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METHODOLOGY APPENDIX

IMPACT ASSESSMENT AND EFFECTS EVALUATION OF ELEMENTS

CENTRAL ARIZONA WATER CONTROL STUDY

MAY 1980

WORKING PAPER

METHODOLOGY APPENDIX

IMPACTS ASSESSMENT AND EFFECTS EVALUATION OF ELEMENTS

Dames & Moore
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1.0 INTRODUCTION

1.0 INTRODUCTION

1.1 IMPACT ASSESSMENT AND EFFECTS EVALUATION OF ELEMENTS

This appendix supplements the Central Arizona Water Control Study (CAWCS) Impact Assessment and Effects Evaluation of Elements, which has been prepared in a series of separate reports, one for each of the proposed project actions. A listing of these project actions as of May 12, 1980, is as follows:

Identification Number	Element
1-1	New Horseshoe Dam and Reservoir
1-2	Modified Horseshoe Dam
1-3	Horseshoe Dam Reoperation
2-1	Cliff Dam and Reservoir
3-1	New Bartlett Dam and Reservoir
3-2	Modified Bartlett Dam
3-3	Bartlett Dam Reoperation
4-1	Enlarged Roosevelt Dam and Reservoir
4-2	Modified Roosevelt Dam
4-3	Roosevelt Dam Reoperation
5-1	Confluence Dam and Reservoir (flood control and regulatory storage)
5-2	Confluence Dam and Reservoir (regulatory storage only)
5-3	Confluence Dam and Reservoir (flood control only)
6-1	Granite Reef Dam and Reservoir (flood control and regulatory storage)
6-2	Granite Reef Dam and Reservoir (regulatory storage only)
6-3	Granite Reef Dam and Reservoir (flood control only)
7-1	Lake Pleasant Conjunctive Use
7-2	New Waddell Dam and Reservoir
8-1	Phoenix Channels (Country Club Dr. to 35th Avenue)
8-2	Phoenix Levees (Country Club Dr. to 35th Avenue)

8-3	Phoenix Greenbelt (Country Club Dr. to 35th Avenue)
9-1	Gila River Channel Clearing
9-2	Gila River Levees (91st Avenue to Gillespie Dam)
10-1	Buttes Dam and Reservoir (without regulatory storage)
10-2	Buttes Dam and Reservoir (with regulatory storage)
11-1	Tat Momolikot Reoperation
11-2	Tat Momolikot Canal
12-1	Florence Dam and Reservoir
12-2	Florence Dam and Reservoir (in conjunction with Buttes Dam and Reservoir)
13-1	Water Exchange with Salt River Project
14-1	Water Exchange with MCMWCD #1

This appendix describes the methodology used in assessing impacts and evaluating effects of the project actions. The methodology was developed in compliance with Principles and Standards for Planning Water and Related Land Resources (Water Resources Council, 1973), regulations of the Corps of Engineers, and instructions of the Water and Power Resources Service.

The level of the data and detail of the assessment are in accordance with the decision-making requirements of this stage (Stage II) of the CAWCS planning process. During Stage II, competing elements will be screened, with the best elements carried forward into systems, and the systems will be evaluated, with the best systems carried forward into Stage III as plans. Both the data base and the scope of the assessment will be expanded as the planning process passes through successive iterations involving evaluation of plans and preparation of an environmental impact statement.

1.2 GENERAL ANALYTICAL PROCEDURE

The general analytical procedure used to determine the environmental and socioeconomic consequences of the project actions includes five sequential steps: 1) identification of issues, 2) inventory of existing conditions, 3) projection of future-without-the-project conditions, 4) impact assessment, and 5) effects evaluation.

Environmental and socioeconomic issues relating to the CAWCS were identified and presented in earlier working papers. The sources of information on issues included governmental and private agencies and organizations; individuals in the private sector; the Governor's Advisory Committee; the Technical Agency Group; the project's public involvement program; newspaper articles; and comments on the Orme Dam Draft Environmental Impact Statement.

Environmental and socioeconomic baseline inventories were prepared as working papers. As with other steps in the assessment, the inventories were developed to a level of detail appropriate for this stage in the CAWCS. The inventories were based primarily on secondary data, supplemented by the data available from the ongoing studies of the project's technical team.

The future without the project is a projection of baseline conditions for each of the elements assuming that the CAWCS project actions are not implemented. It represents the most probable environmental, social, and economic conditions that are expected to prevail in the year 2000. The procedure for developing these projections is discussed in Section 2.0 of this report.

Environmental, social, and economic impacts are measurable changes expected to occur as a result of an action. Impacts are expressed as the difference between the future condition without the project and the future condition with the project. The basic assessment procedure, described in more detail in Section 3.0, follows the general guidelines for impact assessment outlined in the Water and Power Resources Service's manual, Environmental Quality Assessment in Multi-Objective Planning. The procedure consists of an evaluation of components (environmental and socioeconomic disciplines), each utilizing a set of assessment categories.

The assessment categories (such as terrestrial habitat, mineral resources, archaeological sites, etc.) were selected primarily for their usefulness as indicators of impacts likely to be caused by the project actions, and they reflect the issues and principal technical concerns within each component. As with other steps in the planning process, the level of detail (number of categories) will be expanded in future iterations to ultimately meet the required level of detail called for in the preparation of an environmental impact statement.

The effects evaluation is the final step in the analysis of environmental and socioeconomic consequences of the project actions. While the impact is the measurable change in a category caused by an action, the effect is the interpretation of the importance of the impact. Effects were determined on the basis of a set of criteria developed for each category by the technical team in consultation with the Water and Power Resources Service, the Corps of Engineers, and other State, Federal, and local agencies. The effects criteria are described in Section 4.0.

1.3 PREPARERS OF THIS REPORT

This methodology volume was prepared by Dames & Moore under Contract No. 9-07-30-V0053 for the Water and Power Resources Service, U.S. Department of the Interior. Members of the study team who contributed to preparation of this report include:

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2.0 FUTURE WITHOUT THE PROJECT

2.0 FUTURE WITHOUT THE PROJECT

2.1 PROCEDURES

Principles and Standards for Planning Water and Related Land Resources (Water Resources Council, 1973) calls for the projection of the most probable future condition without the project for the purpose of assessing impacts. An impact is the measurable change caused by an action, and it is expressed as the difference between the future condition without the project and the future condition with the project.

The most probable future without the project in reference to environmental, social, and economic parameters is established by identifying the most probable causes of change and predicting the change these causes will have on the existing baseline conditions. The prediction of future change requires the establishment of a set of assumptions that are applied to each parameter.

2.2 ASSUMPTIONS

For this phase of the study, site-specific assumptions that could affect the land, air, and water resources of the impact areas of the study elements were defined. Assumptions for socioeconomic categories were developed for near-site areas and for the region, as required by the categories.

The year 2000 was used as the target date for the assumptions. This date was chosen primarily because of the high degree of reliability

it offered for forecasting future conditions. A number of regional plans use the year 2000 as the target date, providing a solid planning base for the future-without projections in this study. In later phases of the study, future-without projections will be developed for a longer time-frame, i.e., to the year 2035 and ultimately to the year 2100.

In developing the assumptions, agency projections, plans, and programs that can reasonably be expected to be implemented in the next 20 years were reviewed in light of their potential effects on the resource base of the elements. ("Reasonable to expect" refers to plans or programs that are approved, funded, or otherwise in such an advanced planning stage that their implementation is highly likely.)

For the assumptions, the whole range of causes that tend to alter existing conditions was examined. Among these causes are population growth, mining activities, transportation systems, power systems, recreation facilities, water resource developments, changes in land ownership and use, and regulations affecting resource use. The assumptions were developed as a joint effort among the project management and technical teams of Dames & Moore, working in conjunction with the management and technical staffs of the Water and Power Resources Service and the Corps of Engineers.

2.3 FUTURE-WITHOUT CONDITIONS

The most probable future-without conditions for the year 2000 were established by predicting the change that is expected to occur in each of the impact categories as a direct or indirect result of the

assumptions. (For example, population expansion directly affects land use, which in turn affects recreational use, which in turn affects archaeological sites through increased vandalism.)

The most probable future-without conditions for each component are presented in Section 3.0 of each element impact and effect report. The assumptions are listed in Table 3-1 of each report. The description of the future-without for the components (environmental and socioeconomic disciplines) are presented concisely; only the cause and effect in baseline conditions are referenced. The specific future-without conditions for the assessment categories are shown in the impact and effects tables in Section 4.0 of each report.

3.0 IMPACT ASSESSMENT

3.0 IMPACT ASSESSMENT

3.1 GENERAL PROCEDURE

The impact assessment procedure used for Stage II of the CAWCS follows closely that developed by Battelle - Columbus Laboratories for the Water and Power Resources Service in the manual, Environmental Quality Assessment in Multiobjective Planning (1977). This procedure uses a hierarchical system of four levels of information:

- Components (disciplines)
- Categories (classses within components)
- Factors (specific attributes within categories)
- Measurements (data)

For purposes of this assessment, a limited number of categories and factors were selected for analysis. These categories and factors were chosen to:

- reflect the principal issues and technical concerns in the component
- serve as indicators of impacts likely to be caused by the project actions
- provide useful and relevant information to assist decision-makers in evaluating elements and systems in Stage II of the CAWCS.

The categories and factors selected for the assessment were developed through the coordinated efforts of the project's technical and management teams and those of the Water and Power Resources Service and the Corps of Engineers. A more comprehensive assessment involving a wide selection

of categories and factors will take place in Stage III when more technical data are available and the project actions are defined in greater detail.

Once the categories and factors for assessment were selected, the following procedure was followed. For each category, factors were measured for: (1) the existing condition, (2) the future-without-project condition, and (3) the future-with-project condition. The impact, which is the measurable difference between the future-without and the future-with condition, was then determined. Within the data limitations of this stage of the study (primarily secondary data, supplemented with field data from ongoing studies), the factors were measured in physical dimensions (acres of terrestrial habitat, number of archaeological sites, miles of shoreline, decibels, concentrations of pollutants, etc.).

In each report on impacts and effects of elements, the product of the assessment consists of a table summarizing the impact data for the categories in the component and a brief narrative describing impacts and effects. A sample table is provided in Table 3-1.

For each project action under study, there are a number of options. Most of these options have to do with the size of the element, and they are indicated by a letter (A, B, C) added to the number designation of the element. For example, New Waddell Dam and Reservoir (I.D. #7-2) has three options: 500,000 acre-feet of storage (Project Action A), 300,000 acre-feet of storage (Project Action B), and 157,000 acre-feet of storage (Project Action C). In general, it is assumed that the different options do not affect construction impacts, but they do affect operation impacts. Where the construction impacts are sensitive to size differences, these are also reported.

For environmental components, impacts are assessed within a limited geographic area, which is designated in the project action description. The boundaries of the impact area have been drawn 1 mile from the maximum area of inundation for elements including resevoirs and 1/2 mile beyond the construction zone for levees and channels. For social and economic components, impacts extend beyond these boundaries into near-site areas and the region.

In the following subsections, the categories and factors used in the various components are described.

TABLE 3-1

SAMPLE IMPACTS AND EFFECTS TABLE

Category	Existing Condition	Future Without Project	Future With Project				Impact				Effect			
			Construction	Operation			Construction	Operation			Construction	Operation		
				A	B	C		A	B	C		A	B	C
Category														
Factor														
Factor														
Factor														
Category														
Factor														
Factor														
Factor														
Category														
Factor														
Factor														
Factor														

3.2 GEOLOGY AND SOILS

The categories and factor measurements selected for impact assessment in the component of geology and soils include:

- Mineral Resources - number of deposits
- Mineral Collecting - number of sites
- Unique Geological Areas - number of sites
- Prime Farmland - acres of prime farmland
- Soil Erosion - surface acres

The assessment of impacts to mineral resources is largely generic based on areas where deposits are known to occur. The grade and quantity of the deposits are used in the assessment when these are known. Impacts to mineral collecting areas and unique geological areas are assessed in terms of the number of sites affected by an action. Impacts to prime farmland involve the loss or protection of areas designated as prime farmland by the Soil Conservation Service. Soil erosion impacts are assessed in terms of the acreage affected (increase or decrease in erosion) and the erosion hazard of the soils.

The effects criteria used for each of these categories are described in Section 4.2 of this report.

3.3 WATER RESOURCES

Project actions may potentially affect both water quantity and water quality. The increased quantity of water made available by regulatory storage at the various sites under study is a significant benefit to the relatively arid areas of central Arizona. These benefits are shown in the economics component of this assessment and are expressed in terms of additional agricultural acreage irrigated and increased agricultural income and employment.

Three potential water quality categories were considered: water quality standards, salt loading, and limnology. The impacts of regulatory storage on regional salt loading and limnology will be analyzed later in the study. Water quality standards were examined in light of the potential impact of the project actions on constituents for which numerical criteria have been established by the U.S. Environmental Protection Agency (EPA). For purposes of this assessment, total dissolved solids (TDS) was chosen as the factor for measuring impacts in water quality.

Two major considerations led to the choice of TDS as the factor for tracing water quality impacts. First, TDS represents the sum total of all constitutents dissolved in the water. With only a few exceptions, such as temperature, suspended solids, and bacteriological contaminants, the concentration of TDS in the water reflects the quality of the water. Second, TDS concentrations in Colorado River water are higher than concentrations in Agua Fria, Salt, and Verde River water (Table 3-2), and therefore TDS offers a means for assessing any potential degradation of

TABLE 3-2

AVERAGE TOTAL DISSOLVED SOLIDS CONCENTRATIONS
FOR SURFACE WATER IN CAWCS AREA

Location	TDS (mg/l)
Lake Pleasant[a]	266
Verde River Below Bartlett Dam[b]	265
Salt River Below Stewart Mountain Dam[b]	630
Confluence Mix[c]	473
Gila River at Kelvin[b]	1,137
Colorado River Below Parker Dam[b]	722
CAP Water in Central Arizona[d]	747-755

[a]January 1, 1971 - December 31, 1972 and one day sample in 1976.
[b]National Stream Quality Accounting Network (NASQAN), U.S. Geological Survey, 1980; Period of Record, March, 1975 - September, 1979
[c]Weighted Average Using U.S. Geological Survey Streamflow Data.
[d]U.S. Water and Power Resource Service, 1980.

water quality in these surface water sources as a result of mixing of waters in regulatory storage reservoirs.

When water from the Colorado River is mixed with a local source in a regulatory storage reservoir, there could be a change not only in the quality of the natural surface water delivered through the existing system, but also a change in the quality of the CAP water. For this reason, water quality impacts are assessed in two categories: CAP water quality and natural surface water quality. For both categories, TDS is the factor used for measuring the impact.

Applicable EPA criteria for TDS include the recommended criterion of 500 mg/l for drinking water and for surface water. In addition, EPA crop irrigation criteria indicate that irrigation water containing up to 500 mg/l TDS generally will not cause any detrimental effects. For water with TDS concentrations from 500 to 1,000 mg/l, crops with low salt tolerance may show a detrimental effect. Irrigation water that contains over 1,000 mg/l TDS may have adverse effects on many crops and requires careful management practices.

A weighted average has been used to determine the changes in TDS concentrations brought about by regulatory storage. This weighted average uses the average TDS concentration at the site for both the CAP water and the natural surface water. The concentrations of TDS in Colorado River water at various points along the CAP aqueduct were supplied by the Water and Power Resources Service. Representative TDS concentrations for natural surface flows in the study area were obtained from the National Stream Quality Accounting Network (NASQAN) operated by the U.S. Geological Survey. Concentrations of TDS in the Agua Fria River and Lake Pleasant

were estimated from data reported by the Maricopa County Municipal Water Conservation District #1 and by the Water and Power Resources Service. For sites at or below the confluence of the Salt and Verde Rivers, U.S. Geological Survey streamflow records were used to determine a weighted average of the confluence water TDS (Table 3-2).

The changes in the TDS concentration of the water delivered subsequent to regulatory storage mixing are the impacts which are assessed during this stage of the study. The effects criteria applied to these changes are described in Section 4.3 of this report.

3.4 AIR RESOURCES

In order to define pertinent air quality categories, various materials related to air quality issues were researched. Of primary importance were the Arizona and National Ambient Air Quality Standards (NAAQS), which list specific air pollutants and respective legal ambient concentration limits (Table 3-3). Individuals in various governmental air quality agencies were also contacted to obtain their opinions on identification of air quality categories. Finally, regulations dealing with emissions of air pollutants were referenced. As a result, total suspended particulates (TSP) were ultimately considered a single category, with the remaining pollutants being grouped to form another single category.

In assessing impacts, gross emissions of TSP during construction and operational stages were estimated from assumed emission factors and construction actions. These were then modified to reflect project size and required dust suppression practices. The resultant emission figures were subjectively compared with similar data in the nonattainment area plan for TSP to determine an approximate ambient concentration.

The unit of measure used to determine change in TSP, sulfur dioxide, and nitrogen dioxide is micrograms per cubic meter; for carbon monoxide it is milligrams per cubic meter; and for ozone it is tons per day.

TABLE 3-3

AIR QUALITY STANDARDS

Pollutant	Averaging Time	Arizona Standard[a]	Federal Standards[b] Primary	Federal Standards[b] Secondary
Carbon Monoxide	1-hour	50	40	40
	8-hour			
Hydrocarbons	3-hour (6-9 a.m.)	160	160	160
Nitrogen dioxide	Annual	100	100	100
Oxidants (ozone)[c]	1-hour	160	235	235
Particulates	24-hour	150	260	150
	Annual (Geom. Mean)	75	75	60
Sulfur dioxide	3-hour	1,300	--	1,300
	24-hour	365	365	--
	Annual	80	80	--
Lead	Calendar quarter	1.5	1.5	1.5

NOTE: Units are ug/m^3 except for carbon monoxide which has units of mg/m3

[a]Not to be exceeded more than once per year.
[b]Not to be exceeded more than once per year except, in the case of ozone, not to be exceeded more than once per year based on a 3-year running average.
[c]Federal standards specify ozone.

Source: ADHS, 1979[a,b]

3.5 ACOUSTICS

The impacts of acoustics are assessed in the categories of noise on recreation areas, on residential areas, and on wildlife.

In the assessment of impacts, anticipated noise levels were determined from equipment suppliers and recorded data in the Dames & Moore files. These sound levels are then compared with the future-without conditions to determine impacts. Effects criteria are described in Section 4.5.

3.5.1 Construction Noise

The major noise-producing construction activities at the various dam sites will include: borrow pit excavation; dam and spillway excavation and construction; and construction of canals, pumping plants, and transmission line facilities. The "noisiest" period of construction is anticipated during excavation of borrow materials, with an estimated equivalent sound level, L_{eq}, of 73 dB at 1,000 feet from the center of activity. Typical construction equipment, number of units, usage factors, and sound level associated with each are shown in Table 3-4.

Some blasting will be required during the removal of the borrow materials. The over-pressue created from these blasts depends largely on the weight of explosives detonated and on meteorological conditions. Measurement data compiled by Dames & Moore indicate that the impulse noise level produced at 1,000 feet from the center of blasting might be as high as 91 dB. This over-pressure level exists for a duration

TABLE 3-4

BORROW PIT EQUIPMENT, USAGE FACTORS, AND SOUND LEVELS

Equipment[a]	Sound Level at 50 ft in dB	Number of Units[a]	Usage Factor[b]	References
Holland Traveling Belt Loader with 2 Cat D-9's	92	2	.31	c
Dart/Wabco 13DS 120-Ton Bottom Dump Hauler	88	7	.26	e
Cat 660/Athey 100-Ton Bottom Dump Hauler	88	4	.26	e
International/Athey PW 350 100-Ton Bottom Dump Hauler	88	1	.26	e
Off-Highway Trucks	88	14	.26	d
International 3400 and Cat 988C Front End Loaders	91	2	.10	c
Cat 631C Scraper	91	1	.24	c
Cat 641 Scraper	91	1	.24	c
Cat 651 Scraper	91	1	.24	c
Cat 633 Self-Loading Scraper	91	3	.24	c
Cat D9 Dozer	89	3	.31	c
Cat D8 Dozer	88	2	.31	c

Equivalent Sound Level, L_{eq} (total), at 1,000 ft. = 73 dB.

[a]Reference: Luna, D., project manager for Cave Butte Dam construction, 1979. "Three Spreads Push Long Haul Dam."

[b]Usage Factors represent the time equipment is operating at its noisiest mode.

[c]Data Source: U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, April 1977. "Draft-Construction Site Noise Control Cost-Benefit Estimating Manual," Champaign, Illinois.

[d]Data Source: U.S. Environmental Protection Agency, December 1975. "Noise Emission Standards for Construction Equipment: Background Document for Portable Air Compressors," Office of Noise Abatement and Control, Washington, D.C.

[e]Data Source: Dames & Moore files and estimates.

of under 1 second and therefore does not provide hearing damage risk at distance receptors outside the borrow area. An impulsive noise level of less than 140 dB is acceptable by OSHA standards (Federal Register, 20 May 1969).

The contribution of dam and spillway excavation and construction is shown in Table 3-5. It is estimated that during the "noisiest" period of dam construction, the equivalent sound level, L_{eq}, will reach 72 dB at 1,000 feet from the center of the construction activities.

