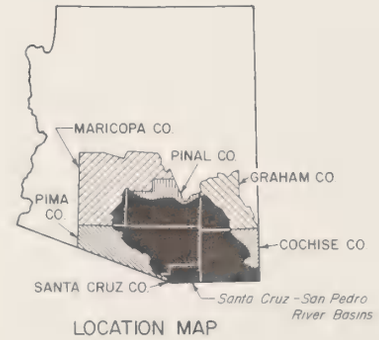
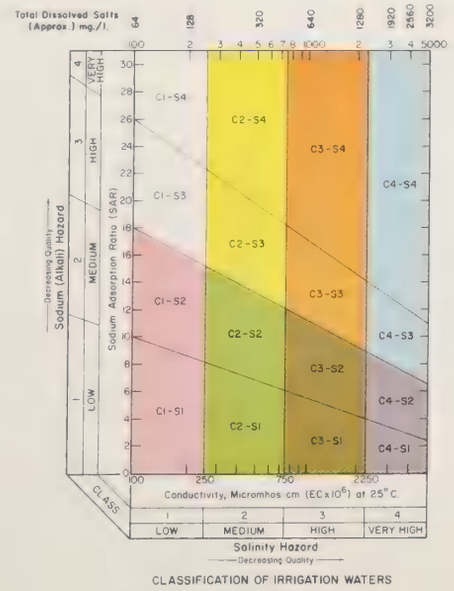
WELL WATER IRRIGATION CLASSIFICATION
Color indicates Irrigation Water Classification.
Numeral indicates wells tested within the township that fall within that class



LOCATION MAP



CLASSIFICATION OF IRRIGATION WATERS

Chart from
U. S. D. A., Handbook No. 60
Diagnosis and Improvement
of Saline and Alkali Soils

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA SCS PORTLAND DEC 1974

M7-EN-23185-11

DESIGNATED CRITICAL GROUND WATER AREAS
and
IRRIGATED LANDS
SANTA CRUZ - SAN PEDRO RIVER BASINS
ARIZONA

1972

10 0 10 20 MILES
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ARIZONA WATER COMMISSION
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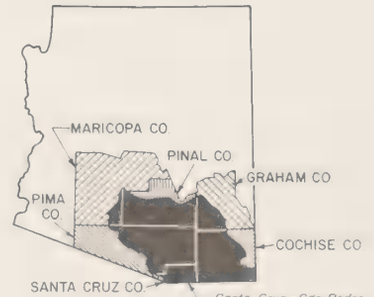


LOCATION MAP

DESIGNATED CRITICAL GROUND WATER AREAS

1	Gila-Santa Cruz - October 15, 1954
2	Gila-Santa Cruz - June 19, 1951
3	Eloy - April 4, 1949
4	Eloy - October 15, 1954
5	Marana - October 15, 1954
6	Tucson - October 15, 1954
7	Sahuarita-Continental - October 15, 1954
8	Douglas Basin - April 1, 1965

IRRIGATED LANDS

- Irrigated land - 1972
- New irrigated land - 1963-1972
- Irrigated land abandoned
- Irrigated land withdrawn for urban use

MEXICO

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-23185-9

GENERAL SOIL MAP

SANTA CRUZ - SAN PEDRO RIVER BASINS

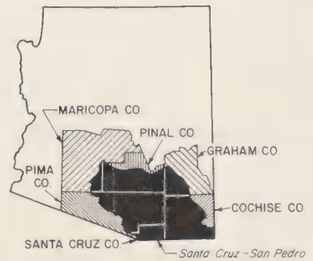
ARIZONA

JULY 1974

10 0 10 20 MILES

SCALE 1:1,000,000

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



LOCATION MAP

LEGEND

SOILS OF THE RIVER BOTTOMS AND ALLUVIAL FANS

A1 GILMAN-ANTHO PIMER ASSOCIATION: Deep, loamy soils, 0 to 3 percent slopes. Vegetation is dominantly desert brush, cacti and annual grass.

A2 COMORO-ANTHONY-GRABE ASSOCIATION: Deep, loamy soils, 0 to 3 percent slopes. Vegetation is dominantly brush and grass.

A3 GUEST ASSOCIATION: Deep, clayey soils, 0 to 1 percent slopes. Vegetation is dominantly grass.

