US Army Corps
of Engineers
Los Angeles District

TANQUE VERDE CREEK, PIMA COUNTY, ARIZONA
LIMITED REEVALUATION REPORT AND
ENVIRONMENTAL ASSESSMENT

FINAL

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EXECUTIVE SUMMARY

This report presents the findings of the Limited Reevaluation Study of Tanque Verde Creek in Tucson, Arizona. Tanque Verde Creek is part of the currently authorized Rillito River and Associated Streams Study (RRAS). Construction of protective measures to control bank erosion along the Rillito River, downstream of Tanque Verde Creek, were authorized by Section 601(b) of the Water Resources Development Act of 1986 (PL 99-662). This study examines the opportunities to stop bank erosion on Tanque Verde Creek which has the potential to destroy both residential and wildlife habitat development.

This report is a complete decision document that presents the results of the current investigation, and to accomplish the following tasks: (1) present study results and findings; (2) indicate compliance with applicable statutes, executive orders and policies; and (3) provide a sound and documented basis for decision makers at all levels to judge the recommended solution.

Tanque Verde Creek is an ephemeral stream, draining a 219 square mile watershed that extends into the Catalina and Tanque Verde Mountains, north and east of Tucson, Arizona, respectively. It combines with another major regional watercourse, Pantano Wash, to become the Rillito River, which continues west along the northern edge of Tucson.

The study reach extends from a short distance downstream of Sabino Canyon Road to Craycroft Road. On the north bank, the existing bank protection begins at Sabino Canyon Road and extends approximately 4,000 feet west (downstream) to Cloud Road. For the remaining distance to Craycroft Road, the north bank is unprotected and the overbank is heavily vegetated with native desert riparian species. On the south bank, the existing soil cement bank protection begins at Sabino Canyon Road and extends approximately 2,700 feet west. An additional section of bank protection, constructed after the 1993 flood, begins approximately 4,220 feet further downstream, and continues 1,600 feet west. The Craycroft Road Bridge is roughly 2,500 feet from that point. At the bridge, the banks are currently protected by soil cement installed either as part of the 1993 flood repairs (north abutment) or as part of the Corps' Rillito River Bank Protection Project (south abutment).

Various erosion control alternatives were developed in cooperation with the non-Federal sponsor and evaluated relative to their effectiveness, acceptability, completeness, and incremental economic efficiency. Engineering analyses indicate that the unprotected areas on the south bank be treated as a nonseparable single contiguous feature. Protection for both the upstream and downstream ends of the existing soil-cement bank protection located midway along the south bank must be provided to completely eliminate its potential for flanking and the risk of re-establishing of the historical meander cutting through Pantano Wash and as far downstream as Alamo Wash. From the array of alternatives, a plan has been selected that is technically feasible, economically efficient, and environmentally sound according to Federal water resources planning criteria. The selected plan includes:

- complete bank erosion control on the southern bank with the construction of two segments of which one is approximately 4,220 linear feet and the other 2,830 linear feet (all being soil cement at a 1:1 slope to the top of bank) and the associated land easements on 10.57 acres for their construction,

- north bank erosion control of 1,550 linear feet, again being soil cement at a 1:1 slope to the top of bank, protecting vulnerable public infrastructure and 5,000 feet of modified bank protection (soil cement at 1:1 but only rising approximately 2 feet along the bank) along the mitigation preserve area, and
- the establishment of a 48-acre riparian habitat area.

The selected plan does not include any provisions for recreation use.

The total first cost for construction of the bank protection of the recommended plan is $4,581,600 (May 2000 price level). The Federal share of the recommended plan is $2,978,000 (65.0% of project cost) and the non-Federal share would be $1,603,600 (35.0% of project cost).

The total annual costs including the annualized gross investment, annual operations and maintenance is currently estimated at $344,700. The period of analysis used to compute annual costs is 50 years with a discount rate of 6⅝ percent.