Widening or construction of access and haul roads is estimated to result in an equivalent sound level of 63 dB at 1,000 feet from the center of the excavation activity (U.S. Environmental Protection Agency, 1974). Traffic along haul roads within the borrow pit has been analyzed along with other borrow pit activities. Traffic along access roads to the site is not anticipated to significantly increase ambient sound levels in these areas, with most materials generated at the site, thereby minimizing traffic noise impacts.

Estimated equipment usage factors and sound levels associated with construction of transmission lines are shown in Table 3-6. Construction activities will generally fall within the tower area of the right-of-way, with the "noisiest" period occurring during tower foundation construction, tower assembly, and erection. Ground clearing and road construction will result in an equivalent sound level of 58 dB at 1,000 feet from the center of construction activity (U.S. Environmental Protection Agency, 1977). The transmission tower construction sound level is estimated to be 61dB at 1,000 feet from the center of construction activity.

TABLE 3-5

DAM AND SPILLWAY EXCAVATION AND CONSTRUCTION EQUIPMENT, USAGE FACTORS, AND SOUND LEVELS

Equipment[a]	Sound Level at 50 ft in dB	Number of Units[a]	Usage Factor[b]	References
Raygo Grader	81	1	.80	c
Cat 824 Compactor	91	1	.10	c
Cat 825 Tamper	99	1	.10	f
Cat 641 Drawn 10,000-Gal. Sprinklers	89	2	.09	c
John Deere JD 500 Backhoe	85	1	.16	d
Gradall 1000 Crane	88	1	.02	e
Insley 35-Ton Crane	88	1	.02	e
Rock Drills, Portable Engine	88	2	.05	e
Cat D-8 Dozer	88	1	.31	c
Bottom-Dump Haulers	88	12	.26	f
Off-Highway Trucks	88	14	.26	d
Concrete Batch Plant	83	1	.10	g

Equivalent Sound Level, L_{eq} (total), at 1,000 ft. = 72 dB.

[a]Reference: Luna, D., project manager for Cave Butte Dam construction, 1979. "Three Spreads Push Long Haul Dam."

[b]Usage Factors represent the time equipment is operating at its noisiest mode.

[c]Data Source: U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, April 1977. "Draft-Construction Site Noise Control Cost-Benefit Estimating Manual," Champaign, Illinois.

[d]Data Source: U.S. Environmental Protection Agency, December 1975. "Noise Emission Standards for Construction Equipment: Background Document for Portable Air Compressors," Office of Noise Abatement and Control, Washington, D.C.

[e]Data Source: Dames & Moore files and estimates.

TABLE 3-6

TRANSMISSION LINE CONSTRUCTION EQUIPMENT[a]
USAGE FACTORS, AND SOUND LEVELS

Equipment[a]	Sound Level at 50 ft in dB	Number of Units[a]	Usage Factor[c,d]
Air Compressor	67	3	.98
Concrete Mixer, Truck Mounted	78	1	.40
Crane, Mobile (15-20 Ton)	83	1	.10
Crane, Mobile (50 Ton)	88	1	.10
Crawler Tractor, 29-199	72	1	.51
Crawler Tractor, 200-450	78	1	.10
Dozer	82	2	.40
Paving Breaker, PP>70	85	1	.07
Pneumatic Tools	85	2	.10
Pulling Machine	78	1	1.00
Tensioning Machine	78	1	1.00
Truck, Mounted w/Boring Equip.	78	2	.05
Truck, Flat Bed	78	2	.04
Truck, Rear Dump	78	1	.02
Truck, Pick-Up & 4 WD	77	10	.10
Wheeled Tractor	72	1	.66

Equivalent Sound Level, L_{eq} (total), at 1,000 ft. = 61 dB.

[a]Reference: Wirth Associates, 1979.
[b]Reference: U.S. Environmental Protection Agency, 1977b.
[c]Reference: U.S. Environmental Protection Agency, 1975.
[d]Reference: U.S. Army Corps of Engineers, 1977, and Dames & Moore estimates. Usage factors represent the time equipment is operating at its noisiest mode.

3.5.2 Operation Noise

Transmission lines and pumping plants are the major sources of noise during the operation phase. Information based on extensive conductor testing indicates measured levels of 50 to 60 dB at 100 feet from transmission lines under extreme meteorological conditions (Perry, 1976). Pumping plant operations are anticipated to be muffled, with day-night sound levels between 50 and 60 dB within 50 feet of the plant, based on previous measurements by Dames & Moore at similar facilities.

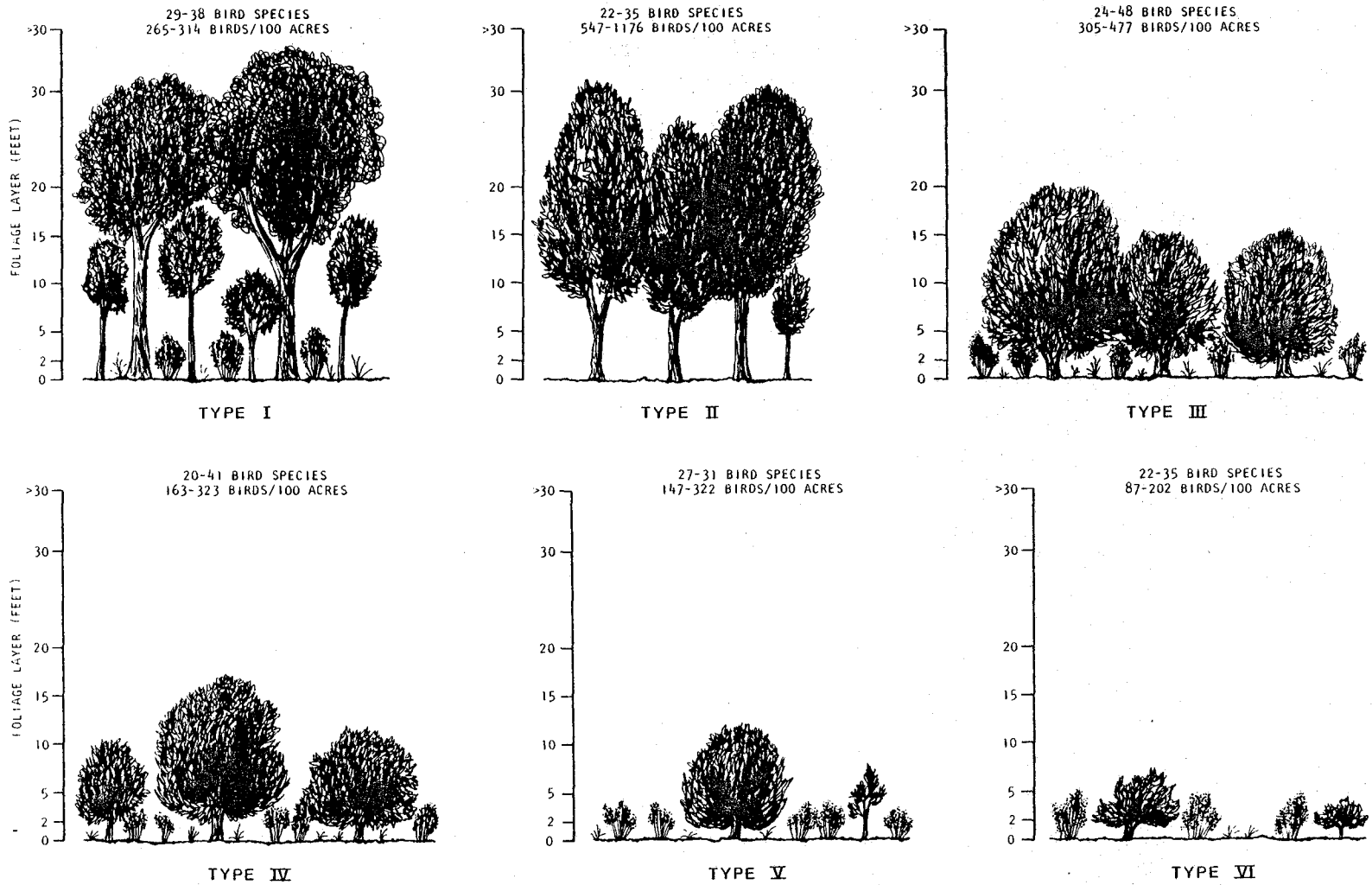
3.6 BIOLOGICAL RESOURCES

Biological resources are assessed in three categories: terrestrial habitat, aquatic habitat, and threatened and endangered species.

In the category of terrestrial habitat, the magnitude of the impact is measured in terms of acres of habitat lost or gained as the result of an action. The factors (habitats) in the category include: paloverde-mixed cacti series, blue paloverde-ironwood association, velvet mesquite association, mixed scrub series, saltcedar association, river and adjacent non-vegetated sand and gravel bars, and urban and developed lands.

The construction impact is computed as the difference between the future-without condition for a particular habitat and the future-with condition following construction. For the operation impact, the future-without condition is defined as the future-without-operation (i.e., the future-without-operation condition incorporates changes that have occurred as a result of construction.

In addition to changes in the quantity of the various habitats, impacts include considerations of general ecological quality. For this assessment, the quality of the habitats is based on the diversity and density of wildlife associated with structural types of vegetation. Studies on the Lower Colorado River (Anderson, et al., 1977) demonstrate a strong correlation between bird and rodent diversity and structural types of riparian vegetation. Also, bird diversity of desert areas has been found to vary according to the life-form of the vegetation (Tomoff, 1971; Raitt and Maze, 1968; Balda, 1967). Figure 3-1 depicts the riparian



NOTE: RANGE OF NUMBER OF SPECIES AND BIRD DENSITIES REPRESENT SAMPLES FROM DIFFERENT VEGETATION COMMUNITIES.

SOURCE: ANDERSON, ENGEL-WILSON, WELLS AND OHMART 1977. ANDERSON AND OHMART 1977.

FIGURE 3-1
RIPARIAN VEGETATION STRUCTURAL TYPES AND BIRD DENSITY

CENTRAL ARIZONA WATER CONTROL STUDY

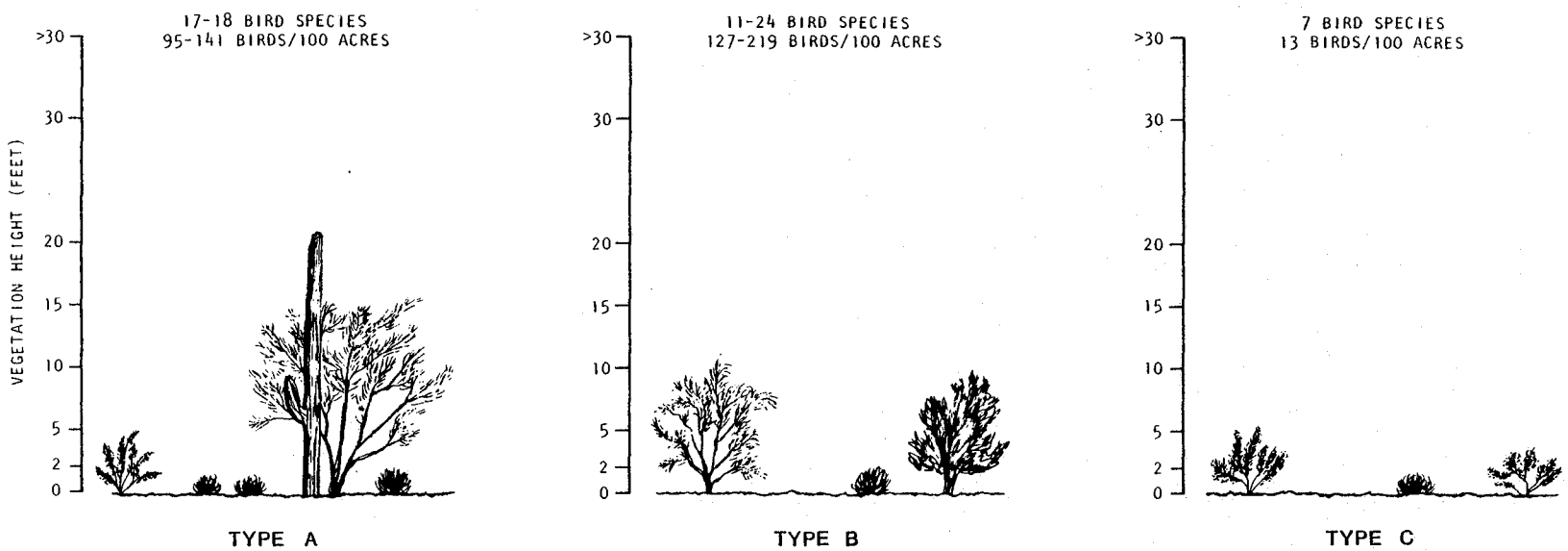
vegetation structural types I through VI and the associated bird species richness and density (sampled during breeding seasons). Figure 3-2 shows desert life-form types and associated bird species richness and density (again sampled during breeding seasons).

The quantitative aspect of the impact in terrestrial habitat is reported in tabular form in Section 4.6 of the various reports on the impacts and effects of elements, and the impact direction, impact duration, and quality of resource affected are treated in the narrative.

The impact on aquatic habitat primarily concerns the replacement of (or loss of) existing flowing stream habitat by nonflowing aquatic habitat which will be created by the various impoundments. The impact magnitude is computed in the same manner as that of terrestrial habitat, but the units are river-miles for flowing stream and surface-acres/acre-feet for nonflowing aquatic habitat. Direction, duration, and quality of resource affected are treated in the assessment narrative.

Impacts to threatened and endangered species relate to direct gains or losses of individuals and to the disruption and modification of preferred habitat. Preferred habitat here means habitat which threatened or endangered species rely on for their existence. Impacts to threatened and endangered species are quantified in terms of preferred habitat acreage modification and/or numbers of individuals or breeding sites affected. Direction, duration, and quality of resource affected are treated in the assessment narrative.

The criteria used for evaluating and rating effects in biological resources are described in Section 4.6 of this report.



NOTE: RANGE OF NUMBER OF SPECIES AND BIRD DENSITIES REPRESENT SAMPLES FROM DIFFERENT VEGETATION COMMUNITIES.

SOURCE: DAMES & MOORE (ON FILE)

FIGURE 3-2

DESERT VEGETATION LIFE - FORM TYPES AND BIRD DENSITY

CENTRAL ARIZONA WATER CONTROL STUDY

3.7 LAND RESOURCES

The land resources impact assessment methodology includes three impact categories: land use, land ownership, and adjacent and proposed uses of land resources.

All land resources impact assessment values presented in this series of reports are estimated first-level impact assessment values that are based on preliminary engineering plans and secondary data sources. Most of the relevant information from secondary data sources is summarized in the October, 1979 CAWCS First Level Environmental Inventory Working Paper and the January, 1980 CAWCS First Level Environmental Future-Without Conditions Working Paper. The major secondary data bases utilized in this initial impact assessment study include:

> A set of 1972-73 1:24,000 orthophotographic map sheets of the various element impact areas from the Arizona State Land Department, and a set of 1:250,000, 1974 land use/land cover map sheets for the CAWCS area from the U.S. Geological Survey. These photographs and maps were used for determining generalized existing land use patterns and for determining compatibility of proposed actions with adjacent land use patterns.
>
> U.S. Forest Service ownership data for Tonto National Forest; a 1976 Maricopa County Planning Department Public Land Owenrship map and a set of 1972-78 ownership maps showing Bureau of Land Management national resource lands/Arizona State Land Department trust lands. These maps were utilized for determining generalized existing land ownership patterns.
>
> Major Federal, State and local governmental plans and programs and proposed private sector developments. These plans were utilized for analyzing the compatibility of proposed project actions with proposed area plans. These major area plans include:
>
> - Central Arizona Project

- Soil Conservation Prime Agricultural Land
- Maricopa Association of Governments 208 Plan
- Maricopa Association of Government's Guide for Regional Development
- Arizona State Urban Lands Task Force Report
- Arizona State Land Selection Task Force Report
- Indian Reservation Community Plans
- Private Large-Scale Development Plans
- Regional Plan for Tonto National Forest
- Proposed RARE II Plans for Wilderness and Scenic River Designations.

As the CAWCS proceeds, a more detailed and up-to-date land resource data base will be compiled and utilized for subsequent in-depth analysis of specific alternative flood control and regulatory storage plans. Additionally, potential secondary land use impacts (e.g., induced private development in the vicinity of new reservoir elements), possible mitigative actions (e..g, establishment of buffer areas) and potential multiple use concepts will be addressed in subsequent phases of study.

For the purposes of the initial first-level impact assessment study, the acreage within each designated project area that will directly be disturbed during construction of the proposed facilities is defined to include all lands that must be purchased for the facility and all lands located within required construction rights-of-way or easements. These construction-related lands are considered as urban/built-up lands for the designated project construction period. Similarly, areas within the designated project area that must be acquired for the operation of the proposed facility are defined to include all lands that will be inundated

under maximum operating levels, and the facility site and maintenance areas. These operation-related impacted lands are considered as water bodies and urban/built-up lands respectively, for the operational phase of the project action. For each of the project action descriptions, estimated acreages of the land area impacted by proposed construction and operation activities are provided.

The land use impact category is comprised of five general land use classifications: urban/built-up lands, agricultural lands, wetlands, water bodies and rangelands. Two additional land use classifications--forested lands and barren areas--that were previously included in the First Level Environmental Inventory and the First Level Environmental Future-Without Conditions Working Papers were dropped from the impact assessment categories because these land use patterns were not present to any significant extent (e.g., minimum continguous area of 10 acres) within the designated project areas. Various land uses which comprise the five general land use classifications have been defined as follows:

> Urban/built-up lands include construction-related areas; and residential, commercial, industrial, institutional, transportation and utility land uses.
>
> Agricultural lands are comprised of irrigated crop lands, orchards and feedlots.
>
> Wetlands are segments along river channels which support the growth of phreatophyte vegetation such as salt cedar.
>
> Water bodies include water-related non-vegetated lands along stream channels and surface water impoundments such as lakes.
>
> Rangelands are open desert areas having vegetative cover comprised of cacti, grasses and shrubs with occasional mesquite, ironwood or paloverde trees.

The land ownership impact category is comprised of three general land ownership classifications: public lands, public lands which have been reserved for an exclusive purpose, and privately-owned lands. Public lands include Federal lands such as the Tonto National Forest and the national resource lands which are managed by the U.S. Forest Service and the U.S. Bureau of Land Management. These public lands are typically managed for multiple purposes, including grazing, water conservation, mineral extraction and outdoor recreation. Reserved public lands are public lands which have been dedicated, withdrawn, set aside, or granted for a specific public purpose or program, such as Indian Reservations, Wilderness Areas, State trust lands, National Monuments, municipal park lands, etc. Such reserved public lands are generally not subject to disposition or change in use under the operation of public land laws. If such public lands are to be acquired for a proposed project action, major public decisions (e.g., Acts of Congress) will be required before such plans can be approved. Private lands include individual and corporate property holdings, and these lands are typically used for urban areas, agricultural production and mineral extraction.

The third category of potential impacts on the adjacent and the proposed use(s) of land resources is comprised of two general classifications: adjacent land use patterns within the designated project action impact zone, and proposed or designated area plans. For each proposed project action, the compatibility of the proposed construction and operation activities with the adjacent land resources within the designated project area are qualitatively assessed. Likewise, the

potential impacts of the project action on proposed or designated plans for areas within the project area are also qualititatively assessed.

The criteria used for evaluating and rating effects in land resources are described in Section 4.6.

3.8 RECREATION

The recreational impacts are assessed in six categories, presented in Table 3-7. The six categories have two organizing keys. One relates to whether the category is associated with facilities or resources. The other key organizes the categories as to their association with flat water, controlled-flow streams, or land.

The term "facilities" is used to connote structural/developed recreational installations. Examples of installations so defined are boat ramps, docks, campsites, and picnic sites. "Resources," on the other hand, refer to water bodies, their shoreline lengths, and land as open space. These resources constitute potential for recreational use. Typical activities that might be engaged in/on these resources include boating, swimming, tubing, fishing, and hiking.

The second key organizes impacts according to their relevance to flat water, controlled-flow streams, or land. Most facilities are assessed in terms of their numbers (e.g., number of campsites or boat ramps). Resources are measured either in length or area.

Information required to outline the existing and future-without conditions was derived from the October 1979, CAWCS First Level Environmental Inventory Working Paper, Volumes I and II, and the January 1980, CAWCS First Level Environmental Future-Without Conditions Working Paper. In addition, supplemental data were also assembled in order to derive an appropriate level of detail.

TABLE 3-7

RECREATION ASSESSMENT CATEGORIES

	Facilities[a]	Resources[b]
	Flat Water Facilities	Flat Water Resources
Flat-Water	o boat ramps o docks o marina o artificial beach	o water surface area (acres) o length of shoreline (miles)
	Controlled-Flow Stream Facilities	Controlled-Flow Stream Resources
Controlled-Flow Stream	o docks o artificial beach o boat ramps o marinas	o stream length (miles)
	Land-Related Facilities	Land-Related Resources
Land-Related	o campsites o picnic sites o trails o golf courses o courts (e.g., tennis, basketball) o marked fields o horse-related	o open space (acres)

[a]Facilities = Structural/developed recreational installations.
[b]Resources = Water bodies (e.g., lake surface and controlled flow stream segments) that represent the potential for recreational use.