A4 GOTHARD-CROT-STEWART ASSOCIATION: Shallow and deep, loamy, saline-alkali soils with areas of silica-lime cemented hardpans at shallow and very shallow depths. 0 to 1 percent slopes. Vegetation is dominantly grass.

SOILS OF THE VALLEY SLOPES

B1 MOHALL-CASA GRANDE-ANTHO ASSOCIATION: Deep, loamy soils with some depressional areas of saline-alkali soils. 0 to 2 percent slopes. Vegetation is dominantly desert brush, cacti and annual grass.

B2 MOHAVE-PINALENO-LATENE ASSOCIATION: Deep, loamy and gravelly loamy soils. 0 to 5 percent slopes. Vegetation is dominantly brush and grass.

B3 CASA GRANDE-LA PALMA: Deep and moderately deep, loamy, saline-alkali soils, some of which have lime-silica cemented hardpans. 0 to 2 percent slopes. Vegetation is dominantly desert brush, cacti and annual grass.

B4 MOHALL-VECONT ASSOCIATION: Deep, loamy soils and deep clayey soils, 0 to 2 percent slopes. Vegetation is dominantly desert brush, cacti and annual grass.

B5 WHITE HOUSE-BERNARDINO ASSOCIATION: Deep, clayey soils, 2 to 8 percent slopes. Vegetation is dominantly brush and grass.

B6 CARALAMPI-WHITE HOUSE ASSOCIATION: Deep, gravelly loamy and clayey soils, 5 to 30 percent slopes. Vegetation is dominantly brush and grass.

B7 CARALAMPI ASSOCIATION: Deep, gravelly loamy soils, 30 to 60 percent slopes. Vegetation is dominantly brush and grass.

B8 BONITA-SONTAG ASSOCIATION: Deep, cobbly and gravelly, clayey soils on basalt, cinders, or ash. 0 to 25 percent slopes. Vegetation is dominantly grass.

B10 CONTINENTAL-TUBAC ASSOCIATION: Deep, clayey soils with some areas of loamy and gravelly soils. 0 to 30 percent slopes. Vegetation is dominantly grass.

B11 CASTO-MARTINEZ ASSOCIATION: Deep, clayey soils and gravelly loamy soils. 0 to 40 percent slopes. Vegetation is dominantly oak and grass.

SHALLOW UPLAND SOILS OVER BEDROCK

C1 CELLAR-GRAHAM-CHERIONI ASSOCIATION: Very shallow and shallow, cobbly and gravelly, loamy, and clayey soils on bedrock. 5 to 30 percent slopes. Vegetation is dominantly grass and brush.

LIMY SOILS ON VALLEY SLOPES AND HIGH FANS

D1 RILLINO-CAVE ASSOCIATION: Deep, gravelly loamy soils, and shallow gravelly loamy soils over lime cemented hardpans. 2 to 15 percent slopes. Vegetation is dominantly desert brush.

D2 LAVEEN-RILLITO ASSOCIATION: Deep, loamy soils and gravelly loamy soils. 0 to 3 percent slopes. Vegetation is dominantly desert brush, cacti and annual grass.

D3 KIMBROUGH-CAVE ASSOCIATION: Very shallow and shallow, gravelly loamy soils over lime cemented hardpans. 0 to 25 percent slopes. Vegetation is dominantly grass and brush.

D4 HATHAWAY-NICKEL ASSOCIATION: Deep, gravelly and very gravelly loamy soils. 0 to 30 percent slopes. Vegetation is dominantly grass and brush.

D5 ELFRIDA-KARRO ASSOCIATION: Deep, loamy soils. 0 to 15 percent slopes. Vegetation is dominantly grass and brush.

SOILS OF THE MOUNTAINS

E1 ROCK OUTCROP-CHERIONI-GACHADO ASSOCIATION: Mountains and buttes with rock outcrop and very shallow and shallow sandy and loamy soils that are gravelly, cobbly and stony. 5 to 75 percent slopes. Vegetation is dominantly desert brush, cacti and annual grass.

E2 LAMPSHIRE-GRAHAM-ROCK OUTCROP ASSOCIATION: Mountains and buttes with very shallow and shallow soils that are gravelly, cobbly and stony and large areas of rock outcrop. 5 to 75 percent slopes. Vegetation is dominantly brush and grass with oak, pinon pine and juniper at the higher elevations.