Average annual bank protection benefits of the proposed bank erosion control elements of the selected plan is $714,100, for a benefit/cost (B/C) ratio of 2.1 and $369,400 in net National Economic Development (NED) benefits. Over 69 percent of the benefits are attributable to structure and content damage reductions with the remaining benefits being related to public property protection (sewer lines) and cleanup costs.

The non-Federal sponsor, Pima County Department of Transportation and Flood Control, has developed a plan to protect a portion of the study area in advance and in connection with the Federal project an approximate 4,220 linear foot section along the creek. With this plan, the non-Federal sponsor has petitioned for Section 104 credit for the advanced construction of a portion of the Federal plan.

The proposed project, which does not alter the 100-year flood plain, would effectively preclude future damages from erosion along the unprotected banks of Tanque Verde Creek. The proposed riparian preserve would sustain the natural condition of the existing habitat and act as an effective buffer for properties located along the northern limit of the geologic flood plain. The analysis presented in this report shows that the selected plan is feasible and serves the public interest. Therefore, it is recommended that the selected plan described herein for bank protection and related measures be authorized for implementation as a Federal project, with such modifications as in the discretion of the Chief of Engineers that may be advisable, and subject to cost sharing and financing arrangements satisfactory to the President and Congress.

TANQUE VERDE CREEK
LIMITED REEVALUATION REPORT
RILLITO RIVER AND ASSOCIATED STREAMS

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CHAPTER I
STUDY AUTHORITY

This Limited Reevaluation Report (LRR) investigates the benefits of providing flood control features on Tanque Verde Creek in Tucson, Arizona, as part of the currently authorized Rillito River and Associated Streams Study (RRAS). A location map is presented in **Exhibit 1, "Study Area Map."** The RRAS was authorized in Public Law 761, Seventy-fifth Congress, known as Section 6 of the Flood Control Act of 1938. This authority, dated June 28, 1938, states:

> *"the Secretary of War (now Secretary of the Army) is hereby authorized and directed to cause preliminary examinations and surveys . . . at the following localities: . . . Gila River and tributaries, Arizona . . ."*

Additional authority was given by Section 601(b) of the Water Resources Development Act of 1986 (PL 99-662) which authorized a project for the Rillito River in Tucson, Arizona, as follows:

> *"Rillito River, Tucson, Arizona. The project for bank erosion control, Rillito River in the vicinity of Tucson, Arizona. Report of the Division Engineer, dated July 14, 1986, for the purpose of providing bank protection against the level of flooding that occurred in October 1983, at a total cost of $26,000,000 with an estimated first Federal cost of $19,550,000 and an estimated first non-Federal cost of $6,450,000. Section 104 of this act shall apply to the project authorized by this paragraph."*

Specific appropriations language further detailing the scope of study for this Limited Reevaluation Report was included in the Energy and Water Development Appropriations Bill, 1998 (PL 105-62), House Report 105-190 [to accompany H.R. 2203], which stated:

> *"Rillito River, Arizona.—Subsequent to authorization of the Rillito River and Associated Streams, Arizona, project, severe flooding has caused damages to public infrastructure and private property along Tanque Verde Creek immediately upstream of its confluence with the Rillito River, between Craycroft and Sabino Canyon Roads. The Corps of Engineers is directed, as part of the Rillito River project, to accomplish a limited reevaluation report of Tanque Creek [sic] immediately upstream and including Craycroft Road Bridge to determine the advisability of extending the bank protection and related measures. The analysis will be consistent with that of the Chief of Engineers' report for the Rillito Creek project to include full use of location benefits for economic justification purposes. The Committee has provided $5,000,000 for this work and the construction of pedestrian bridges required for safety purposes."*

The Pima County Department of Transportation and Flood Control submitted to the Los Angeles District an application, dated June 5, 1998, for credit for implementing flood damage reduction measures in advance of specific project authorization pursuant to Section 104 of the Water Resources Development Act (WRDA) of 1986. The application is for a credit to construct approximately 4,220 linear feet of soil cement bank protection along the south bank of the Tanque Verde Creek. On June 7, 1999, the Assistant Secretary of the Army for Civil Works granted conditional approval for the credit (Appendix A). Final approval and credit determination will be subject to the results of the LRR, Administration review and approval, project authorization, and other requirements of Section 104 of WRDA 1986.