3.9 CULTURAL RESOURCES

3.9.1 Archaeological Resources

Impacts to archaeological resources are assessed in the category of archaeological sites, with four evaluation factors: sherd and lithic scatters, one room sites, 2-5 room sites, 6+ room sites. In addition, note was made of any unique features occurring within these sites: e.g., ball courts, trash mounds, or platform mounds. The total acres of archaeological remains were determined per element.

Impacts were assessed for three stages of the project: construction, inundation, and operation and management. Construction includes all acreage disturbed by construction; inundation includes flooded areas and lake shore at the maximum pool evevation; operation and management includes all acreage in the impact area not included under construction or inundation impacts (i.e., the secondary impact zone - that area to be impacted due to increased accessibility and population volume).

In general, the quantity which appears as the unmitigated impact to archaeological resources in the impact assessment table was derived via the following procedure. The density per acre of each of the defined site types (factors) was computed for each sampling strata within an impact area. Impact areas were assessed as to what strata or combinations of strata they represented. Site frequencies were computed by multiplying impact acreage by appropriate site density estimates.

The consideration of the future-without specified in Principles and Standards is treated in a qualitative fashion in the section titled "Future-Without Conditions" in the individual impacts and effects reports. However, in the quantitative impact assessment, the archaeological resource base in the future without the project is regarded as being equivalent to that described for the existing condition. There are two primary reasons underlying this decision:

1) The difference between the future without the project and the existing condition is a qualitative difference rather than a quantitative difference. That is, while in most cases there may be a predictable change in the internal structure of individual sites, the overall number of sites will remain essentially unchanged.

2) Current legislation specific to the management of cultural resources requires that all impacts caused by a federally funded project be considered in an impact assessment, irrespective of a potential future condition. In developing a useful and relevant document for use by decision makers in the Central Arizona Water Control Study, it was considered advisable to work within the guidelines expressed in the pertinent cultural resource legislation.

3.9.2 Historical Resources

Impacts to historical resources are assessed in the category of historical sites. Assessment of impacts in this category is based on the following sources of change in the historical resource base:

(a) Deterioration or alteration of all or part of a property;

(b) Isolation from or alteration of its surrounding environment;

(c) Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;

(d) Transfer or sale of a federally-owned property without adequate conditions or restrictions regarding preservation, maintenance, or use; and

(e) Neglect of a property resulting in its deterioration or destruction (36 CFR Part 800.9)

Given these guidelines, impact assessment involves essentially the identification of changes in the quality or condition of a cultural property which may occur as a result of specific project actions. Such actions may involve construction-related activities, as well as the use and maintenance of water storage and flood control facilities and features.

In preparing an impact assessment for each of the Central Arizona Water Control Study elements under investigation, it is necessary to qualify the results of this assessment in several ways.

(1) Until such time as inventory sites can be visited and documented as a basis for significance evaluation, it must be assumed that all sites are potentially eligible for inclusion in the National Register.

(2) As indicated in all preceding deliverables, information concerning the present existence and condition of many of the inventory sites is unavailable, since the first level inventory is based on a review of existing historical and site file information.

(3) It is possible that descriptions of proposed actions at specific elements may change as more refined project specifications are developed. Should this occur, it may be necessary to modify the results of impact assessment accordingly.

(4) Any adverse effect determination regarding a particular cultural resource assumes that the site will be totally destroyed. As more reliable project and archaeological data become available, it may be possible to quantify the level or intensity of potential adverse effects.

(5) The potential for the mitigation of adverse effects through archaeological/historical data recovery and site documentation is not a factor during impact assessment.

3.10 ECONOMICS

Economic impacts of the proposed elements are assessed in four categories: project employment, project expenditures and income, water supply (agricultural income and employment), and flood damage reduction. The economic evaluation categories, factors, and units of measurement on which the impact assessment is based are presented in Table 3-8. It should be noted that the agriculture impacts are based on preliminary projections subject to revision upon completion of Abt Associates' working papers on water supplies and agriculture impacts and the Indian Distribution Division Report #4. Further, flood damage figures are to be forthcoming from The Natelson Company.

The data for Factors 1 and 3 (see Table 3-8) are obtained from the project action descriptions. The existing construction workforce is projected to be about 46,000 to 47,000 during the period of projected startup (late 1984) and over 50,000 by 1990.

Factors 3, 4, and 5 are calculated using the 1977 Water Resources Council's Guideline 5, Regional Multipliers. In this case Factor 4 equals Factor 3 times 2.716; Factor 5 equals Factor 4 times .236; and Factor 2 is derived from Factor 5 divided by a $20,000 average wage. This total project direct and indirect employment is allocated to individual years as a percent of expenditures in that year relative to the total project expenditures.

Determining the agricultural impacts of regulatory storage necessitates first setting down a conceptual framework within which

TABLE 3-8

ECONOMIC EVALUATION CATEGORIES, FACTORS, AND UNITS OF MEASUREMENT

Evaluation Category	Unit of Measurement
Project Construction and Operation Employment (Peak Year)	
1. Direct Project Employment	# Workers % Construction Work Force
2. Total Direct and Indirect Employment (including agriculture)	# Workers
Project Expenditures and Income (Total)	
3. Direct Project Expenditures	$
4. Total Regional Direct and Indirect Expenditures (including agriculture)	$
5. Total Regional Direct and Indirect Income (including agriculture)	$
Water Supply Impacts (Yearly)	
6. Projected CAWCS Regulatory Storage	Acre-Feet
7. Cost of Water	$
8. Agricultural Acreage (irrigated)	
Maricopa County	Acres
Pinal County	Acres
9. Agricultural Employment:	
Maricopa County	# Workers
Pinal County	# Workers
10. Agricultural Income:	
Maricopa County	$
Pinal County	$
Flood Damages	
11. Value Protected Relative to 100 Year Flood	$

impacts can be determined. Several considerations are important. These include:

- o Regulatory storage water will only be allocated to agricultural users in Central Arizona.
- o Under CAP, this water can only be used as a one-for-one replacement of groundwater withdrawals. Therefore, no new acreage will be supported by this action during the 50-year project life.
- o A user will need a delivery ststem to receive this water which will likely be built only if the use of other CAP water is anticipated.
- o Because the supply of regulatory storage water will be variable, the user must maintain groundwater pumping capabilities in order to keep acreage irrigated during periods of low supply.

Within these overall conditions the economic value of regulatory storage water for agriculture should, like any input to a production process, be valued by its marginal revenue product. This is the increased revenues generated by the inputs from an increased rate of usage. The marginal revenue product is then compared to the marginal cost to determine its optimum level of use.

In this case the marginal revenue product, hereafter referred to as economic value, can be examined in two ways: (1) as the value to the individual farmers, as measured by their increased income, and (2) as the value to Central Arizona as a whole as measured by the total change in direct and indirect expenditures (or revenues) and income.

Unfortunately, the actual analysis is not particularly simple because the use and value of regulatory storage water depends upon the profitability of agriculture and the cost of alternative water supplies, both of which vary by location and through time. Table 3-9 and Figure

TABLE 3-9

ALTERNATIVE SCENARIOS FOR VALUING
REGULATORY STORAGE (CAWCS) WATER IN AGRICULTURE
(At Any Point In Time)

Scenario	Economic Value Implications
1. CAWCS water costs more than alternative sources.	1. Will not be used in agriculture therefore no economic value.
2. CAWCS water is of equal or lower cost than alternative sources. and Both water costs are low enough to allow breakeven or profitable farming.	2. Value to farmers equals the differential in water costs times the amount of water provided. Value to society is the same as for farmers since no additional acreage is farmed.
3. CAWCS water is of equal or lower cost than alternative sources. and Both water costs are too high for profitable farming.	3. If farming continues at a loss the economic value of the water to farmers and society equals the differential in water costs. If no farming occurs the economic value is zero.
4. CAWCS water is of lower cost than alternative sources. and Current water is, at or before this time of project initiation, too expensive for profitable farming while CAWCS water allows profitable farming.	4. The whole income from farming can be attributed to new CAWCS water. In addition the direct agricultural expenditures (or revenues) and indirect and induced expenditures and income is the value to the whole Central Arizona Region.
5. CAWCS water is of lower costs than alternative sources. and At sometime in the future alternative costs become too expensive to allow profitable farming whereas substituting CAWCS water would allow profitable farming.	5. The economic value equals the differential in water costs times the amount of water provided up to the time when alternatives would no longer be profitable. Then the economic value equals the direct and indirect expenditures and incomes attributable to agricultural operations using CAWCS water.

3-3 present five scenarios of the type of situation that may be encountered by an individual farmer when considering the use of regulatory storage water. In these displays the "zero profit water price" is the price of water where agricultural acreage has no profitability. Water prices above this level, cetens paribus, will generally cause losses to be incurred while water prices below this level allow profits to be made.

In general, at any point in time, the economic value of the regulatory storage water, given the above-mentioned constraints, is equal to either the differential in water costs times the volume used in already profitable acreage, or to the total direct and indirect expenditures and income derived from agricultural operations supported by regulatory storage water in previously non-profitable acreage.

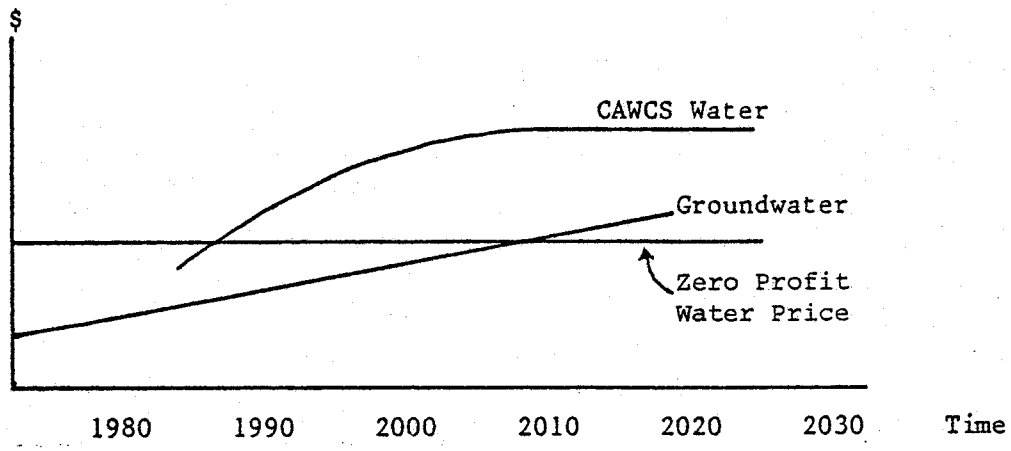
Two questions arise:

- o Is the regulatory storage water cheaper than alternative sources and if so, at what locations and in what time frames?
- o Would acreage exist which would be unprofitable (and perhaps be abandoned) which would become profitable with regulatory storage water, and, if so, at what locations and in what time frames?

At present we are in the process of analyzing these questions by examining groundwater withdrawal rates and prices, farm budgets, crop patterns, etc. throughout Central Arizona. It does appear that several areas will be able to convert nonprofitable acreage in future time periods to profitable acreage with regulatory storage water. However, because the analysis is not completed, we have for purposes of this assessment estimated that all regulatory storage water will be used to revive nonprofitable acreage. Further, we have assumed the geographic

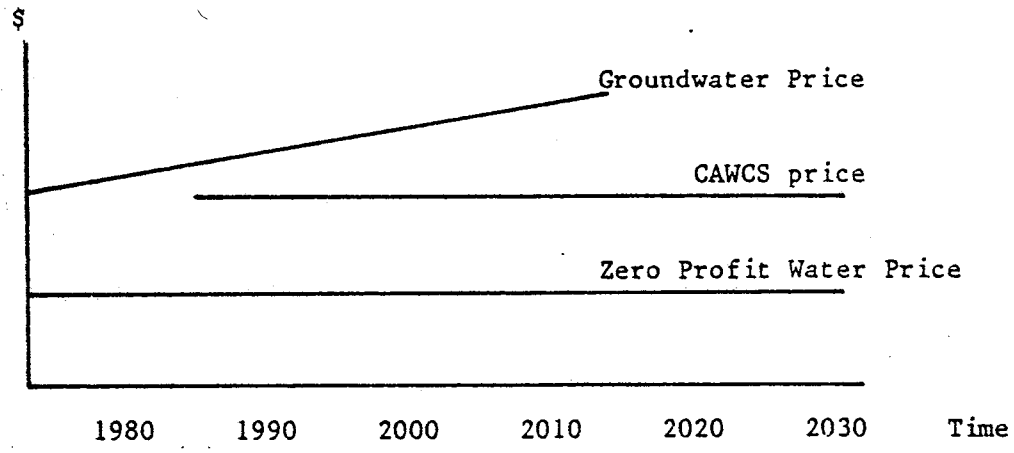
FIGURE 3-3

Scenario 1
(Constant $)



Implication: Never use CAWCS water. Economic value equals zero.

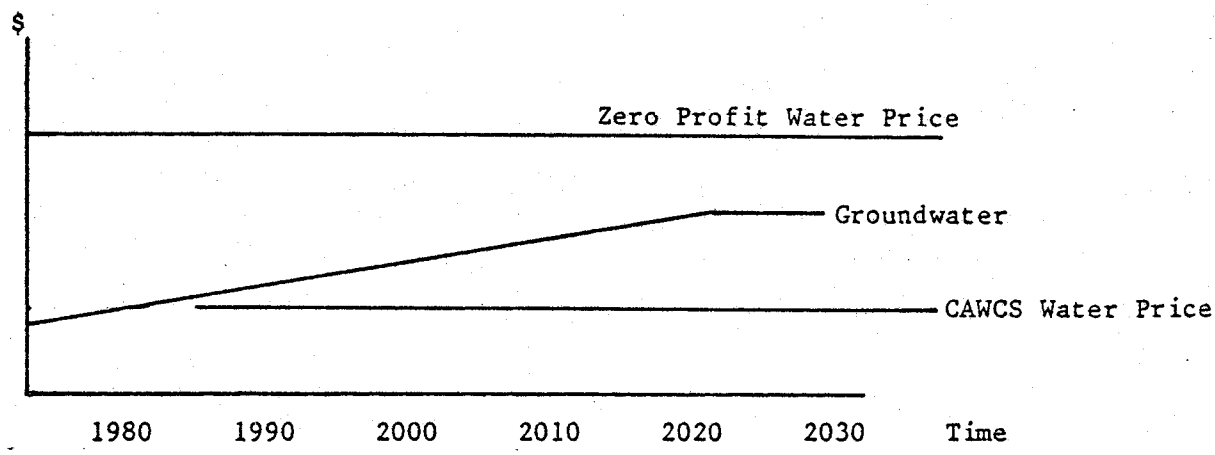
Scenario 2
(Constant $)



Implication: No agriculture or non-profitable agriculture. If agriculture continues then CAWCS economic value equals the differential in water price times CAWCS water usage.

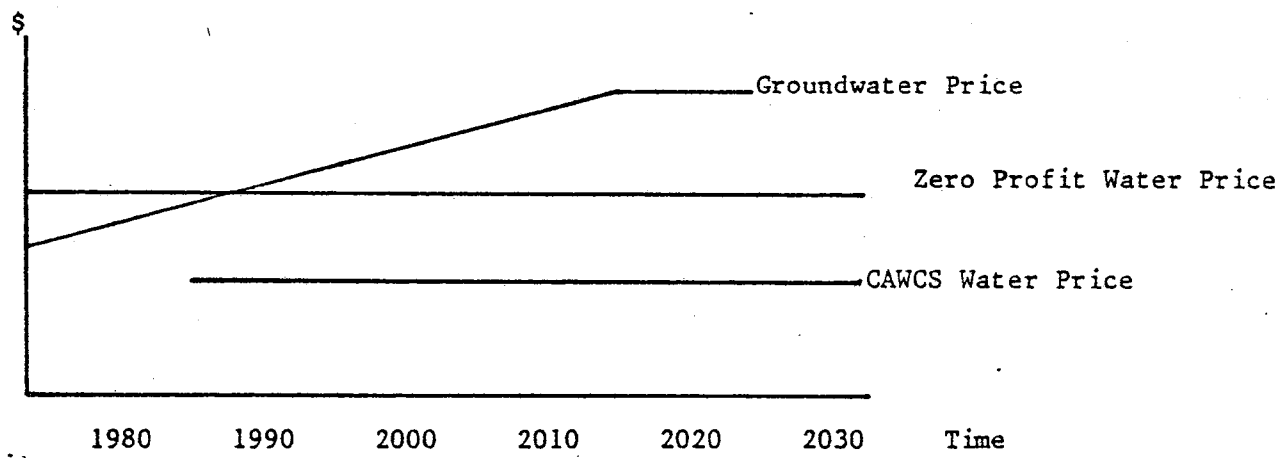
FIGURE 3-3 (Cont.)

Scenario 3
(Constant $)



Implication: Use CAWCS water. Economic value equals the water price differential times CAWCS water usage.

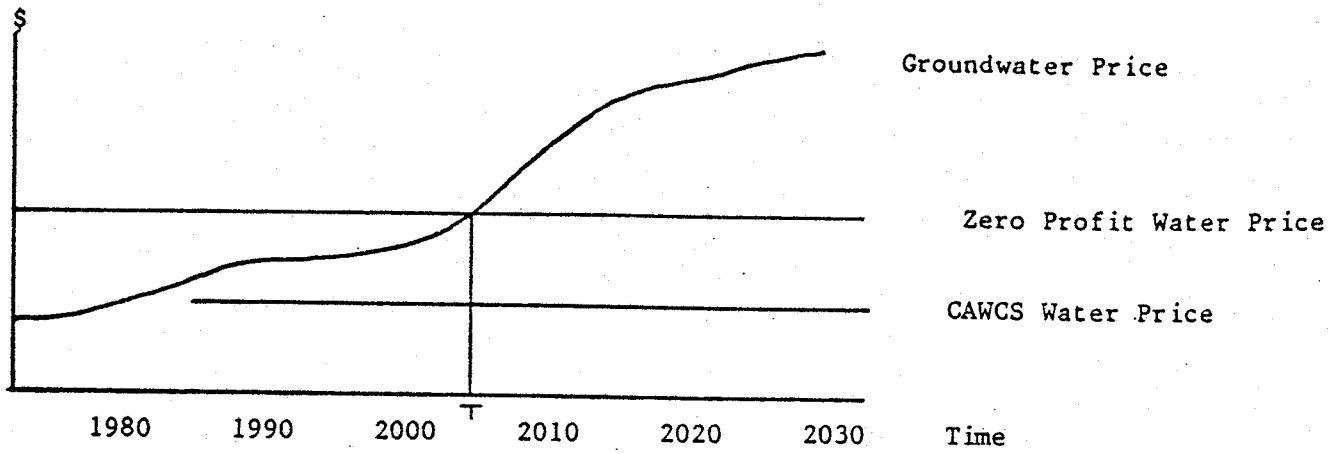
Scenario 4
(Constant $)



Implication: Use CAWCS water. Economic value equal the value of agriculture expenditures and income plus indirect and induced regional effect expenditures and income.

FIGURE 3-3 (Cont.)

Scenario 5
(Constant $)



Implication: Use CAWCS water. Economic value equals price differential times CAWCS water use up to time T plus the value of agriculture expenditures and income and indirect and induced regional expenditure and income effects after time T.

split of the regulatory storage water use and acreage will follow the other CAP agricultural water allocations. This equals roughly 33.7 percent to Maricopa County, 58.4 percent to Pinal County and 7.96 percent to Pima County.

Because the water allocations are not based upon need or willingness to pay, it is unlikely that all the regulatory storage water will go to actual or potentially unprofitable acreage. Rather, it is likely that a great deal of it will replace more expensive groundwater on already profitable acreage. Therefore, these figures represent the probable maximum estimate of the value of the additional water.

Another perspective on the effect and value of regulatory storage water is that this water will further reduce groundwater overdrafts, thereby creating additional water supply for future generations. Our preliminary estimates indicate that a supply of 100,000 acre-feet of additional water yearly will create a situation in 2035 where groundwater depth will be reached four years later with a maximum yearly savings in groundwater costs of less than $4 per acre-foot than would have occurred without regulatory storage. This stream of benefits over the 50-year time horizon discounted at a 6 percent rate yields a benefit in the vicinity of an additional $400,000. This amounts to less than 2 percent of the yearly value as described above and in detail below.

Evaluation Factors 1, 3, and 6 are from the project action descriptions. The agricultural figures are calculated as follows: total change in acreage equals the regulatory storage divided by 5.5 acre-feet/year/acre typical withdrawal. (Actual values range from 2.5 to 8.5 acre-feet/acre depending upon crops.) Changes in acreage are allocated

to Maricopa County (33.7 percent), Pinal County (58.4 percent), and Pima County (7.8 percent) reflecting their proposed shares of CAP agricultural water. Total change in employment is calculated at 1.2 percent of the change in acreage, representing a projected ratio of workers to acreage. This represents a 24 percent reduction from the current statewide ratio including unpaid household workers which is .0158 (Arizona Crop and Livestock Reporting Service, Arizona Agriculture Statistics, 1978). Income changes are then calculated as $15,000 times the increase in the number of workers (1977 statewide income was 283.3 million). Given statewide employment of 20,500 including unpaid household workers and proprietors, this averages just under $15,000 per employee (these figures average the highly divergent incomes of proprietors and hired help).