E3 MIRABAL-BARKERVILLE-ROCK OUTCROP ASSOCIATION: High mountains with shallow, gravelly and cobbly soils and large areas of rock outcrop. 5 to 75 percent slopes. Vegetation is dominantly mixed conifers.

E4 FARAWAY-BARKERVILLE-ROCK OUTCROP ASSOCIATION: Mountainous areas with very shallow and shallow, gravelly and cobbly soils and large areas of rock outcrop. 5 to 75 percent slopes. Vegetation is dominantly oak, juniper, and grass with pine at the higher elevations above 6200 feet.

E5 TORTUGAS-ROCK OUTCROP ASSOCIATION: Very shallow and shallow very cobbly and gravelly loamy soils and rock outcrop. 30 to 60 percent slopes. Vegetation is dominantly oak, juniper and grass with pine at the higher elevations above 6200 feet.

ERODED LANDS

F1 ERODED AND GULLIED CALCIORTHIDS ASSOCIATION: Deeply dissected, gravelly and very gravelly loamy and sandy soils and soil materials. 15 to 60 percent slopes. Vegetation is brush with some grass.

DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA SCS PORTLAND OREG. 1974

M7-EN-23185-1

VEGETATION, CROPLANDS, URBAN & MINING AREAS

SANTA CRUZ - SAN PEDRO RIVER BASINS

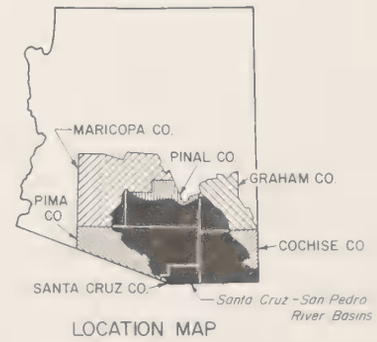
ARIZONA

1972

10 0 10 20 MILES

SCALE 1:1,000,000

BY
ARIZONA WATER COMMISSION
AND
U.S. DEPARTMENT OF AGRICULTURE



LOCATION MAP

LEGEND

RIPARIAN

PINE-MIXED CONIFER
- 0-30% Canopy
- 31-60% Canopy
- 61-100% Canopy

OAK WOODLAND-CHAPARRAL
- 0-30% Canopy
- 31-60% Canopy
- 61-100% Canopy

DESERT
- Chihuahuan
- Sonoran
- Largely Barren

GRASSLAND

CROPLAND

URBAN AREAS
- Existing
- Being Planned & Developed

MINING AREAS

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

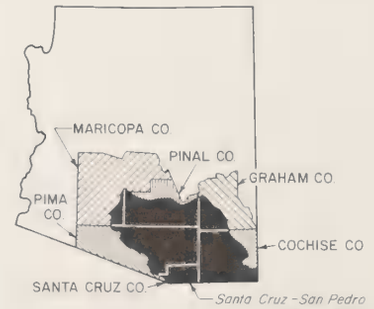
M7-EN-23185-10

LAND OWNERSHIP AND ADMINISTRATION
SANTA CRUZ - SAN PEDRO RIVER BASINS
ARIZONA

1972

10 0 10 20 MILES
SCALE 1:1,000,000

BY
ARIZONA WATER COMMISSION
AND
U.S. DEPARTMENT OF AGRICULTURE



LOCATION MAP

LEGEND

FEDERAL LAND, administered by:
- Forest Service
- Bureau of Land Management
- National Park Service
- Department of Defense
- Other

STATE LAND, administered by:
- State Land Department
- Other State Agencies
  State Parks, Game & Fish Dept., Dept. of Corrections, Military Dept.