Both employment and income are allocated to counties in the same manner as was acreage supported by the additional water.

Factors 2, 4, and 5 each have two parts: a direct and induced agricultural part and a direct and induced operations part. These parts are added together to obtain the totals. The facilities operations part is calculated in the exact same fashion as described for project construction.

The agriculture calculations are figured by taking the total acreage supported by the additional water and multiplying by $650 per acre (reflecting approximate per acre cash receipts for cotton in Central Arizona during the period from 1977 to 1979, as reported in Arizona Agricultural Statistics, 1978. Upland cotton was chosen as it represents about 50 percent of the acreage in Central Arizona). This is then multiplied by the WRC cotton multiplier of 2.455 for BEA Area 162 to

obtain total direct, indirect, and induced expenditures. Total agricultural direct and indirect and induced incomes are derived by taking total expenditures multiplied by .29 representing the income component multiplier. Total agricultural direct and indirect induced employment is calculated by dividing total direct and indirect income by $15,000. Again, each agricultural figure is added to facility operations figures to achieve the totals for Factors 2 through 5.

Effects criteria for the factors within the economic categories are described in Section 4.10 of this report.

3.11 SOCIAL ASPECTS

The purpose of the social assessment is to assess the social impacts likely to occur as a result of implementing or not implementing various CAWCS water development plans. The procedures used are designed to meet the social assessment requirements of the Water Resources Council's Principles and Standards. The social analysis procedures for the CAWCS were designed jointly by members of the CAWCS study team and representatives of the Water and Power Resources Service (WPRS) and the U.S. Army Corps of Engineers.

The social analysis methodology is derived from procedures presented in the Social Assessment Manual (SAM) (Abt Associates, 1976). The methodology, however, has been modified to conform to the requirements of the Social Well-Being Account as stated in Reclamation Instructions. Further modifications have been made by CAWCS and WPRS team members to mold the process to meet the specific objectives of this study. The result has been to focus on the social impacts and effects caused by flood control and regulatory storage of CAP water and to deemphasize social phenomena, such as crime rates, etc., which probably are not significantly affected by these water projects.

3.11.1 Data Collection

The methodology utilizes both quantitative and descriptive data. The process consists of gathering information from primary and

secondary sources about social phenomena in the CAWCS area, analyzing the data, and presenting the findings.

Primary information is gathered through talks with representative community leaders and individuals with knowledge of specific areas or issues. A "snowball" technique is used to obtain names of persons with whom additional discussions are held. The process of talking with people continues until it is apparent that no new information is forthcoming on topics of interest to the social assessment. Care is taken to insure that dicussions are held with a broad cross section of geographic and interest group representatives. In addition, the public involvement process is used to obtain information on perceived social impacts and effects. The data obtained from primary sources are generally qualitative, which may restrict the types of measurement used in the analysis.

Secondary data sources include government and non-government reports (e.g., census data, housing block studies), newspaper articles, and other various types of documents. The secondary data are primarily quantitative, and are used extensively to define existing conditions in the CAWCS area.

Population statistics are from Maricopa Association of Governments (MAG) publications, from the Bureau of Reclamation Economic Assessment Model (BREAM) projections, and from The Natelson Company's estimates of the number of floodplain residents.

In compliance with OMB research clearance regulations, the methodology being utilized here relies on informal, unstructured discussions rather than on formalized interviews or surveys for the major source of primary data. A strength of this technique is that the trained

researcher is able to uncover and explore new topics of interest as opposed to the more formal survey which frequently restricts the researcher to a predetermined set of questions.

The data collection process has three waves. The first two, both of which have been completed, have focused on the gathering of baseline data and perceptions of the potential impacts of elements. The baseline data gathering was conducted so that community profiles of potentially impacted communities could be developed. The profiles followed the organization of social well-being categorizations as set forth in SAM. The perceptions of elements were those of community leaders who, incidently, also contributed information useful in the baseline existing condition profiles.

The remaining data collection effort is to assess potential impacts and social effects attributable to CAWCS systems. This major effort will focus, in part, on providing answers to specific questions, e.g., would there be support from people in rural areas for flood control measures in the floodplains through Phoenix. A second objective will be to seek reactions from potentially impacted people to the impact and social effects assessments devised by the staff. The particulars of the final data collection effort are still being developed.

3.11.2 Assessment Procedures

At this level of analysis, care was taken to limit the assessment to only those social categories which have a direct relationship with either regulatory storage of CAP water or flood control. The impact

area examined is limited to those geographic areas or groups which will be directly impacted by project actions.

The five social impact categories listed below are used in the evaluation of elements process:

1. Permanent Relocation--the number of persons permanently relocated as a result of construction of an element.

2. Inundation Relocation--the number of persons temporarily relocated (because of flooding or temporary construction effects).

3. Transportation Disruptions--the number of bridge closures, particularly over the Salt and Gila Rivers, that may cause social disruptions to persons on either side of the affected crossing.

4. Community Disruption--the number of communities or portions of communities that are inundated by periodic flooding.

5. Interruption of Service Delivery Systems--the number of services (e.g., telephone, public safety, etc) that are interrupted by periodic flooding.

Each of these categories is described in terms of existing conditions, future conditions without the project, and future conditions with the project. Under the future-with-project scenario, potential impacts and effects of both construction and operation are addressed.

The statements made concerning existing conditions are derived from the baseline socioeconomic report prepared by Abt Associates Inc. Additional specific information on the demographic characteristics of those living in the flood plains is being produced by The Natelson Company.

The primary areas impacted during the operation or functioning of a project will be downstream floodplains. Projections concerning

the social impacts in these areas are developed from data contained primarily in two sources: the future-without report prepared by Abt Associates, and population and land use projections developed by The Natelson Company and Battelle. Special attention is given to planned developments in relation to the floodplain. For example, knowledge about the number and size of bridges planned for crossing the Salt River is vital in determining the potential for flood-related transportation disruptions.

The number of persons residing within potential impact areas is estimated based on a projection of those who currently reside in the area. The projection is modified based on projected changes in land use.

The number of people who will be relocated by the construction of a project is based on estimates of the location of residents in the construction impact area, which is a defined area indicated in each project action desription.

Flood control and prevention measures will affect individual residents, entire communities, and service delivery systems within communities. Estimates are made from examining available plans and talking with individuals knowledgeable about specific communities about what conditions would be for the flood plain areas if floods could be controlled.

Individuals and communities located downstream from flood control elements could be significantly affected by the operation of those elements. Population estimates derived from projections of existing conditions and modified by estimates of land use in floodplains

are made for the number of people who would be affected by variations in flood control.

These include individuals who would be impacted by flooding if there were no controls; persons who in the future, based on extensive flood control measures, would be able to live in former floodplains; and those individuals who are dependent (economically and socially) on access to either side of the Salt or Gila Rivers. Projections of the number of people who will be located in former flood plain areas are being developed by The Natelson Company.

4.0 EFFECTS CRITERIA

4.0 EFFECTS CRITERIA

4.1 INTRODUCTION

Four dimensions were used in developing the effects evaluation: direction (adverse or beneficial), duration, and magnitude of the impact and quality of the resource affected. For each category in the impact assessment, principal investigators developed criteria based on these dimensions. The criteria were then used to rate effects as follows: high, medium, or low adverse; high, medium, or low beneficial; or no effect.

In the following sections the effects criteria for the categories in each component are presented. These criteria were developed by the principal investigators in the CAWCS in consultation with peers in the Water and Power Resources Service, U.S. Army Corps of Engineers, and other State, Federal, and local agencies. A listing of persons who participated in the development of the criteria may be found at the end of each of the sections that follow.

4.2 GEOLOGY AND SOILS

The effects criteria for geology and soils reflect the professional judgment of the study team and peers from the Arizona Bureau of Geology and Mineral Technology, the Arizona Department of Mineral Resources, the U.S. Army Corps of Engineers, the U.S. Soil Conservation Service, and the U.S. Water and Power Resources Service. A list of those who contributed to the development of the criteria is presented at the end of this section.

Mineral Resources

The mineral resources effects criteria for construction and operation are given in Table 4-1. All effects for mineral resources are considered adverse since any impact would result in a loss. The loss of (or loss of access to) a mineral resource site, if it is one of local significance with development potential, is considered of low significance. However, if it is the only site in Arizona, the loss is considered of high significance. The effect is considered short-term if the duration is for the construction and/or operation phases of the project; the effect is considered long-term if the duration is for a period beyond the operation phase of the project. The quality of the mineral resource is dependent upon the potential economic value of the resource which is based upon geologic descriptions of the area and upon present and past mining activity. If more than one economic mineral resource occurs in a project area, the one resulting in the highest impact/effect is considered.

Prime Farmland

The prime farmland effects criteria for construction and operation are given in Table 4-2. Effects for prime farmland are considered

TABLE 4-1

MINERAL RESOURCES -- EFFECTS CRITERIA FOR CONSTRUCTION AND OPERATION ACTIVITIES

	Low	Moderate	High
Direction	Adverse (-)	Adverse (-)	Adverse (-)
Magnitude	Mineral deposit of local (vicinity of project) significance with development potential	Mineral deposit of regional (in that portion of the state) significance with development potential	Mineral deposit of statewide significance with development potential
Duration	> 0 to 5 years construction phase	> 5 to 100 years operation phase	> 100 years
Quality	potentially low economic value	potentially moderate economic value	potentially high economic value

*To determine the overall environment effect, the significance of magnitude, duration, and quality are considered as equal. A rating of high is equal to 3; a medium is equal to 2; and a low is equal to 1. The values for the magnitude, duration, and quality are added together and the average is determined. The resultant value is then compared with the scale to determine the overall environmental effect. The direction of the effect is determined by the nature of the effect; that is, whether it is beneficial or adverse. The direction has no numerical value.

L	M	H
1.0 – 1.7	1.7 – 2.4	2.4 – 3.0

Example: Magnitude Low = 1
Duration Medium = 2 1 + 2 + 3 = 6
Quality High = 3

Average 6 ÷ 3 = 2 2 is Medium (from scale)

Direction Adverse (-)

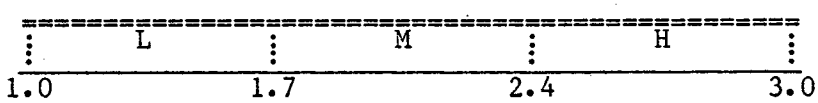
Effect = Medium Adverse (-M)

TABLE 4-2

PRIME FARMLAND -- EFFECTS CRITERIA FOR CONSTRUCTION AND OPERATION ACTIVITIES

	Low	Moderate	High
Direction	Beneficial (+) or Adverse (-)	Beneficial (+) or Adverse (-)	Beneficial (+) or Adverse (-)
Magnitude	> 0 to 10 acres	> 10 to < 100 acres	≥ 100 acres
Duration	0 to 2 years	> 2 to 10 years	> 10 years
Quality	Soil Conservation Service Capability Class III soil	Soil Conservation Service Capability Class II soil	Soil Conservation Service Capability Class I soil

*To determine the overall environmental effect, the significance of magnitude, duration, and quality are considered as equal. A rating of high is equal to 3; a medium is equal to 2; and a low is equal to 1. The values for the magnitude, duration, and quality are added together and the average is determined. The resultant value is then compared with the scale to determine the overall environmental effect. The direction of the effect is determined by the nature of the effect; that is, whether it is beneficial or adverse. The direction has no numerical value.



Example: Magnitude Low = 1
Duration Medium = 2 1 + 2 + 3 = 6
Quality High = 3

Average 6 ÷ 3 = 2 2 is Medium (from scale)

Direction Adverse (-)

Effect = Medium Adverse (-M)

adverse if the prime farmland is lost due to a project action; the effects are considered beneficial if the prime farmland is protected from loss due to a project action. A loss of (or the protection of) 100 acres of prime farmland is highly significant while a loss of (or protection of) 10 or fewer acres would be of low significance. The effect is considered short-term if the duration is for 10 years or less; the effect is considered long-term if the duration is for more than 10 years. These periods of duration were established by recommendations from the U.S. Soil Conservation Service (personal communication 4/22/80) and are based, in part, upon the economic importance of prime farmland. The quality of the prime farmland is based upon the capability class of the soil as defined by the Soil Conservation Service (U.S. Department of Agriculture, 1973). Soils of Capability Class I have few limitations that restrict their use for cultivation and other uses; soils of Capability Class II have some limitations that reduce the choice of plants or require moderate conservation practices; soils of Capability Class III have severe limitations that reduce the choice of plants and/or require special conservation practices. The loss of an area of prime farmland with soils of Capability Class I is considered of high significance while the loss of an area of prime farmland with soils of Capability Class III is considered of low significance.

Mineral Collecting

The mineral collecting effects criteria for construction and operation are given in Table 4-3. All effects for mineral collecting are considered adverse since any impact would result in a loss. A mineral collecting site or area is considered significant if it is one of 10 or

TABLE 4-3

MINERAL COLLECTING -- EFFECTS CRITERIA FOR CONSTRUCTION AND OPERATION ACTIVITIES

	Low	Moderate	High
Direction	Adverse (-)	Adverse (-)	Adverse (-)
Magnitude	mineral found at > 10 other sites in Arizona	mineral found at > 1 but ≤ 10 other sites in Arizona	only known location in Arizona for this mineral
Duration	> 0 to 5 years construction phase	> 5 to 100 years operation phase	> 100 years
Quality	common mineral of average quality	not so common mineral of average quality or common mineral of above average quality	rare mineral or not so common mineral of above average quality average quality

*To determine the overall environmental effect, the significance of magnitude, duration, and quality are considered as equal. A rating of high is equal to 3; a medium is equal to 2; and a low is equal to 1. The values for the magnitude, duration, and quality are added together and the average is determined. The resultant value is then compared with the scale to determine the overall environmental effect. The direction of the effect is determined by the nature of the effect; that is, whether it is beneficial or adverse. The direction has no numerical value.

L	M	H
1.0 – 1.7	1.7 – 2.4	2.4 – 3.0

Example: Magnitude Low = 1
Duration Medium = 2 1 + 2 + 3 = 6
Quality High = 3

Average 6 ÷ 3 = 2 2 is Medium (from scale)

Direction Adverse (-)

Effect = Medium Adverse (-M)

fewer sites in Arizona. Of greatest significance is an only known locality for collection of a particular mineral in Arizona. The effect is considered short-term if the duration is for the construction and/or operation phases of the project; the effect is considered long-term if the duration is for a period beyond the operation phase of the project. The quality dimension includes not only the general quality of the mineral but also the relative abundance of that mineral.

Soil Erosion

The soil erosion effects criteria for construction and operation are given in Table 4-4. An effect is considered adverse if there is an overall increase in soil erosion due to a project action; an effect is considered beneficial if there is an overall decrease in soil erosion. The change in soil erosion rate in less than 3,000 acres is considered of low significance while the change in rate for more than 10,000 acres is considered of high significance. The effect is considered short-term if the duration is for the construction and/or operation phases of the project; the effect is considered long-term if the duration is for a period beyond the operation phase of the project. The quality dimension is based upon the erosion hazard potential of the soil series as designated by the Soil Conservation Service, U.S. Department of Agriculture. Soils with a slight erosion hazard have losses of up to 2 tons per acre per year; moderate erosion hazard, 2 to 5 tons per acre per year; high or severe erosion hazard, more than 5 tons per acre per year (U.S. Soil Conservation Service, personal communication 4/22/80).

TABLE 4-4

SOIL EROSION -- EFFECTS CRITERIA FOR CONSTRUCTION AND OPERATION ACTIVITIES

	Low	Moderate	High
Direction	Adverse (-) or Beneficial (+)	Adverse (-) or (Beneficial (+)	Adverse (-) or Beneficial (+)
Magnitude	$\leq$ 3,000 acres affected	3,000 to 10,000 acres affected	> 10,000 acres affected
Duration	> 0 to 5 years construction phase	> 5 to 100 years operation phase	> 100 years
Quality	slight erosion hazard (0-2 tons/acre/year)	moderate erosion hazard (2-5 tons/acre/year)	high or severe erosion hazard (> 5 tons/acre/year)

*To determine the overall environmental effect, the significance of magnitude, duration, and quality are considered as equal. A rating of high is equal to 3; a medium is equal to 2; and a low is equal to 1. The values for the magnitude, duration, and quality are added together and the average is determined. The resultant value is then compared with the scale to determine the overall environmental effect. The direction of the effect is determined by the nature of the effect; that is, whether it is beneficial or adverse. The direction has no numerical value.

L	M	H
1.0 – 1.7	1.7 – 2.4	2.4 – 3.0

Example: Magnitude Low = 1
Duration Medium = 2 1 + 2 + 3 = 6
Quality High = 3

Average 6 ÷ 3 = 2 2 is Medium (from scale)

Direction Adverse (-)

Effect = Medium Adverse (-M)

Unique Geological Areas

Unique geological areas effects criteria for construction and operation are given in Table 4-5. All effects for unique geological areas are considered adverse since any impact would result in a loss. The loss of a unique geological area, to which there are no other similar type features within the study area, is considered of low significance; however, the loss of a unique geological area which is the only such feature in the United States is considered of high significance. The effect is considered short-term if the duration is for the construction and/or operation phases of the project; the effect is considered long-term if the duration is for a period beyond the operation phase of the project. It is assumed that quality is not a factor in determining a unique geological area.

TABLE 4-5

UNIQUE GEOLOGICAL AREAS -- EFFECTS CRITERIA FOR CONSTRUCTION AND OPERATION ACTIVITIES

	Low	Moderate	High
Direction	Adverse (-)	Adverse (-)	Adverse (-)
Magnitude	only known site with similar type feature in study area	only known site with similar type feature in Arizona	only known site with similar type feature in United States
Duration	> 0 to 5 years construction phase	> 5 to 100 years operation phase	> 100 years
Quality		no variance in quality	

*To determine the overall environmental effect, the significance of magnitude, duration, and quality are considered as equal. A rating of high is equal to 3; a medium is equal to 2; and a low is equal to 1. The values for the magnitude, duration, and quality are added together and the average is determined. The resultant value is then compared with the scale to determine the overall environmental effect. The direction of the effect is determined by the nature of the effect; that is, whether it is beneficial or adverse. The direction has no numerical value.

L	M	H

1.0 1.7 2.4 3.0

Example: Magnitude Low = 1
Duration Medium = 2 1 + 2 + 3 = 6
Quality High = 3

Average 6 ÷ 3 = 2 2 is Medium (from scale)

Direction Adverse (-)

Effect = Medium Adverse (-M)

People Contacted or Offering Comments on Geology/Soils Effects Criteria

Mr. Doug Pease
Soil Conservation Service
U.S. Department of Agriculture
3/11/80; 3/13/80; 3/24/80; 4/2/80; 4/22/80

Mr. Charles Orvis
U.S. Army Corps of Engineers
3/13/80; 3/28/80; 4/9/80; 4/10/80

Ms. Susan DuBois
Arizona Bureau of Geology and Mineral Technology
3/14/80

Mr. Arthur Bloyd
Mineral Museum -- Arizona Department of Mineral Resources
3/17/80

Dr. Wesley Peirce
Arizona Bureau of Geology and Mineral Technology
3/19/80; 3/31/80

Mr. Gus Dornbusch
Soil Conservation Service
U.S. Department of Agriculture
4/9/80; 4/22/80

Ms. Gail Cordy
U.S. Water and Power Resources Service
4/10/80

Mr. R. H. Raymond
U.S. Water and Power Resources Service
4/11/80; 4/15/80

Mr. G. D. Ford
U.S. Water and Power Resources Service
4/15/80

Mr. Gary Turlington
U.S. Water and Power Resources Service
4/15/80

Mr. Carl Pacheck
Soil Conservation Service
U.S. Department of Agriculture
4/22/80

Mr. Don Gomert
Soil Conservation Service
U.S. Department of Agriculture
4/22/80

4.3 WATER RESOURCES

Water quality impacts in this stage of the CAWCS are changes in the concentrations of total dissolved solids (TDS) in CAP water and natural surface water as a result of regulatory storage mixing at the various sites.

The procedure for the effects evaluation is as follows: The possible surface water TDS concentration is determined to range from that of the water with the lowest TDS to that of the highest TDS at each site. The percent change in TDS concentration is then determined for both CAP water and natural surface water. If the TDS concentration increases, the effect is adverse, and if it decreases, the effect is beneficial. The degree of the adverse or beneficial effect is determined after considering water quality standards, percent change in water quality, volume of water affected, and the designated subsequent use, as indicated in Table 4-6.

The only drinking water standard for TDS which can be surpassed is the EPA recommended secondary standard of 500 mg/l. Surface water criteria established by the EPA also have a 500 mg/l limit for TDS. In addition, crop irrigation recommendations from the EPA state that irrigation water containing up to 500 mg/l TDS generally will not cause any detrimental effects.

TABLE 4-6

WATER QUALITY EFFECTS EVALUATION CRITERIA

	L Low	M Medium	H High
Direction	Decrease in TDS: Beneficial (+)	Decrease in TDS: Beneficial (+)	Decrease in TDS: Beneficial (+)
	Increase in TDS: Adverse (-)	Increase in TDS: Adverse (-)	Increase in TDS: Adverse (-)
Magnitude	Change in TDS less than 15%	Change in TDS 15-30%	Change in TDS greater than 30%
	Volume of water affected less than 50 Kaf/yr	Volume of water affected 50-100 Kaf/yr	Volume of water affected greater than 100 Kaf/yr
Duration	Life of project	Life of project	Life of project
Quality	Change in TDS does not pass 500 mg/l mark	Change in TDS passes 500 mg/l mark	Change in TDS passes 500 mg/l mark
	Water use is less than 15% M&I	Water use is 15-30% M&I	Water use is greater than 30% M&I

Persons Consulted in Developing and/or Evaluating Water Resources Effects Criteria:

John Boyer, Arizona Water Water Commission
Pat Campbell, MAG 208 Water Quality Management Program
Marc Bennett, Arizona Department of Health Services
Jerry O'Connell, Maricopa County Water Conservation District #1
Tom Burbey, Water and Power Resources Service
Larry Morton, Water and Power Resources Service
William Greenslade, Dames & Moore

4.4 AIR RESOURCES

Each impact is characterized in terms of its direction (adverse or beneficial), magnitude, duration, and the quality of the air resources. Criteria are established whereby the effect of each impact can be rated as low, medium or high; effects criteria are presented in Table 4-7.

In all cases air quality impacts are considered adverse. Magnitude is evaluated quantitatively whenever possible or else in terms of some characteristic directly related to quantity. Duration is basically defined in terms of short-term or long-term actions. Quality is evaluated in terms of site location relative to the Maricopa County Urban Planning Area and metropolitan Phoenix, as well as the population located within an area of highest potential air pollution around the construction area.

For TSP emissions during the construction phase, a gross emission factor is used as a base figure and is then modified by factors determined from the matrix in Table 4-7. The resultant emission factor is then evaluated as being "low", "medium" or "high" relative to data contained in the nonattainment area plan for TSP. In all other cases the effects of air pollutants are evaluated arithmetically by assigning numerical values to the "low", "medium" and "high" columns.

TABLE 4-7

AIR QUALITY EFFECTS CRITERIA

	L (Low)	M (Medium)	H (High)
CONSTRUCTION:			
TSP:			
Direction	Adverse or beneficial	Adverse or beneficial	Adverse or beneficial
Magnitude[a]	Less than 5,000 tons per year of uncontrolled TSP	5,000-10,000 tons per year of uncontrolled TSP	More than 10,000 tons per year of uncontrolled TSP
Duration	5 years or less (factor value = 1)	6-10 years (factor value = 1.5)	More than 10 years (factor value = 2)
Quality	Element located outside non-attainment area (factor value = 1)	Element located within non-attainment area but outside metropolitan area (factor value = 1.5)	Element located within both a nonattainment area and a metropolitan area (factor value = 2)
	Population of area most susceptible to violations of standards is 0-20,000 (factor value = 0.1 - 1.0 depending on population	Population of area most susceptible to violations of standards is 20,000-50,000 (factor value = 1.0)	Population of area most susceptible to violations of standards is more than 50,000 (factor value = 1.1+ depending on population

TABLE 4-7 (Cont'd.)

AIR QUALITY EFFECTS CRITERIA

	L (Low)	M (Medium)	H (High)
OTHER AIR POLLUTANTS:[b]			
Direction	Adverse or beneficial	Adverse or beneficial	Adverse or beneficial
Magnitude	Mostly mobile sources	Mostly non-continuous point sources	Mostly continuous point sources
Duration	5 years or less	6-10 years	More than 10 years
Quality	Same as for TSP	Same as for TSP	Same as for TSP
OPERATION/ MAINTENANCE:			
TSP AND OTHER AIR POLLUTANTS:[b]			
Direction	Adverse or beneficial	Adverse or beneficial	Adverse or beneficial
Magnitude	0-33% increase in recreation area	34-66% increase in recreation area	67%+ increase in recreation area
Duration	Not applicable	Not applicable	Not applicable
Quality	Same as for construction phase	Same as for construction phase	Same as for construction phase

[a]Uncontrolled TSP emissions modified by scope (cost) and area factors.
[b]Effect values: Low = 1; Medium = 2; High = 3. Overall effect value is an arithmetic average of individual values.

Persons Contacted Regarding Air Quality Effects Criteria

Gordon, John L., Senior Chemist, Dames & Moore, dates: 2/18/80, 3/17/80

Aymar, Arthur A., Assistant Chief, Bureau of Air Quality Control, Arizona Department of Health Services, dates: 3/3/80, 4/10/80, 4/14/80

Johnston, Grant W., Chief, Bureau of Air Pollution Control, Maricopa County Health Department, dates: 3/4/80, 4/11/80

Patterson, Brian, MAGTPO, date: 3/4/80

Toy, Doug, WPRS (Boulder City), date: 3/20/80

Wagner, Jim, WPRS (Phoenix), date: 3/27/80

Herzmark, Leonard, Manager, Enforcement Unit, Bureau of Water Quality Control, Arizona Department of Health Services, date: 4/15/80

4.5 ACOUSTICS

Due to the interrupting effect of construction and operational activities and the relatively high noise levels within close proximity of the center of such activities, construction- and operation-generated noise can have varying effects on people. These effects can be grouped into three general categories:

1. subjective effects of annoyance, nuisance, and dissatisfaction;
2. interference with activities such as speech, sleep, learning/performance; and
3. physiological effects, such as startle, nervous tension, and hearing loss.

Of greatest importance are those effects which lead to interference with activities and subsequent annoyance.

Accurate speech communication is crucial to formal education, occupational efficiency, family relationships, and the overall quality of human life. Face-to-face personal conversations at the usual distance of 5 feet can proceed normally where the environmental (A-weighted) sound levels are about 65 dBA. For conversations involving groups of people where the distance between speaker and listener is 5 to 12 feet, the level of environmental sound should be less than 50 to 60 dBA.

The Federal Environmental Protection Agency has found that when average (A-weighted) environmental sound levels exceed 55 decibels, people begin to be annoyed. At ambient sound levels greater than 75 decibels, more than 55 percent of the exposed people are highly annoyed (EPA, 1971).

Sleep is disturbed by high ambient noise levels which produce a "poor" sleep pattern with long periods of light sleep and frequent awakenings.

The performance of tasks demanding accuracy or having a complex series of steps is adversely affected by high frequency noise or irregular bursts of noise. Learning, especially in small children, can be seriously hindered by the presence of high or constant levels of ambient noise, since the noise can be a barrier to speech perception and exchange, as previously mentioned.

4.5.1 Construction Noise Effects Criteria

Numerous studies have been prepared to evaluate the effects of noise on wildlife and humans. The EPA's Levels Document (1974); the International Standards Organization Recommendation 1996 (1969); HUD's Environmental Criteria and Standards, Part 51 (1979); and other applicable standards and studies have been reviewed in determining the noise effects evaluation criteria for use in this study. Table 4-8 presents a summary of the sound level criteria used in evaluating the effects of construction noise on noise-sensitive areas. Construction noise impacts and effects, where applicable, are assumed to be short-term and adverse unless otherwise noted.

TABLE 4-8

SUMMARY OF NOISE LEVEL EFFECTS EVALUATION CRITERIA FOR CONSTRUCTION ACTIVITIES

Effect	Sound Level	Area	Interpretation
Negligible	$L_{dn} \leq 55$ dB	All areas	Construction undertaken is not generally anticipated to result in any short-term adverse noise impacts.
Low (minor annoyance or interference with outdoor activities)	L_{dn} = 55 to 65 dB	Outdoors in residential areas, recreational areas, or other outdoor areas where people spend widely varying amounts of time and other places in which quiet is the basis of use.	Construction undertaken will generally be anticipated to result in minor cases of speech interference; indoor activities will not generally be affected.
Medium (moderate annoyance or interference with indoor and outdoor activities)	L_{dn} = 65 to 75 dB	Outdoors in residential areas, recreational areas, or other areas where people spend widely varying amounts of time and other places in which quiet is the basis of use.	Construction undertaken will generally be anticipated to result in cases of speech and sleep interference resulting in numerous complaints when ambient sound levels increase by 10 to 15 dB over existing conditions. Nearby residences with conventional construction (including open windows for ventilation) will experience indoor sound levels sufficient to cause some interference and annoyance.
High (major annoyance or interference with indoor and outdoor activities and possible hearing loss)	$L_{dn} > 75$ dB	All areas except heavy industrial or manufacturing areas or commercial areas near major existing noise sources.	Construction undertaken will result in threats of community action at noise-sensitive residential or recreational areas. Construction workers exposed to an 8-hour daily exposure of over 90 dB are anticipated to experience hearing loss and will be required to wear hearing protection devices.

4.5.2 Operational Noise Effects Criteria

Table 4-9 presents a summary of the sound level criteria used in evaluating the effects of operational noise on noise-sensitive areas. Operational noise impacts and effects, where applicable, are generally assumed to be long-term and adverse unless otherwise noted.

4.5.3 Noise Effects Evaluation

To determine the impacts of noise on residential, recreational, and wildlife areas, the contribution of construction and operational activities is estimated based on previous measurement data and prediction models for similar equipment, operations, or activities. These construction and operational sound level contributions are extrapolated from the center of each activity to neighboring noise-sensitive areas using hemispherical sound radiation. The assumption of hemispherical sound radiation allows for 6 dB sound attenuation for every doubling of distance from the source. The assumption of hemispherical sound radiation does not include the effects of sound attenuation due to foliage, air and ground absorption, and the barrier effects of topography or intervening structures, and is therefore conservative. To estimate the effects, the estimated daytime and nighttime equivalent sound levels of each contribution are added to the estimated background ambient sound levels. Each contribution is added on an energy basis then compared to the noise effects criteria shown in Tables 4-8 and 4-9 to identify the degree of noise impact, if applicable.

TABLE 4-9

SUMMARY OF NOISE LEVEL EFFECTS EVALUATION CRITERIA FOR OPERATIONAL ACTIVITIES

Effect	Sound Level	Area	Interpretation
Negligible	$L_{dn} \leq 55$ dB	All areas	Operational activities will not generally be anticipated to result in any short- or long-term adverse noise impacts.
Low (minor annoyance or interference with outdoor activities)	L_{dn} = 55 to 65 dB	Outdoors in residential, recreational, or other outdoor areas where people spend widely varying amounts of time and other places in which quiet is the basis of use.	Operational activities will generally be anticipated to result in minor cases of speech interference outdoors. Indoor activities will not generally be affected.
Medium (moderate annoyance or interference with indoor and outdoor activities)	L_{dn} = 65 to 75 dB	Outdoors in residential, recreational, or other areas where people spend widely varying amounts of time and other places in which quiet is the basis of use.	Operational activities will generally be anticipated to result in cases of speech and sleep interference resulting in numerous complaints when ambient sound levels increase by 10 to 15 dB over existing conditions. Nearby residences with conventional construction (including open windows for ventilation) will experience indoor sound levels sufficient to cause some interference and annoyance.
High (major annoyance or interference with indoor and outdoor activities and possible hearing loss)	$L_{dn} > 75$ dB	All areas except heavy industrial or manufacturing areas or commercial areas near major existing noise sources.	Operational activities will result in threats of community action at noise-sensitive residential or recreational areas.

4.6 BIOLOGICAL RESOURCES

For the effects evaluation, biological categories were assigned priorities on the basis of issues identified earlier in Stage II. Threatened and endangered species have top priority due to the Endangered Species Act (PL 95-632) requirements and protection status. Riparian habitats have second priority because of the limited amount of these habitats, and the importance placed on them in the Fish and Wildlife Coordination Act (PL 85-624) and Executive Orders 11988 and 11990. Aquatic habitat and non-riparian terrestrial habitat are ranked third due to their importance as a resource on which many species depend.

The evaluation of effects in biological resources combines these priority ranks with ranks developed from the criteria for the assessment categories. The category criteria are shown in Table 4-10; the methodology used to derive effects is described in the following paragraphs.

Criteria for threatened and endangered plants and wildlife reflect the U.S. Fish and Wildlife Service's interpretations of the Endangered Species Act. The significance of the impact, i.e. the effect, focuses on gains or losses in productivity and habitat utilization (Table 4-10).

Criteria for terrestrial habitat were developed with respect to the impact dimensions of direction, duration, magnitude, and quality of resource affected. Quality of resource represents the intrinsic ecological value and the uniqueness of the habitat.

TABLE 4-10

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK: Construction	RANK: Operation/Maintenance
A. Threatened and endangered plants and wildlife.		
1. An endangered or threatened plant or wildlife species occurs at or near a project site, and an action will cause:		
a) The elimination of population productivity within or adjacent to the site (e.g. the loss of reproductive adults, the loss of breeding sites such as nests, or the loss of foraging habitat on which the species depend).	-H	-H
b) Indirect or short-term impact on the population productivity within or adjacent to the site such that productivity is not permanently reduced to zero (e.g. breeding adults are not lost but may be disrupted from breeding during the construction phase, foraging habitat and other preferred habitat is modified but remains sufficiently intact to sustain site-specific productivity).	-M	-M

TABLE 4-10 (Cont'd.)

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK	
	Construction	Operation/ Maintenance
2. An endangered or threatened plant or wildlife species occurs at or near a project site but does not reproduce within or near the site, and an action will cause loss of preferred habitat such that the potential for utilization diminishes (e.g. a nearby endangered plant population or endangered wildlife that includes non-breeding and wintering individuals).	-L	-L
3. An action will cause habitat enhancement such that:		
a) Productivity of a local endangered or threatened plant or wildlife species' population increases or a nearby population can colonize and become productive in the area.	+H	+H
b) Individuals of an endangered or threatened plant or wildlife species are attracted to and utilize the site and adjacent area (e.g. a nearby endangered plant population or endangered wildlife species that includes non-breeding and wintering individuals).	+M	+M
c) Preferred habitat becomes established and may potentially support an endangered or threatened species.	+L	+L

TABLE 4-10 (Cont'd.)

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK: Construction	RANK: Operation/Maintenance
B. Terrestrial riparian habitat.		
1. Cottonwood-willow series and mixed broadleaf series.		
a) The magnitude of impact represents a gain or loss of more than 20% of the habitat on either the Salt, Verde, Agua Fria, or Gila River segment within the CAWCS Project area or 10% of the habitat within the overall CAWCS project area; or	±H	±H
b) Structural types I and II and the magnitude of impact is the gain or loss, or extensive modification of---		
(1) more than 100 acres;	±H	±H
(2) 10 to 100 acres;	±M	±H
(3) less than 10 acres.	±L	±L
c) Structural types III and IV and the magnitude of impact is the gain or loss, or extensive modification of---		
(1) more than 640 acres;	±H	±H
(2) 100 to 640 acres;	±M	±H
(3) 10 to 100 acres;	±L	±M
(4) less than 10 acres.	±L	±L
d) Structural types V and VI and the magnitude of impact is the gain or loss, or extensive modification of---		

TABLE 4-10 (Cont'd.)

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK: Construction	RANK: Operation/Maintenance
(1) more than 1280 acres;	±H	±H
(2) 640 to 1280 acres;	±M	±H
(3) 100 to 640 acres;	±L	±M
(4) less than 100 acres.	±L	±L
2. Mesquite series and saltcedar disclimax series.		
a) The magnitude of impact represents a gain or loss of more than 20% of the habitat on either the Salt, Verde, Agua Fria, or Gila River segment within the CAWCS Project area or 10% of the habitat within the overall CAWCS project area; or	±H	±H
b) Structural type II and the magnitude of impact is the gain or loss, or extensive modification of---		
(1) more than 1280 acres;	±H	±H
(2) 640 to 1280 acres;	±M	±H
(3) 100 to 640 acres;	±L	±M
(4) less than 100 acres.	±L	±L
c) Structural types III and IV and the magnitude of impact is the gain or loss, or extensive modification of---		
(1) more than 1280 acres;	±H	±H
(2) 640 to 1280 acres;	±M	±M
(3) 100 to 640 acres;	±L	±M
(4) less than 100 acres.	±L	±L

TABLE 4-10 (Cont'd.)

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK: Construction	RANK: Operation/Maintenance
d) Structural types V and VI and the magnitude of impact is the gain or loss, or extensive modification of---		
(1) more than 2560 acres;	±H	±H
(2) 1280 to 2560 acres;	±M	±M
(3) 640 to 1280 acres;	±L	±M
(4) less than 640 acres.	±L	±L
3. Mixed scrub series.		
a) Structural types IV, V, and VI and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 2560 acres;	±H	±H
(2) 1280 to 2560 acres;	±M	±M
(3) 640 to 1280 acres;	±L	±M
(4) less than 640 acres.	±L	±L
4. Cattail series.		
a) The magnitude of impact represents a gain or loss of more than 20% of the habitat on either the Salt, Verde, Agua Fria, or Gila River segment within the CAWCS Project area or 10% of the habitat within the overall CAWCS project area; or	±H	±H

TABLE 4-10 (Cont'd.)

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK: Construction	RANK: Operation/Maintenance
b) Structural type VI and the magnitude of impact is the gain or loss, or extensive modification of---		
(1) more than 20 acres;	±H	±H
(2) 10 to 20 acres;	±M	±H
(3) 2 to 10 acres;	±L	±M
(4) less than 2 acres.	±L	±L
C. Terrestrial non-riparian habitat.		
1. Paloverde-mixed cacti series and blue paloverde-ironwood association.		
a) Structural type A and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 9600 acres;	±H	±H
(2) 6400 to 9600 acres;	±M	±H
(3) 2560 to 6400 acres;	±M	±M
(4) 1280 to 2560 acres;	±L	±M
(5) less than 1280 acres.	±L	±L
b) Structural type B and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 9600 acres;	±H	±H
(2) 6400 to 9600 acres;	±M	±M
(3) 2560 to 6400 acres;	±L	±M
(5) less than 2560 acres.	±L	±L

TABLE 4-10 (Cont'd.)

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK: Construction	RANK: Operation/ Maintenance
c) Structural type C and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 20,000 acres;	±H	±H
(2) 9600 to 20,000 acres;	±M	±M
(3) 6400 to 9600 acres;	±L	±M
(4) less than 6400 acres.	±L	±L
2. Saltbush series and creosotebush-bursage series.		
a) Structural type C and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 20,000 acres;	±H	±H
(2) 9600 to 20,000 acres;	±M	±M
(3) 6400 to 9600 acres;	±L	±M
(4) less than 6400 acres.	±L	±L
3. Agricultural lands and developed urban lands.		
a) Structural type II (e.g. edge habitat with cottonwood and willows) and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 1280 acres;	±H	±H
(2) 640 to 1280 acres;	±M	±M
(3) 100 to 640 acres;	±L	±M
(4) less than 100 acres.	±L	±L

TABLE 4-10 (Cont'd.)

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK: Construction	RANK: Operation/Maintenance
b) Structural type III (e.g. edge habitat with cottonwood, mesquite, mature orchard, etc.) and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 2560 acres;	±H	±H
(2) 1280 to 2560 acres;	±M	±M
(3) 640 to 1280 acres;	±L	±M
(4) less than 640 acres.	±L	±L
c) Structural type IV (e.g. citrus groves; edge habitat of shrubs and grasses) and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 9600 acres;	±H	±H
(2) 2560 to 9600 acres;	±M	±H
(3) 1280 to 2560 acres;	±L	±M
(4) less than 1280 acres.	±L	±L
d) Structural type V and VI (e.g. croplands, fallow, irrigation lands, etc.) and the magnitude of impact is gain or loss, or extensive modification of---		
(1) more than 20,000 acres;	±M	±H
(2) 9600 to 20,000 acres;	±M	±M
(3) 2560 to 9600 acres;	±L	±M
(4) less than 2560 acres.	±L	±L

TABLE 4-10 (Cont'd.)

EFFECTS EVALUATION CRITERIA AND RANKS FOR BIOLOGICAL RESOURCES

Criteria	RANK: Construction	RANK: Operation/Maintenance
D. Aquatic habitat and fisheries.		
1. Non-flowing habitat and the impact involves fluctuation or permanent change in water volume and depth such that---		
a) There is a gain of more than or a loss to less than minimum pool;	±H	±H
b) There is already a conservation pool in excess of the recommended minimum pool and the impact involves fluctuation in the conservation pool;	±M	±M
c) There is gain or loss only in the pool levels greater than the conservation pool, as defined in (b).	±L	±L
2. Flowing habitat in which impact represents gain or loss of more than 20% of the perennial stream mileage represented in either the Salt, Verde, or Gila River segments within the CAWCS Project area; or	±H	±H
a) more than 10 miles of perennial river;	±H	±H
b) 6 to 10 miles;	±M	±H
c) 3 to 6 miles;	±M	±M
d) 1 to 3 miles;	±L	±M
e) less than 1 mile.	±L	±L

Subsets of habitat quality were defined in terms of quality and magnitude (Table 4-10), and compared to impact duration to establish ranks that depict the effect. Duration was defined as short-term (approximately 5 years, or the length of the construction phase) or long-term (50 to 100 years, or the operational life of the project). Impact direction was treated in the criteria formulation as adverse (-) or beneficial (+) which simply represents gain or loss of resource.