- COUNTY & MUNICIPAL

PRIVATE LAND:
- Individual & Corporate
- Existing urban
- Subdivisions being planned and developed

- Indian Trust Lands

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-23185-5

GENERALIZED FLOOD PRONE AREAS

SANTA CRUZ - SAN PEDRO RIVER BASINS

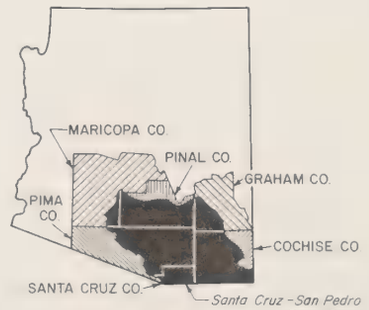
ARIZONA

JULY 1974

10 0 10 20 MILES

SCALE 1:1,000,000

BY
ARIZONA WATER COMMISSION
AND
U.S. DEPARTMENT OF AGRICULTURE



LOCATION MAP

DEGREE OF FLOOD HAZARD

MOST SEVERE: Riverine flood plain areas and detention reservoirs. Whole area subject to inundation from floods of large magnitude.

<1/2% | 1/2% to 1% | >1%

MODERATE TO LOCALLY SEVERE: Bottom lands and alluvial fan flood plain areas with slope designations of <1/2%; 1/2% to 1%; and >1%, respectively. These areas are subject to inundation from ponding and sheet flow due to local intense storms.

SLIGHT: Incised, well dissected uplands. Generally not subject to flooding except in the narrow valley bottoms.

SLIGHT TO NONE: Mountains or rugged uplands. Flood hazard is slight to nil, except along channels shown and in the many mountain washes too small to delineate.

Note: This map is a generalization of flooding conditions and is not intended for use in detailed planning. Scale of flood prone areas has been exaggerated on small tributaries for illustrative purposes.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA SCS PORTLAND OREG 1974

M7-EN-23185-8

EROSION CLASSIFICATION

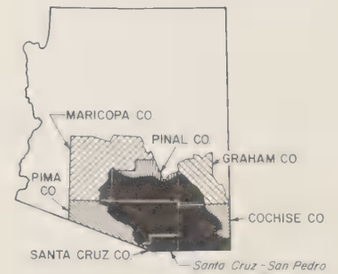
SANTA CRUZ - SAN PEDRO RIVER BASINS

ARIZONA

JULY 1974

10 0 10 20 MILES

SCALE 1:1,000,000



LOCATION MAP

LEGEND

Present Average Rate of Erosion

- Greater than 4.5 Acre Feet Per Square Mile Per Year*
- 1.5 - 4.5 Acre Feet Per Square Mile Per Year
- 0.75 - 1.5 Acre Feet Per Square Mile Per Year
- 0.35 - 0.75 Acre Feet Per Square Mile Per Year
- Less than 0.35 Acre Feet Per Square Mile Per Year

Severe streambank erosion. Greater than 50 percent of banks eroding laterally at average annual rate greater than 0.5 ft. Bank height greater than 8 ft.

Moderate streambank erosion. Either greater than 50 percent of banks affected by erosion and banks greater than 5' high, or greater than 75 percent of the banks are actively eroding.

*Areas of class 1 too small for mapping on this scale. Other class delineations include areas of higher and/or lower rates too small for mapping.

Gully erosion not shown but is generally active within classes 2 and 3.

MEXICO

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7-EN-23185-2

PROJECT SITE MAP

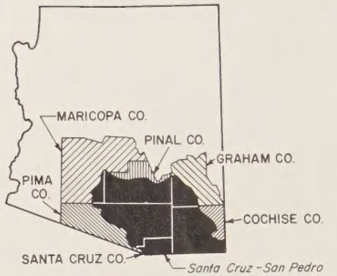
SANTA CRUZ - SAN PEDRO RIVER BASINS

ARIZONA

SEPTEMBER 1977

10 0 10 20 MILES

SCALE 1:1,000,000



LOCATION MAP

PROJECT SITES

1 Cactus Forest Watershed
2 Arivaipa Canyon Area
3 Santa Cruz Watershed, West Branch
4 Willcox Playa Wetland Area
5 St. David Watershed
6 Gardner Canyon Area
7 Patagonia-Sonoita Creek Area
8 Blue Haven Area
9 Bog Hole Area
10 Parker Canyon Area
11 Ramsey Canyon Area
12 Carr Canyon Area
13 Leslie Canyon Dam Site (Proposed)

Source:
Base map prepared by SCS, WTSC Carto Unit from USGS 1:500,000 series.
Thematic detail compiled by state staff.
U.S. DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE USDA-SCS PORTLAND, OR 1977

M7-EN-23185-12