The criteria were then assigned ranks based on professional judgment. Two levels of weighting were necessary for combining priority criteria (discussed above) and category criteria. Ranks were treated numerically by converting letter ranks to integers, using a uniform, linear effects scale as follows:

ASSIGNED RANK:	-H	-M	-L	N	+L	+M	+H
NUMERICAL VALUE:	-3	-2	-1	0	+1	+2	+3

where H = high effect, M = medium effect, L = low effect, and N = no effect.

Matrices representing different terrestrial habitats were constructed in which effects were computed as the weighted cross product as follows:

$v_{ij} = Pd_ik_j$ where v_{ij} is the element value of priority rank (P) times duration rank (d_i, i = 1,2 for construction phase and operation and maintenance phase) times the quality subset quantity (k_j, j = 1 . . . . n as shown in Table 4-10).

Since the priority ranks, duration ranks, and quality subset quantity ranks were assigned discrete integers, the cross product values were a discontinuous series of integers, namely 1, 2, 3, 4, 6, 8, 9, 12, 18 and 27. Their frequency was plotted and the values ranked as discontinuties in the plotted distribution. High (H) was assigned to v_{ij} = 12, 18, or 27; medium (M) was assigned to v_{ij} = 6, 8, or 9; and low (L) was assigned to v_{ij} = 1, 2, 3, or 4.

Criteria for aquatic habitat were developed for reservoirs and perennial streams (Table 4-10). The non-flowing aquatic criteria focus on water volume and depth recommended by the U.S. Fish and Wildlife Service to sustain a minimum pool that would maintain a viable fishery. The recommended minimum pools for the various elements are given in Attachment A at the end of this section.

Perennial streams not only support fish populations, but they are also preferred foraging habitat for the bald eagle and the main water resource for riparian woodland habitats. Uniqueness (percent affected to amount of stream in the reach) and ecological value (magnitude or mileage affected) are incorporated in the criteria in a manner paralleling that discussed for terrestrial habitat.

A Technical Agency Group workshop including ten professionals representing six organizations was held to review and revise the effects criteria (see listing on page 4-36). A consensus was reached among the reviewers that conservation of native habitats should have precedence over modified habitats. The combined effects for all habitats for a given action should reflect the maximum impacts on the natural conditions rather than reflect the effects on artificially created habitats. For

example, precedence is given to flowing stream habitats over impoundment habitats, and native terrestrial and riverine habitats over secondary growth habitats resulting from disturbance. Thus the combined effects for habitat losses are the maximum negative value representing the loss of native habitat.

Technical Agency Group Workshop Participants on Effects Criteria

Arizona Game and Fish Department
Mr. John Carr

Maricopa Audubon Society
Ms. Sue Monroe

Salt River Project
Mr. Bill Davis
Mr. Glenn Harris

U.S. Corps of Engineers
Ms. Carol Grooms
Ms. Stephannie Ostrum

U.S. Fish and Wildlife Service
Ms. Jennifer Fowler
Mr. Rick Lamaire

U.S. Forest Service, Tonto National Forest
Mr. Larry A. Forbis
Mr. Pete Weinel

ATTACHMENT A

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Ecological Services
2934 W. Fairmount Avenue
Phoenix, Arizona 85017

December 18, 1979

Memorandum

To: Agency Manager, Central Arizona Water Control Study, Water and Power Resources Service, Phoenix

From: Field Supervisor, Phoenix (ES)

Subject: Minimum Pool Elevations for Central Arizona Water Control Study Alternatives

The attached lists are our preliminary recommendations for minimum pools for reservoirs under consideration as alternative project elements.

If you should have any questions concerning these recommendations, please contact us.

cc w/att.:
Director, Arizona Game and Fish Dept., Phoenix
Area Manager, USFWS, Phoenix

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Date	Initial	To
12/21	ARB	100
12/21	12	105
12/26	SM	170
		150
Inf. Copy		

Confluence Site

Maximum: capacity - 1,655,450 a.f. includes flood storage
surface acres - 24,100
elevation - 1,513

Minimum: capacity - 47,000 a.f. el. 1,374
surface acres - 2,300
mean depth - 20 ft.
% storage - 2.8 (of total)

Comments: designated pool for high dam

Granite Reef

Maximum: capacity - 1,776,000 a.f. includes flood storage
surface acres - 24,600
elevation - 1, 500

Minimum: capacity - 49,000 a.f. el. 1,350
surface acres - 2,300
mean depth - 21 ft.
% storage - 2.7 (of total)

Comments: pool for high dam

Cliff Sites

No pool - flood control only; if the Cliff alternative should include the breaching of Horseshoe Dam, our recommended minimum pool would be similar to that proposed for Horseshoe.

Horseshoe

Maximum: capacity - 239,000 a.f. (no flood storage)
surface acres - 3,750
elevation - 2,058

Minimum: capacity - 10,000 a.f. el. 1956
surface acres - 793
mean depth - 12 ft.
% storage - 4.1

Comments: minimum figure, based on conservation storage capacity, not flood storage. 100,000 a.f. added for CAP.

Bartlett

Maximum: capacity - 279,000 a.f. no flood storage
surface acres - 3,650
elevation - 1,841

Minimum: capacity - 10,000 a.f. el. 1,659
surface acres - 425
mean depth - 23 ft.
% storage - 3.5

Comments: minimum figure; does not include flood storage. 100,000 a.f. added for CAP.

Roosevelt

Maximum: capacity - 1,482,000 a.f. no flood control
surface acres - 19,665
elevation - 2,142

Minimum: capacity - 15,000 a.f. el. 1,987
surface acres - 1304
mean depth - 11.5
% storage - 1.0

Comments: base figure; actual pool should be larger to accommodate good fish populations. Adds 100,000 a.f. for CAP.

Alternate Pools for Roosevelt

5% of storage		3.7% of storage
75,000 a.f.	Capacity	55,000 a.f.
4,006	Surface Acres	3,014
18.7 ft.	average depth	18.2 ft.

3.7% = average of all pool sizes
5.0% - a round figure

New Waddell (Lake Pleasant)

Maximum: capacity - 310,000 a.f.
surface acres - 5,075
elevation - 1,625

Minimum: capacity - 5,026 a.f. el. 1,483
surface acres - 228
mean depth - 22 ft.
% storage - 1.6

Comments: Lake survived at 10-12 ft. depth over one summer (1977). At proposed pool should be safe.

Tat Momolikot

Maximum: capacity - 535,518 a.f.
surface acres - 20,237
elevation - 1,559

Minimum: capacity - 24,500 a.f. el. 1,510
surface acres - 2,500
mean depth - 9.8 ft.
% storage - 4.5

Comments: very shallow basin. Quantities used here assume new dam. Existing dam is another possibility.

Instream Flows

Aqua Fria - below New Waddell - none

Gila - below Buttes - minimum 50 cfs instantaneous year round
figure from previous reports

Salt - below Stewart Mtn - winter = 175 cfs instantaneous (min.)
summer = 350 cfs instantaneous (min.)
figures are % of 10-year average releases

Verde - below Bartlett - winter - 100 cfs instantaneous minimum to reach confluence

summer - 200 cfs instantaneous to reach confluence
figures from 10-year average releases

Releases from Bartlett Dam may have to be higher. Should not exceed Stewart Mountain release.

Florence

Maximum: capacity - 110,799 a.f.
surface acres - 3,631
elevation - 1,592

Minimum: capacity - 8,806 a.f. el. 1,546
surface acres - 855
mean depth - 10 ft.
% storage - 7.9

Comments: maintain at least 10 ft. of water on top of sediment.

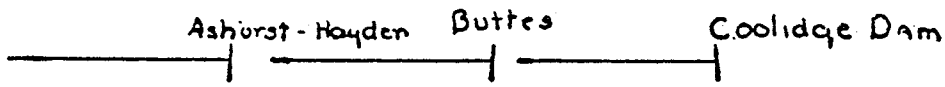
Buttes

Maximum: capacity - 406,083 a.f.
surface acres - 5,897
elevation - 1787

Minimum: capacity - 1935 a.f. el. 1,620
surface acres - 210
mean depth - 9.2
% storage - .47

Comments: minimum of 8 ft. ave on top of sediment pool.

Buttes Instream flow



Water released from Buttes would go down river by canal and the riverbed. At Ashurst-Hayden, most would be diverted for irrigation except 50 cfs which would go on below to water a currently dry segment of the Gila River.

50 cfs was chosen as the amount by examining historic record. Using data from Bureau of Reclamation, Arizona Projects Office, 1914-1970, the flow in this area averaged (monthly) over 50 cfs 85% of the time. Thus, 50 cfs provided an easily managed base flow that would maintain the river.

Data from Arizona Game and Fish Department

Lake Pleasant

		Temp °C		O_2 ppm	
Date	Maximum depth	Surface	Bottom	Surface	Bottom
7/28/77	29 ft.	31°	27°	8.0	.2
8/19/77	22 ft.	32°	27°	6.9	3.4
9/2/77	16 ft.	32°	28.5°	4.9	2.6
9/9/77	12 ft., 10 in.	30°	29.5°	5.05	2.75
9/15/77	10 ft, 8 in.	26.5°	25.6°	4.95	3.98
9/23/77	9 ft., 7 in.	24°	24°	5.6	5.1
9/30/77	10 ft.	26°	27°	8.55	7.2

During the summer of 1977, Lake Pleasant nearly went dry and, at the same time, there was great concern that there would be a severe fish kill. Fortunately, although the fish were stressed, the lake did not kill.

The table above shows temperature and oxygen data recorded by Arizona Game and Fish Department on the lake during that summer. Although surface temperatures were somewhat high, more reasonable temperatures were found in the water column. Temperature standards for proposed minimum pools should be established. Temperature at the bottom should not exceed 27°C and surface temperatures not exceed 32°C (preferably below 30°C but this may be difficult to accomplish during Arizona summers). The bottom temperature of 27°C should be regarded as an absolute maximum.

Dissolved oxygen was adequate at all times except on 7/28 at the bottom. Extremely low oxygen levels at the bottom of lakes during the summer is quite common. At shallower depths, oxygen was always adequate. Since the BOD load of the proposed reservoirs is not known, the actual oxygen levels that will occur cannot be predicted for the proposed pools. In some of the deeper pools, summer stratification may develop. This will also have an impact on the oxygen levels. For example, in San Carlos Lake, on June 5, 1976, the maximum depth was 50 feet. Temperatures ran from 21.5°C at the bottom to 25.0°C at the surface. Oxygen went from .2 ppm at the bottom to 6.9 ppm at the surface. Adequate oxygen was only available above the thermocline at 30 feet. Dissolved oxygen levels should be maintained above 2 ppm through as much of the pool as possible. This is, of course, a minimum figure. Oxygen levels in the upper waters should be as high as necessary to obtain optimal fish survival.

4.7 LAND RESOURCES

For the first-level land resources effects evaluation of proposed project actions, plans for the replacement-in-kind of displaced facilities, for the development of additional recreational facilities, and for potential mitigative measures have not been included because the plans for such measures and facilities have yet to be completed. In subsequent phases of the CAWCS program the land resources effects criteria will be refined and expanded as appropriate to include such factors.

The land resources effects criteria presented in this section are used to differentiate the significance (adverse, beneficial; low, medium, and high) of identified project action construction and operational impacts for each of the three land resources categories: land use patterns, land ownership patterns, and adjacent and proposed uses of land resources. For each project action, a professional judgment is made as to the significance of impacts on land resources. The effects evaluation is based on the dimensions of direction, magnitude, duration, and the quality of impacted resources as described below.

The direction criterion refers to whether the identified effect will modify or maintain the land resources within the project area by the year 2000. Those proposed project construction and operational activities which would modify land resources within the project area are considered as adverse (-) effects, whereas those activities which would not alter the land resources are considered as neutral (0) effects. However, land resources impacts will likely be viewed in different and opposing contexts by the individual parties affected. Land resources can be

perceived either as beneficial, insignificant, or adverse depending upon an individual's interests and perspectives and various public interest groups. Individuals whose properties are specifically impacted by proposed actions are likely to oppose a project favorably perceived by the general public. Also, public interest groups are likely to have different viewpoints on the same project action. For example, the inundation of wetland areas supporting riparian vegetation may be favorably perceived by flat-water recreation interests but adversely perceived by conservation interests. Therefore, in addition to the professional directional judgment as to the probable maintenance or alteration of land resources, public decision-makers in subsequent evaluations of proposed project actions will also have to consider the public views as to the significance of identified land resources impacts.

The magnitude criterion addresses the effects of the size of land area impacted (disturbed, inundated, etc.) by the proposed construction and operation project actions. Differentiations as to low, medium, and high effects on the land resources within the project area are defined in terms of the total land area impacted and, where appropriate, in terms of the number of acres within specific categories of impacted resources.

The duration criterion is the estimated length of time which the impacted land resources are preempted. Generally, construction activities are defined as short-term impacts occurring during the identified construction periods of 5 years or less, and therefore are assessed as being low (L) in temporal importance. Borrow areas, construction sites, and other construction areas not impacted by the operation of the

proposed facility are required by various legislative and regulatory statutes to be subsequently returned to their natural appearance and use as part of the project action during post-construction reclamation activities. Relatively longer periods of time are likely to be required before such land areas can completely be reclaimed. Therefore, reclamation activities are assessed as being medium (M) in temporal importance. On the other hand, operational impacts are defined as long-term impacts to land resources lasting throughout and beyond the designed economic life of the project. Since all of the project actions are designed to have an economic life of 100 years, and are scheduled to be operational shortly after 1990, the duration of all operational impacts is essentially the same. These long-term, operational-related land resources impacts of proposed project actions are therefore regarded as irreversible and irretrievable commitments of land resources and as having high (H) temporal ramifications.

Lastly, the quality of impacted land resources criterion addresses the qualitative aspects of the identified land resources impacts. This criterion is defined in terms of the presence or absence of unique land resources and the quality (i.e., productivity, intensity of use, etc.) of surrounding land uses. Unique land resources areas may either already have been identified as unique areas and are being preserved as such, or they may be perceived as unique land resources which are undergoing or awaiting further study. Quality of impacted land resources effects of low (L) importance are defined as those project actions in which no identified or perceived unique land resources will be impacted, and the quality of any impacted land resources is generally the same as

that of similar surrounding land resources. Effects of medium (M) significance include those land resources impacted by the proposed project action which are perceived to have special qualities or attributes, and/or the productivity/intensity of use of these resources is somewhat greater than those of similar surrounding land resources. Lastly, quality of impacted land resources of high (H) significance is defined as those land resources impacted by the proposed project action which are identified as unique, special resource areas (e.g., prime farmlands and pristine wilderness areas), and/or the productivity/intensity of use of these resources is substantially greater than those characteristic of similar surrounding land resources. For project actions in which the effects values are not mutually exclusive in terms of the quality of impacted resource significance levels as defined above, greater importance will be placed on the presence of unique or special resource area value rather than on the productivity/intensity of use value.

The application of these direction, magnitude, duration, and quality of resource criteria within the context of each of the three land resources categories is specified in the following subsections.

4.7.1 Land Use Criteria

Table 4-11 provides a synopsis of the effects evaluation criteria that are presented below, and which are applied to the identified construction and operational impacts to determine the effects

TABLE 4-11

EFFECTS EVALUATION: SUMMARY OF LAND USE IMPACT CRITERIA

	Low	Medium	High
	CONSTRUCTION AND OPERATION EFFECTS		
Direction[a]	neutral (0) or adverse (-)	neutral (0) or adverse (-)	neutral (0) or adverse (-)
Magnitude	≤1,000 total acres impacted and/or <25 percent of urban/built-up, agricultural, water bodies & wetland areas within the designated area are directly impacted	Between 1,000 and 5,000 total acres impacted and/or between 25 percent and 50 percent of the urban/built-up, agricultural, water bodies and wetland areas within the designated area are directly impacted	≥5,000 total acres impacted and/or ≥50 percent of the urban/built-up, agricultural, water bodies & wetland areas within the designated area are directly impacted
Duration	Temporarily impacted for 5 years or less	Temporarily impacted for more than 5 years	Permanently impacted for economic life of project and beyond
Quality	No unique resources impacted and quality of impacted resources characteristic of similar surrounding land uses	Impacted land resources perceived to have special attributes and/or the quality of resources impacted are somewhat greater than similar surrounding land uses	Impacted land resources are identified as unique or special areas and/or the quality of resources impacted are substantially greater than similar surrounding land uses

[a]Public decision makers must subsequently consider the views of impacted parties and interest groups.

(significance) of the proposed project action on land use patterns within each of the designated project areas.

The construction and operation of most of the structurally-related project actions will necessarily require a change in the total acreage of a particular land use classification (e.g., urban/built-up lands, agricultural lands, wetlands, water bodies, or rangelands), and thus will be assessed as adverse effects. Within the CAWCS area, urban/built-up, agricultural lands, water impoundments, and wetland land uses are generally perceived as being more important land uses than the vast areas classified as rangelands which comprise approximately 75 percent of the total CAWCS area. For the first level effects evaluation, urban/built-up, agricultural lands, water impoundments, and wetland land uses are assumed to be of equal importance. In subsequent phases of the CAWCS program, the land use impact assessment and effects criteria will be expanded to include more detailed land use classifications (e.g., access and productivity of grazing lands, residential properties, crop lands, etc.).

The magnitude criterion for assessing the effects of project changes in land use patterns is defined in terms of the total land area impacted and in terms of acreage changes by individual land use classes within the area impacted by the proposed project action. Low, medium, and high magnitude effects are classified as impacts to $\leq$1,000 acres; <1,000 and >5,000 acres; and $\leq$5,000 acres; and as impacts to $\leq$ 25 percent; 25 percent and >50 percent; and $\geq$50 percent, respectively, of the total acreage of lands within each category which will be directly impacted by proposed construction or operational activities. In instances where the

effects or significance values may be assigned to two different categories (because the categories are not mutually exclusive), greater importance is placed on the magnitude of changes within the project area rather than on changes within individual land use classifications. Similarly, nonexclusive effect values between individual land use classifications will be resolved by professional judgment on a project action-by-project action basis.

The duration and quality of impacted resources criteria for land use effects are as stated above and as shown in Table 4-11.

4.7.2 Land Ownership Criteria

Table 4-12 provides a synopsis of the effects evaluation criteria which are applied to the identified construction and operational impacts to determine the effects (significance) of the proposed project actions on land ownership patterns within each of the designated impact areas.

The procurement of land areas required for the proposed construction and operation of a project action may result in a change in the total number of acres within the project area that are classified in one of the three particular land ownership categories (e.g., public, public-reserved, or private lands). Those project actions which would result in a change of land ownership patterns within the project area are assessed as resulting in adverse (-) land ownership effects, whereas those project actions not altering land ownership patterns are assessed as neutral (0) effects.

TABLE 4-12

EFFECTS EVALUATION: SUMMARY OF LAND OWNERSHIP CRITERIA

	Low	Medium	High
	CONSTRUCTION AND OPERATION EFFECTS		
Direction[a]	neutral (0) or adverse (-)	neutral (0) or adverse (-)	neutral (0) or adverse (-)
Magnitude[b]	Ownership changes to ≤1,000 total acres and/or only non-reserved public lands affected	Ownership changes of between 1,000 and 5,000 total acres and/or no public reserved lands and ≤500 acres of privately owned lands affected	Ownership changes to ≥5,000 total acres and/or public reserved lands or >500 acres of privately owned lands affected
Duration	Temporarily impacted for 5 years or less	Temporarily impacted for more than 5 years	Temporarily impacted for economic life of the project and beyond
Quality	No changes in land ownership patterns	Few changes in land ownership patterns having minor consequences	Several changes in land ownership patterns having major secondary consequences

[a]Public decision makers must subsequently consider the views of impacted parties and interest groups.

[b]Reserved public lands are public lands which have been dedicated, withdrawn, set aside, or granted for a specific public purpose or program, such as Indian Reservations, Wilderness Areas, state trust lands, National Monuments, etc. Such reserved public lands are generally not subject to disposition or change in use under the operation of public land laws.

The criterion for assessing the magnitude of projected changes in land ownership patterns is expressed in terms of the acreage of public, public-reserved, and private lands located within rights-of-way required for the proposed project construction and operational activities (including easements). Within the CAWCS area, impacts to public-reserved lands (e.g., Indian reservations, National monuments, wilderness areas, state trust lands, municipal parks, etc.) and privately owned lands are generally perceived to be more important than impacts to other public lands administered by Federal agencies (e.g., U.S. Forest Service and the Bureau of Land Management). Land ownership modifications defined as being low (L) in significance are those in which <1,000 total acres and no public-reserved or private lands are affected; medium (M) effects as ≤1,000 total acres but >5,000 total acres and/or no public-reserved land and ≤500 acres of privately owned lands affected; and high effects (H) as ≤5,000 total acres, and/or public-reserved lands or >500 acres of privately owned lands affected. In cases where the effects values are not mutually exclusive, greater importance will be placed on the effects to public-reserved and private lands than on the total acreage of additional land areas required for the proposed project aciton.

As defined above, the magnitude criterion is an indicator of the likely degree of difficulty with which the rights to surface land areas required for the construction and operation of a proposed project action can be obtained, regardless of the method of acquisition (e.g., easement, purchase, land exchange, patent, intra-agency agreements, or eminent domain). In subsequent phases of the CAWCS project, this criterion will be expanded to include subsurface rights and the number of

parties (governmental agencies, private corporations, and individuals) whose properties would be affected by required land parcels and easements.

In terms of duration, land ownership changes resulting from the acquisition of lands required for the proposed project action are assessed as being long-term and permanent changes. Peripheral lands encumbered by easements required for operational and maintenance activities are similarly assessed as being long-term encumbrances. However, lands encumbered by construction-related easements are assessed as being short-term, temporary encumbrances.

Lastly, from a land ownership perspective, the criterion used to assess the quality of resources impacted by proposed construction and operational activities is defined in terms of secondary regional consequences which such changes in land ownership patterns may cause. For example, the tax base of local governmental units may be affected by changes in land ownership patterns if a significant number of privately owned parcels are removed from the tax base. Quality of resource effects of land ownership modification are thus defined as being of low (L) significance for project actions in which no changes in land ownership patterns will result from implementation of the proposed construction and operational project actions. Similarly, project effects of medium (M) significance are those actions in which few land ownership changes will result from implementation of proposed project actions and such land ownership changes will likely have minor adverse or beneficial consequences from a regional perspective. Those project actions requiring several changes in land ownership patterns which may have major consequences from a regional perspective are defined as of high (H) significance.

4.7.3 Adjacent and Proposed Land Resource Use Criteria

Table 4-13 provides a synopsis of the effects evaluation criteria that are applied to identified construction and operational impacts to determine the effects (significance) of the proposed project actions on adjacent and proposed uses of the land resources within the designated impact areas.

The effects of identified construction and operation impacts of proposed project actions on adjacent or proposed land resources is, in essence, a professional judgment as to the relative degree of compatibility of the proposed project action with adjacent land areas, and with proposed or designated plans for the land resources within the project area.

Again, in terms of the direction criterion, those project actions which would change adjacent land resources or which would conflict with another proposed use of the land resources within the project area as documented in an existing plan are assessed as adverse (-) effects. Similarly, those project actions which would not alter adjacent land resources and which are generally consistent with other documented proposed use(s) of the land resources within the project area are assessed as neutral (0) effects.

The magnitude criterion for determining the effects on adjacent and proposed use of land resources is defined in terms of relative degree(s) of compatibility as follows. The effects of proposed project-related construction and operational activities are defined as low (L) significance if the project actions are likely to be very compatible with

TABLE 4-13

EFFECTS EVALUATION: SUMMARY OF ADJACENT AND PROPOSED LAND RESOURCE USE CRITERIA

	Low	Medium	High
	CONSTRUCTION AND OPERATION EFFECTS		
Direction[a]	neutral (0) or adverse (-)	neutral (0) or adverse (-)	neutral (0) or adverse (-)
Magnitude	Very compatible; no significant adverse effects on adjacent land resources and/or not likely to conflict with implementation of other proposed plans	Generally compatible; few adverse effects on adjacent land resources and/or few potential conflicts with implementation of other proposed plans	Mostly incompatible; several adverse effects on adjacent land resources and/or few identified conflicts with implementation of other proposed plans
Duration	Temporarily impacted for 5 years or less	Temporarily impacted for more than 5 years	Permanently impacted
Quality	No unique adjacent resource areas are affected and project action would result in a similar or higher and better use of land resources than those resulting from other alternative plans	Adjacent land resources perceived to have special attributes and/or the project action would result in slightly lower use of land resources in comparison to other proposed project area plans	Adjacent land resources are identified as unique or special areas and/or the project action would result in substantially lower use of land resources in comparison to other proposed project area plans

[a]Public decision makers must subsequently consider the views of impacted parties and interest groups.

the adjacent land resources within the designated project area and if such actions will not likely conflict with the implementation of other proposed plans for the use of the land resources within the designated project area should such proposed plans be subsequently implemented. Effects of medium (M) significance are defined as those generally compatible project actions which have few identified impacts of minor significance to adjacent land resources and/or to the implementation of other proposed plans for the use of the land resources within the designated project area. High (H) effects are defined as those mostly incompatible project actions whose identified construction and operational activities will likely create several adverse impacts of major significance to adjacent land resources and/or to the implementation of proposed plans for other use(s) of the land resources within the designated project area. In applying this compatibility criterion, the decision rule that will be used in cases where the effects values are not mutually exclusive is that greater importance will be placed on the effects to adjacent land uses rather than on the effects to proposed uses of the land resources.

The duration criterion for determining the temporal significance of identified impacts on adjacent and proposed land resources as presented in Table 4-13 is the same as previously defined for the land use and land ownership categories.

Lastly, the quality of impacted resource criterion is defined in terms of the presence or absence of unique resources or specific attributes of the impacted adjacent land areas, and in terms of the theoretical highest and best use of the land resources for conflicting

proposed plans for the use of the land resources located within the designated project area. Specifically, those project actions which would not affect any unique resource areas and which would result in a similar or higher and better use of the land resources from a theoretical land use planning perspective than alternative plans are defined as low (L) in significance. Project actions which would impact adjacent land resources which are perceived to have special attributes and/or which theoretically would result in slightly lower use of the land resources in comparison to those resulting from other proposed project area plans are defined as having medium (M) significance. Project actions of high (H) significance are those which would impact adjacent land resources that have been identified as unique or special areas and/or which theoretically would result in substantially lower use of the land resources in comparison to those resulting from other proposed project area plans. In applying this quality of impacted resources criterion, the decision rule that will be used in cases where the effects values are not mutually exclusive is that greater importance will be placed on the effects on adjacent unique land resources areas rather than on effects to proposed uses of the land resources.

Persons Contacted Regarding Land Resources Effects Criteria

In addition to peer review by CAWCS team members, comments on the first-level land resources impacts and effects methodology were sought and received from the following agencies and individuals:

Water & Power Resources Service
Stanley F. Seigal

Arizona State Land Department
Gerald L. Smith

Maricopa Association of Governments
Tom Ford and James Reynolds

The Natelson Company, Inc.
Joseph E. McClure

4.8 RECREATION

Recreation criteria were developed for application during the first level impact assessment only and may be modified for subsequent assessments. The criteria are organized to differentiate between effects characterized as being HIGH, MEDIUM, or LOW in significance for the dimensions of DIRECTION, MAGNITUDE, DURATION, and QUALITY OF IMPACTED RESOURCE OR FACILITY.

DIRECTION refers to whether the effect is viewed to be beneficial, neutral, or adverse from a recreational standpoint. For example, benefit may be realized if recreational facilities or resources are increased or enhanced. On the other hand, adverse or negative effects may occur if facilities or resources are depleted or their attractiveness reduced. The direction of the effect is a perception, and may vary according to viewpoint. Therefore, various interest groups, depending on their orientation, may perceive the direction differently. For example, flat-water recreationists may perceive increased flat-water resources beneficially. However, the expansion of such resources might necessitate the reduction of controlled-flow stream resources. Tubers, for instance, would probably view this as an adverse effect.

MAGNITUDE addresses the amount or size of the impact. The possible unavailability of conceptual recreation plans for each project location, coupled with the level of project detail available for first level analysis, limits the extent to which the MAGNITUDE of the effect can be fully described. Rather, the differentiation among a high, medium, and low magnitude necessarily employs that information which

forms a basis of comparison for that category. The recreational categories used to describe the impacts and effects include water- and land-based recreational facilities and resources. Therefore, the magnitude of effect is measured by the extent to which study area facility and resources bases are affected (e.g., in acres, stream-miles, or number of facilities).

For each of the recreational categories addressed by the magnitude dimension, the differentiation among HIGH, MEDIUM, and LOW effect levels is based on the share (percent) of study area facilities and resources affected. Professional judgment was employed to specify the threshold at which the impact would be considered a LOW-level effect, a MEDIUM-level effect, and a HIGH-level effect. An impact of less than 10 percent of the total resource or facility base was defined as a LOW-level effect; an impact on 10-25 percent of the total facility/resource base was judged to induce a MEDIUM-level effect; and an impact on more than 25 percent of the facility/resource base was determined to be in the HIGH range of effect levels.

DURATION provides a time dimension to the effect; therefore, the measure is some length of time. For construction, the degree of effect (high, medium, or low) is measured by the number of years that the effect will take place. For operation, the effect is experienced throughout the life of the project. Therefore, duration is not a particularly relevant dimension for recreational effects during operation because the operable life of most alternatives is considered to be the same.

The QUALITY OF IMPACTED RESOURCE OR FACILITY addresses those qualitative aspects of the impact that can be influential in determining

the actual effect of that impact. This dimension focuses on the following aspects:

- The availability and accessibility of substitute facilities or resources (such as other flat-water, campgrounds, boat ramps, etc.)
- The comparability of those substitutes in terms of:
  - o ability to support additional recreational use
  - o mix of facilities available
  - o general perceived attractiveness as suggested by use levels
- The current use levels of those impacted facilities and resources as an indication of desirability and resulting effects on study area recreation. The differentiation among HIGH, MEDIUM, and LOW level effects is based on whether the facility or resource is heavily, moderately, or not heavily used recreationally. Due to the range of facilities and resources to be examined, coupled with the variation in measurement methods and accuracy, it was not possible to specify quantitatively heavy or moderate use levels in a general sense. Therefore, professional judgment was employed to determine whether use is heavy or moderate for each project area's facilities and resources.

4.8.1 Flat-Water Facilities

Table 4-14 summarizes the effects criteria applied to flat-water facilities. The first level effects evaluation will incorporate information from the conceptual recreation plans for each project action location when available. Moreover, it is assumed that all facilities present in a future-without condition would be "replaced-in-kind" as a component of the project action. Impacts are not accrued in conjunction with replacement-in-kind. The operational criterion for MAGNITUDE bases the level of effect on the share of available, comparable facilities (in the future-without time frame) that are impacted by the project action. Table 4-15 displays information on flat-water facilities present on major water bodies in the study area. These data will be useful in ascertaining MAGNITUDE.

4.8.2 Flat-Water Resources

Table 4-16 displays the effects criteria that were determined to be appropriate for differentiating effect levels for flat-water resources, both in construction and operation. The MAGNITUDE measure for construction addresses the extent to which the study area's flat-water surface area and shoreline distance has been affected. (Other environmental aspects that may influence recreation, such as water quality and air quality, are addressed in other components of the environmental analysis.) The share of total comparable resources impacted is employed

TABLE 4-14

EFFECTS EVALUATION: SUMMARY OF RECREATION CATEGORIES AND CRITERIA FOR FLAT-WATER FACILITIES

Dimension	Low	Medium	High
		CONSTRUCTION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	<10 percent of comparable facilities available in the study area are affected	10-25 percent of comparable facilities available in the study area are affected	>25 percent of comparable facilities available in the study area are affected
Duration	<2 years	2-5 years	>5 years
Quality of Impacted Resource	the facilities are not heavily used or substitutes of similar quality are numerous	the facilities are moderately used or substitutes of similar quality are limited	the facilities are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.

TABLE 4-14 (Continued)

Dimension	Low	Medium	High
		OPERATION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude[b]	<10 percent of comparable facilities available in the study area are affected	10-25 percent of comparable facilities available in the study area are affected	>25 percent of comparable facilities available in the study area are affected
Duration	NA	NA	NA
Quality of Impacted Resource	the facilities are not heavily used or substitutes of similar quality are numerous	the facilities are moderately used or substitutes of similar quality are limited	the facilities are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.
[b]Without consideration of conceptual recreation plans to accompany project action.
NA = Not Applicable.

TABLE 4-15

MAJOR FLAT-WATERS AND THEIR PUBLIC
EXISTING WATER-BASED RECREATIONAL FACILITIES

Major Boating Resource	Shore-line Miles	Maximum Surface Acreage	Boat Docks	Boat Ramps	Beach	Restroom	Picnic Tables	Rama-das	Designated Parking Spaces
Roosevelt Lake	80	17,300	0	2		1 permanent 8 temporary	0	0	1 park-ing lot
Lake Pleasant	61	3,690	3	3	1	8 db. dual	191	7	350
Saguaro Lake	22	1,260	1	3		10 buildings	70	16	200
Bartlett Lake	14	2,700	0	1		6 buildings	0	0	1 park-ing lot
Apache Lake	38	2,660	0	2		5 buildings	35	0	
Canyon Lake	25	950	2	2		15 buildings	27	14	300
Horseshoe	16	2,800							
TOTAL	256	31,430	6	13	1		323	37	

Source: "Arizona State Lake Improvement Fund Plan", 1973 by Arizona Outdoor Recreation Coordination Commission.

TABLE 4-16

EFFECTS EVALUATION: SUMMARY OF RECREATION CATEGORIES AND CRITERIA FOR FLAT-WATER RESOURCES

Dimension	Low	Medium	High
		CONSTRUCTION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	the surface water area does not change noticeably or is in-increased (or decreased) by <10 percent of flat-water surface area available in the study area	the surface water area is increased (or decreased) by 10-25 percent of total flat-water surface area available in the study area	the surface water area is increased (or decreased) by >25 percent of total flat-water surface area available in the study area
Duration	<2 years	2-5 years	>5 years
Quality of Impacted Resource	the resources are not heavily used or substitutes of similar quality are numerous	the resources are moderately used or substitutes of similar quality are limited	the resources are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.

TABLE 4-16 (Continued)

Dimension	Low	Medium	High
		OPERATION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	the surface water area does not change noticeably or is in-increased (or decreased) by <10 percent of flat-water surface area available in the study area	the surface water area is increased (or decreased) by 10-25 percent of total flat-water surface area available in the study area	the surface water area is increased (or decreased) by >25 percent of total flat-water surface area available in the study area
Duration	NA	NA	NA
Quality of Impacted Resource	the resources are not heavily used or substitutes of similar quality are numerous	the resources are moderately used or substitutes of similar quality are limited	the resources are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.
NA = Not Applicable.

to differentiate between low, medium, and high effect levels. Comparability will be based on characteristic recreational use. For example, the large reservoirs of Tonto National Forest and Lake Pleasant are largely comparable from a recreation standpoint. These water bodies represent the large expanses of flat-water in the study area. They accommodate public use and have a similar mix of recreational facilities and resources associated with them. Table 4-15 outlines the surface area and shoreline extents of the reservoirs in the study area portion of Tonto National Forest and Lake Pleasant. Such data were used to ascertain the extent to which the impacts affected the total flat-water resource base of comparable facilities.

The MAGNITUDE criterion for operation focuses on the overall addition to, or depletion of, available flat-water resources. The ranges employed were judged to be appropriate given the total variation that is expected to exist among all project actions. Also considered is the relative scarcity of flat-water resources in the study area and the extent to which the project action impacts total supply.

The criterion for the QUALITY OF IMPACTED RESOURCE dimension is also presented in Table 4-16. The discrimination of high, medium, and low effect levels is based on:

- Recreation use levels
- Availability of comparable substitutes

The qualitative aspects of recreational effects are considered via this dimension. Their consideration ensures a comprehensive view of resulting effects. The same criteria were viewed to be applicable to both the construction and operation phases.

The differentiation among high, medium, and low effects resulting from the duration of the project action on flat-water resources is also presented in Table 4-16. For construction, the thresholds of each level depend on the number of construction years during which the impact will be ongoing. Duration was not viewed as being as applicable dimension during operation; duration is assumed to equal project life.

4.8.3 Controlled-Flow Stream Facilities

Table 4-17 addresses the effects criteria applied to controlled-flow stream facilities. They are consistent with those applied to controlled-flow stream resources. The direction and magnitude of the operational effect does factor in the conceptual recreation plan when available and applicable to this category. The project action includes replacement-in-kind of all facilities present in a future-without condition. Therefore, no recreational impacts are associated with such replacement-in-kind.

4.8.4 Controlled-Flow Stream Resources

The effects criteria applied to controlled-flow stream resources are outlined in Table 4-18. The MAGNITUDE dimension is based on the share of total stream-miles with controlled flow that are impacted by the project action. Once again, the QUALITY OF IMPACTED RESOURCE dimension addresses the extent to which the resource is used recreationally and the

TABLE 4-17

EFFECTS EVALUATION: SUMMARY OF RECREATION CATEGORIES AND CRITERIA FOR CONTROLLED-FLOW STREAM FACILITIES

Dimension	Low	Medium	High
		CONSTRUCTION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	<10 percent of facilities available in the study area are affected	10-25 percent of facilities available in the study area are affected	>25 percent of facilities available in the study area are affected
Duration	<2 years	2-5 years	>5 years
Quality of Impacted Resource	the facilities are not heavily used or substitutes of similar quality are numerous	the facilities are moderately used or substitutes of similar quality are limited	the facilities are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.

TABLE 4-17 (Continued)

Dimension	Low	Medium	High
		OPERATION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	<10 percent of facilities available in the study area are affected	10-25 percent of facilities available in the study area are affected	>25 percent of facilities available in the study area are affected
Duration	NA	NA	NA
Quality of Impacted Resource	the facilities are not heavily used or substitutes of similar quality are numerous	the facilities are moderately used or substitutes of similar quality are limited	the facilities are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.
[b]Without consideration of conceptual recreation plans to accompany project action.
NA = Not Applicable.

TABLE 4-18

EFFECTS EVALUATION: SUMMARY OF RECREATION CATEGORIES AND CRITERIA FOR CONTROLLED-FLOW STREAM RESOURCES

Dimension	Low	Medium	High
		CONSTRUCTION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	<10 percent of available stream-miles in the study area are affected	10-25 percent of available stream-miles in the study area are affected	>25 percent of available stream-miles in the study area are affected
Duration	<2 years	2-5 years	>5 years
Quality of Impacted Resource	the resources are not heavily used or substitutes of similar quality are numerous	the resources are moderately used or substitutes of similar quality are limited	the resources are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.

TABLE 4-18 (Continued)

Dimension	Low	Medium	High
		OPERATION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	<10 percent of available stream-miles in the study area are affected	10-25 percent of available stream-miles in the study area are affected	>25 percent of available stream-miles in the study area are affected
Duration	NA	NA	NA
Quality of Impacted Resource	the resources are not heavily used or substitutes of similar quality are numerous	the resources are moderately used or substitutes of similar quality are limited	the resources are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.
NA = Not Applicable.

availability of comparable substitutes. The study area resource base for this category is presented in Table 4-19.

4.8.5 Land-Related Facilities

The effects criteria developed for application to land related facilities are presented in Table 4-20. They conform to those outlined for controlled-flow stream facilities, as well as flat-water facilities. For most project action locations the land-related recreational facilities are primarily camping/picnicking areas that are within close proximity to larger water bodies. Therefore, the set of comparable facilities will be those with similar characteristics and under public ownership. Table 4-21 provides information on water body-related recreational sites. Most of the public land-related recreational facilities that would be impacted by a project action alternative are located in some proximity to water bodies. Therefore, Table 4-21 provides data on sites that can be deemed comparable and useful for an assessment of areawide recreational effects.

The activity profile reported in the columns enables the screening of sites that are similar in recreational use. For example, if there is a publicly-owned camping/picnic site located adjacent to a water body impacted by a project action alternative, by using Table 4-21 it can be ascertained how many water body-adjacent sites are present in the study area. In the case of camping/picnic areas, 14 such publicly-owned sites are present. Such information will be helpful in assessing the areawide effects of impacts on land-related recreational facilities.

TABLE 4-19

CONTROLLED-FLOW STREAM
RESOURCES[a] IN THE STUDY AREA

River	Stream Length	Miles
Gila	o Eastern boundary of study area to Ashurst-Hayden Dam	33.5
Salt	o Eastern boundary of study area to Granite Reef Dam (excluding lakes)	35.2
Verde	o Northern boundary of study area to confluence with the Salt (excluding Bartlett and Horseshoe)	43.6
	Total	112.3

[a]Defined as those stretches of open river whose streams flow for most of the year.

TABLE 4-20

EFFECTS EVALUATION: SUMMARY OF RECREATION CATEGORIES AND CRITERIA FOR LAND-RELATED FACILITIES

Dimension	Low	Medium	High
		CONSTRUCTION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	>10 percent of comparable and available facilities in the study area are affected	10-25 percent of comparable and available facilities in the study area are affected	>25 percent of comparable and available facilities in the study area are affected
Duration	<2 years	2-5 years	>5 years
Quality of Impacted Resource	the facilities are not heavily used or substitutes of similar quality are numerous	the facilities are moderately used or substitutes of similar quality are limited	the facilities are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.

TABLE 4-20 (Continued)

Dimension	Low	Medium	High
		OPERATION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude[b]	>10 percent of comparable and available facilities in the study area are affected	10-25 percent of comparable and available facilities in the study area are affected	>25 percent of comparable and available facilities in the study area are affected
Duration	NA	NA	NA
Quality of Impacted Resource	the facilities are not heavily used or substitutes of similar quality are numerous	the facilities are moderately used or substitutes of similar quality are limited	the facilities are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.
[b]Without consideration of conceptual recreation plans to accompany project action.
NA = Not Applicable.

TABLE 4-21

ACTIVITIES ASSOCIATED WITH RECREATIONAL SITES ADJACENT TO OR ENCOMPASSING WATER BODIES IN THE CAWCS STUDY AREA

Map ID	Site Name	County	Owner	Camping	Picnicking	Fishing	Boating	Golfing	Non-Pool Swimming - Unimproved Facility	Non-Pool Swimming - Improved Facility	Swimming Pool	Spray Pad	Court Games	Marked Fields	Playground/Totlot	Amphitheatre/Bandshell	Horse Arena	Trails
1	Burnt Corral	Gila	Federal	X	X	X	X											
2	Cholla Bay	Gila	Federal			X	X											
3	Horse Pasture	Gila	Federal	X	X	X	X		X									
4	Inspiration Point	Gila	Federal			X	X		X									
5	Schoolhouse Point	Gila	Federal			X	X											
6	Acacia	Maricopa	Federal		X	X	X			X								
7	Apache Lake Campground	Maricopa	Federal	X	X	X	X		X									
8	Bagley Flat	Maricopa	Federal	X	X	X	X											
9	Bartlett Lake	Maricopa	Federal	X	X	X	X											
10	Boulder Creek	Maricopa	Federal		X	X	X		X									
11	Bull Dog	Maricopa	Federal			X	X		X									
12	Butcher Jones Picnic	Maricopa	Federal		X					X								
13	Firebird Lake	Maricopa	Federal		X	X	X		X									
14	Granite Reef	Maricopa	Federal	X	X	X												
15	Horseshoe Lake	Maricopa	Federal	X	X	X	X		X									
16	Laguna Beach Campground	Maricopa	Federal	X	X	X	X		X									
17	Palo Verde Boating Site	Maricopa	Federal		X	X	X		X									
18	Riverside	Maricopa	Federal	X	X	X	X		X									
19	Saguaro Del Norte	Maricopa	Federal		X	X	X											
20	The Point - Canyon Lake	Maricopa	Federal	X	X	X	X		X								X	
21	Paradise Valley Park	Maricopa	County		X			X										
22	Casey Abbott Rec. A	Maricopa	County	X	X			X							X	X		
23	Lake Pleasant Reg. Park	Maricopa	County	X	X	X	X			X								
24	Chaparral Park	Maricopa	Scottsdale		X	X	X							X	X			
25	Chestnut Park	Maricopa	Scottsdale		X	X						X	X		X			
26	Cortez Park	Maricopa	Phoenix		X	X	X						X	X	X			
27	Dobson Ranch Golf	Maricopa	Mesa					X					X					
28	Esteban Park	Maricopa	Phoenix		X	X							X	X	X			
29	Granda Park	Maricopa	Phoenix		X	X							X					
30	Joseph Reed Park	Maricopa	Mesa		X	X							X		X			
31	Kiwanis Park	Maricopa	Tempe		X	X												
32	Maricopa Lake	Maricopa	Sun City		X		X						X	X				
33	Marivale Golf	Maricopa	Phoenix					X										
34	McKellips Lake	Maricopa	Scottsdale		X	X	X											
35	Papago Park	Maricopa	Phoenix					X										
36	Road Runner Park	Maricopa	Phoenix		X	X							X	X	X			
37	Encanto Park	Maricopa	Phoenix		X	X	X	X			X		X	X	X	X		X
37	Vista Del Camino	Maricopa	Scottsdale		X	X						X	X	X	X			
38	Sunnyslope High School	Maricopa	Public School		X								X					
39	Arizona Biltmore	Maricopa	Commercial					X										
40	Big Surf	Maricopa	Commercial		X					X								
41	Lakes West Country Club	Maricopa	Commercial					X										
42	Litchfield Park	Maricopa	Commercial					X										
43	North Golf Course	Maricopa	Commercial					X										
44	Phoenix Manor	Maricopa	Commercial		X													
45	Riverview Country Club	Maricopa	Commercial					X										
46	South Golf Course	Maricopa	Commercial					X										
47	The Inn at McCormick	Maricopa	Commercial				X	X										
48	Willow Brook Ctry. Club	Maricopa	Commercial					X										
49	Leisure World Gldn. Hill	Maricopa	Commercial															
50	Palm Lakes Village	Maricopa	Commercial		X	X	X											
51	Sun City Country Club	Maricopa	Commercial					X										
52	The Lakes	Maricopa	Commercial				X											
53	Union Hills Country Club	Maricopa	Commercial					X										
54	Fountain Hills Park	Maricopa	Non-Profit															
55	Lakeview Center	Maricopa	Non-Profit		X			X										
56	Apache Lake Marina & Res	Maricopa	Commercial				X			X								
58	Fountain of the Sun	Maricopa	Commercial															
59	Road Runner	Maricopa	Commercial		X	X												
60	Boyce Thompson SW	Pinal	State		X													X
61	Rest Area	Pinal	State		X				X									
62	Phon D. Sutton	Maricopa	Federal		X	X				X								
63	Coon Bluff	Maricopa	Federal	X	X	X				X								
64	Windy Hill	Gila	Federal	X	X	X	X			X								
65	Washington Park	Maricopa	Phoenix		X	X							X	X	X			
66	El Dorado Park	Maricopa	Scottsdale		X	X	X				X		X	X	X			X
67	Canal Park	Maricopa	Tempe		X	X												

Sources:
- U.S.F.S., Southwestern Region, Recreation Sites in Southwestern National Forests, 1979.
- Arizona State Parks, Pick a Park (brochure), 1979.
- Maricopa County Parks and Recreation Department, Lake Pleasant Regional Park, 1979.
- Phoenix Parks, Recreation, and Library Department, Our Phoenix Parks (brochure), 1979.
- Phoenix Parks and Recreation Department, Encanto Park (brochure), 1979.
- Phoenix and Valley of the Sun Convention and Visitors Bureau, Valley of the Sun Visitor's Guide, Spring/Summer 1979.
- City of Scottsdale, Recreation Division, Program Facilities, 1979.
- City of Tempe, Parks and Recreation Department, Summer Parks and Recreation Program, 1979.
- Mesa Parks and Recreation Department, Parks and Facilities, July, 1979.
- Mesa Parks and Recreation Department, Summer Programs, 1979.
- Big Surf, Big Surf (brochure), 1979.
- Thatcher, Carolyn, consultant planner to the Gila River Indian Reservation conversation regarding Firebird Lake, November 1979.
- Bruscato, Virginia, Phoenix Manor, conversation regarding water-related recreational activities, November 1979.
- Long, Joseph, Palm Lakes Village, conversation regarding water-related recreational activities,

The conceptual recreation plans developed for each project action location will probably focus on land-related facilities. Therefore, the effects evaluation for this category will be the one that incorporates most heavily that input of the conceptual plans.

4.8.6 Land-Related Resources

Table 4-22 focuses on the effects criteria for the sixth recreational category: land-related resources. The criteria presented are consistent with those outlined in previous tables with the exception of the MAGNITUDE dimension. The differentiation among high, medium, and low is based on the amount of land in each impact zone that would be added to or subtracted from those comparable recreation resources. The comparable resource base may be very extensive depending on the type of land affected. For example, approximately 1.9 million acres of Tonto Naitonal Forest alone lie within the CAWCS area. Another possible comparable resource is the Weiler Green Belt in western Maricopa County that encompasses approximately 63,000 acres. In addition, the Maricopa County Park System alone includes over 92,000 acres and the Maricopa County municipal park systems over 18,000 acres.*

The divisions between the three MAGNITUDE rankings (high, medium, and low) as shown in Table 4-22 are based on the potential range among all project actions, coupled with professional judgement.

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*Maricopa County Planning Department, "A Report Upon Future General Land Use for Maricopa County, Arizona," 1975.

TABLE 4-22

EFFECTS EVALUATION: SUMMARY OF RECREATION CATEGORIES AND CRITERIA FOR LAND-RELATED RESOURCES

Dimension	Low	Medium	High
		CONSTRUCTION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	10 percent of comparable recreation-oriented land of the study area is affected	10-25 percent of comparable recreation-oriented land of the study area is affected	>25 percent of comparable recreation-oriented land of the study area is affected
Duration	<2 years	2-5 years	>5 years
Quality of Impacted Resource	the resources are not heavily used or substitutes of similar quality are numerous	the resources are moderately used or substitutes of similar quality are limited	the resources are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.

TABLE 4-22 (Continued)

Dimension	Low	Medium	High
		OPERATION	
Direction[a]	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)	beneficial (+), neutral (0), or adverse (-)
Magnitude	10 percent of comparable recreation-oriented land of the study area is affected	10-25 percent of comparable recreation-oriented land of the study area is affected	>25 percent of comparable recreation-oriented land of the study area is affected
Duration	NA	NA	NA
Quality of Impacted Resource	the resources are not heavily used or substitutes of similar quality are numerous	the resources are moderately used or substitutes of similar quality are limited	the resources are heavily used or substitutes of similar quality are either non-existent or severely limited

[a]Direction may vary as perceived by various interest groups.
NA = Not Applicable

Persons Consulted in Developing and/or Evaluating Recreation Effects Criteria

Mary Alice Bivens, Arizona Outdoor Recreation Coordination Committee

William Richwine, Maricopa County Parks and Recreation Department

Eileen Marrinen, U. S. Army Corps of Engineers

Larry Marlow, Water and Power Resources Service

Ben Maiden, Battelle Laboratories

4.9 CULTURAL RESOURCES

4.9.1 Archaeological Resources

Archaeologists involved in management of cultural resources recognize that the excavation of archaeological sites is not always the best form of management. The discipline has developed rapidly, and objectives, techniques, and methods of archaeological analysis have changed even within the past decade. There is a strong consensus, therefore, that archaeologists of the future will have a much improved set of procedures for the study of prehistoric sites. For this reason archaeolgists favor in-place conservation of archaeological resources as the preferred management strategy. Excavation of archaeological sites is used only when conservation of the resource is not possible.

Within this general framework, the terms conservation and preservation are used in different ways. Conservation of the resource refers to in-place maintenance of archaeological sites or features without alteration or disturbance. Preservation of the resource refers more generally to the preservation of information about the resource for future generations. This can be done in the form of museum collections, photographic documentation, and/or excavation reports. Preservation does not require that the physical remains of the site be maintained, and for that reason is a lesser alternative to conservation. Conservation of the resource provides greater alternatives for research in the future, while data preservation is limited to the state of the art at the current time.

This management philosophy underlies our definitions of criteria for evaluating the effect of proposed projects on archaeological resources.

4.9.1.1 Direction and Duration

The direction of effects on archaeological resources may be considered as beneficial or adverse according to the principles of conservation/preservation described in the preceding paragraphs. The adverse effect will involve the total destruction and/or partial alteration and deterioration of archaeological sites due to construction, inundation, and increased accessibility. As archaeological sites are non-renewable resources, the duration of these adverse effects must be considered long-term (permanent) and irreversible.

A beneficial effect may occur with the collection and preservation of archaeological data from endangered sites as a result of mitigative efforts. The duration of these effects is difficult to assess. While the data collected under current levels and standards of archaeological expertise will be a permanent record, the relative use and relevance of this data may be short-term due to increasing technological advancements in the discipline.

4.9.1.2 Magnitude of Effects

Adverse effects will be assessed as being either high, medium or low. A high adverse effect will result from direct impacts created

by construction activities which will totally destroy archaeological sites. Dam construction, transmission line, canal and road construction, and borrow areas constitute the main factors accounting for high adverse effects. Medium adverse effects are specifically those that will result from inundation of archaeological sites. The resultant chemical and other physical transformations that will occur on archaeological sites will cause substantial damage to the resource; however, in most cases the destruction will be partial. Low adverse effects are considered to be the results of impacts on sites in the secondary impact zone. Increased recreation facilities and accessibility to previously inaccessible sites will result in the degradation of the regional archaeological resource base.

High beneficial effects would result from the potential development of archaeological sites for educational purposes and the initiation of a strong and active management and protection program related to these sites. Medium beneficial effects will be primarily the decrease in erosion due to decreases in flooding at certain riverine archaeological sites. Low beneficial effects will result from "passive management" - that is, any activities which restrict accessibility to sites and which help keep them in their current state.

4.9.1.3 Quality of Resource

Defining the quality of the archaeological resource is a subjective matter which can change with time. Archaeologists of the 1930s defined quality differently than archaeologists do today, and we

can expect such definitions to continue to change in the future. Nonetheless, at any particular point in time there can be a relatively wide sense of agreement within the discipline as to the factors which contribute to the quality of the cultural resource base. A series of such factors will be used in this study to assess the relative quality of the resource base. These include a) the legal definition of significance (based on National Register criteria), b) the relative complexity of the archaeological resource base, c) the relative occurrence of rare or unique phenomena in the resource base, and d) the current condition of the resource base. The quality of the resource base is recorded as a high, medium or low ranking. The procedure for determining the quality of the resource base is complex and will be presented in a separate technical report on the archaeological resources of each CAWCS element.

4.9.1.4 Procedure for Evaluating Effects

These four criteria (direction, duration, magnitude, and quality) are used in conjunction to establish the overall effect of any given project on the archaeological resource base. The overall effect is stated as a rating of high, medium, or low which has either a beneficial or adverse value. The ratings are obtained from the matrix shown in Table 4-23.

The ratings for overall effect are contained in the cells of the matrix, and are determined by a combination of the ratings for the quality and magnitude criteria. The directionality of the effect determines whether a beneficial (+) or adverse (-) value is given to the rating.

TABLE 4-23

MATRIX FOR DETERMINING OVERALL EFFECTS

		Magnitude of Effect		
		Low	Medium	High
Quality of Resource Base	Low	± Low	± Low	± Medium
	Medium	+ Low	+ Medium	+ High
	High	± Medium	± High	± High

Individuals Consulted in Developing and/or Evaluating Effects Criteria

	Date
Gene Rogge, Archaeologist, Water and Power Resources Service	3/7/80
Martin McAllister, Archaeologist, U.S. Forest Service, Tonto National Forest	4/80 (TAG)
Frank Fryman, Arizona State Historic Preservation Office	4/11/80 (AAC)
Lynn Teague, Arizona State Museum	4/11/80 (AAC)
Pat Georgi, Archaeologist, Bureau of Land Management	4/11/80 (AAC)

4.9.2 Historical Resources

Criteria for the evaluation of effects may be expressed in terms of dimensions which characterize an impact or a resource. In evaluating the potential effects of project actions upon historical cultural resources, four dimensions are recognized: direction of impact, magnitude of impact, duration of impact, and quality of the affected resource.[1]

4.9.2.1 Direction of Impact

Impacts may be adverse, resulting in the deterioration, alteration or destruction of important data values and qualities which characterize a particular historic site resource. Such qualities may include a site's potential use as a public educational-recreational resource. Impacts may be beneficial, resulting in the protection or enhancement of important data values and qualities which characterize a historic site. A no adverse effect determination may also be made with respect to an anticipated adverse impact at a site, provided that it is feasible to recover significant data values from that site through archaeological and historical research procedures.

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[1]The development of effects evaluation criteria has been based primarily on the application of concepts and standards which have a basis in historic preservation legislation and implementing guidelines. In addition, these criteria have been discussed with representatives of the Arizona State Historic Preservation office (F. Fryman, 4/11/80) and the U.S. Forest Service, Tonto National Forest (M. McCallister, 4/10/80).

4.9.2.2 Magnitude of Impact

Impact magnitude is a subjective measure of the amount of change (adverse or beneficial) which may occur in the presence and condition of significant data values and qualities which characterize a site. In many cases of direct adverse effect, a high magnitude rating will be applied since these sites, and their characteristic data values and qualities, will be totally destroyed. A medium magnitude rating will be applied if a site will be less than totally destroyed as a result of project actions. Such impacts may occur, for example, when a site is partially or marginally affected by a project action. A low magnitude rating implies a very minor or negligible loss of important data values. Low, medium, and high impact magnitude ratings may also be associated with beneficial effects.

4.9.2.3 Duration of Impact

The occurrence of an adverse impact assumes that significant data values which characterize a site will be permanently lost. Beneficial effects may be temporary or short-term (ST), or permanent or long-term (LT).

4.9.2.4 Quality of the Resource

All first level inventory historic sites are either listed in the National Register of Historic Places, or are assumed to be potentially

eligible for inclusion in the National Register. As such, each site is subject to consideration and protection under provisions of the National Historic Preservation Act of 1966 as amended.

The results of effects valuation, or the application of the above criteria to the evaluation of impacts defined during the impact assessment process, are illustrated in an environmental effects display for each project element. This display categorizes the number of sites at a particular element in terms of the direction, magnitude, and duration of effects which will occur as a result of both construction and operation actions. The display also indicates the number of sites at which it may be possible be successfully mitigate anticipated adverse impacts through archaeological-historical data recovery procedures, assuming that adequate funding is available to support the application of such procedures. In instances where sites would be lost under future-without conditions, mitigative data recovery may result in a beneficial effect since, without project-imposed mitigation requirements, important data values would ultimately be lost. In other instances, mitigation may result in no adverse effect, pursuant to 36 CFR Part 800. The detrmination that impacts at such sites could be satisfactorily mitigated, resulting in a no adverse effect determination, would of course depend upon the approval, by the Arizona State Historic Preservation Officer and the Advisory Council on Historic Preservation, of a recommended mitigation plan to recover significant data values. It may be determined, for example, that impacts at specific sites cannot be adequately mitigated in compliance with the requirements of historic preservation legislation, or that a site manifests a heritage value paramount to the scentific value

which it may contain. In either case it may be recommended that such sites be permanently avoided and preserved in the public interest.

4.10 ECONOMICS

For this level of analysis (Stage II), economic effects are expected to be beneficial. Criteria for evaluating effects have been developed primarily on the basis of magnitude, as shown in Table 4-24.

TABLE 4-24

ECONOMIC EFFECTS CRITERIA[a]

Category	Low	Medium	High
	Construction Activities		
Direct Project Employment	<0.5	0.5% to 5%	>5%
	Of Maricopa County Construction employment per year		
Total Direct and Indirect Regional Employment	<0.5%	0.5% to 5%	>5%
	Of total Maricopa County Employment per year		
Total Direct and Indirect Regional Expenditures	<100	100 to 1000	>1000
	Millions of 1980 dollars per year		
Total Direct and Indirect Regional Income	<50	50 to 500	>500
	Millions of 1980 dollars per year		
	Operation Activities		
Total Direct and Indirect Regional Employment (including Agricultural Effects)	<500	500 to 2000	>2000
	Permanent jobs over project life		
Direct Agricultural Employment	<100	100 to 400	>700
	Permanent jobs over project life		
Total Direct and Indirect Regional Income (including Agricultural Effects)	<12	5 to 50	>50
	Millions of 1980 dollars per year		
Direct Agricultural Income	<2	2 to 8	>8
	Millions of 1980 dollars per year		
Total Direct and Indirect Expenditures (including Agriculture)	<25	25 to 100	>100
	Millions of 1980 dollars per year		
Value of Protected Property[b] Relative to 100 Year Flood	--	--	--

[a]Economic effects considered at this level of analysis are expected to be beneficial (positive).
[b]To be provided by The Natelson Company

4.11 SOCIAL ASPECTS

The social effects criteria presented in Table 4-25 were developed in consultation with individuals representing the Water and Power Resources Service, the U.S. Army Corps of Engineers, Dames & Moore, and Abt Associates. The criteria, however, must be considered as tentative at this stage. Until representatives of affected groups have had the opportunity of validating social effects assessments, they remain estimates rather than verified reflections of the social realities within a given area.

TABLE 4-25

SOCIAL EFFECTS CRITERIA

Category	Low	Medium	High
	Construction Activities[a]		
Permanent Relocation:	<10 People	10-100 People	>100 People
	Operation Activities[b]		
Inundation Relocation: Temporary	<50 People <1 Day	>50 People, <7 Days or <50 People, >1 Day	>500 People >7 Days
Transportation Disruption (Salt and Gila River Crossings)	Closure of <40 Traffic Lanes	Closure of 40-70 Traffic Lanes	Closure of >70 Traffic Lanes
Community Disruption	<3 Communities	3-7 Communities	>7 Communities
Interruption of Service Delivery System	<3 Systems, <50 People	>3 Systems, >500 People or >3 Systems, >50 People	>5 Systems, >500 People

[a]Social effects considered at this level generated by construction activities may be either adverse (negative) or beneficial (positive).
[b]Social effects considered at this level generated by operation (functioning) activities are expected to be either neutral or beneficial (positive).

Individuals Consulted in Developing and/or Evaluating Social Effects Criteria

Terry White, Dames & Moore

Jan Henley, Dames & Moore

Debby Saint, Water and Power Resources Service

Chris Gehlker, Water and Power Resources Service

Joe Mantey, U.S. Army Corps of Engineers

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