CHAPTER II
STUDY PURPOSE, STUDY SCOPE, AND STUDY AREA

A. Study Purpose and Scope

This Limited Reevaluation Report provides an interim response to the study authority cited in Chapter I. As part of the currently authorized Rillito River and Associated Streams Study (RRAS), the Corps of Engineers completed the *Survey Report and Environmental Assessment for the Rillito River and Associated Streams* in 1987. This report examined flood related problems on the Rillito River and major tributaries, including Tanque Verde Creek. At the time of the final report, there were no economically justified flood control solutions on Tanque Verde Creek, with the exception of Forty-Niners Country Club Estates (which was later studied by the Corps under the Section 205 of the Continuing Authorities Program). Since the publication of the final report, severe flooding has demonstrated that there could be substantial damages to private property, public infrastructure, and existing riparian areas along Tanque Verde Creek, especially within the reach between Craycroft Road and Sabino Canyon Road. Therefore the Pima County Flood Control District, the proposed non-Federal sponsor, has requested this re-evaluation study.

This Limited Reevaluation Report (LRR) investigates the feasibility and incremental justification of adding bank protection and a riparian area preserve on the Tanque Verde River between Craycroft Road and Sabino Canyon Road. The primary project purpose is reduction of flood damages along Tanque Verde Creek. Alternatives examined are consistent with the measures recently completed by the Corps on the Rillito River and have been developed to provide flood protection for private property, public infrastructure, and existing riparian areas along Tanque Verde Creek between Craycroft Road and Sabino Canyon Road. This report is intended to accomplish the following tasks:

- Provide a complete presentation of the results and findings of the investigation into flood related problems along Tanque Verde Creek;
- Indicate compliance with applicable statutes, executive orders and policies; and
- Provide a sound and documented basis for decision makers at all levels to judge the recommended solution(s).

B. Study Area

Tanque Verde Creek is an ephemeral stream, draining a 219 square mile watershed that extends into the Catalina and Tanque Verde Mountains, north and east of Tucson, Arizona, respectively. It combines with another major regional watercourse, Pantano Wash, to become the Rillito River, which continues west along the northern edge of Tucson. Craycroft Road, a major north-south arterial city/county roadway, crosses directly over the confluence via an 850-foot long multispan bridge. The Rillito River continues for approximately 12.2 miles in a northwest direction to its confluence with the Santa Cruz River, and includes a total drainage area of 934 square miles. The natural Rillito River channel averages 250 feet in width and 4 to 7 feet in depth.

The reach of Tanque Verde Creek between Craycroft Road and Sabino Canyon Road is approximately two miles long and is partially bank protected. **Exhibit 2** shows the study area vicinity. The study reach extends a short distance downstream of Craycroft Road and a short distance upstream of Sabino Canyon Road. The study reach is better defined as the unprotected portion of Tanque Verde Creek from the area of Craycroft Road to Sabino Canyon Road. On the north bank, the existing bank protection begins at Sabino Canyon Road and extends approximately 4,000 feet west (downstream) to Cloud Road. For the remaining distance to Craycroft Road, the north bank is unprotected and the overbank is heavily vegetated with native desert riparian species. On the south bank, the existing soil cement bank protection begins at Sabino Canyon Road and extends approximately 2,700 feet west. An additional section of bank protection, constructed after the 1993 flood, begins approximately 4,220 feet further downstream, and continues 1,600 feet west. The Craycroft Road Bridge is roughly 2,500 feet from that point. At the bridge, the banks are currently protected by soil cement installed either as part of the 1993 flood repairs (north abutment) or as part of the Corps' Rillito River Bank Protection Project (south abutment). **Exhibit 3, "Aerial Photo,"** shows the existing and proposed structures in the study area.

Regional Characteristics

The following discussion on the regional characteristics of the study area is largely taken from the discussion of the surrounding area found in the Rillito River Survey Report (USACE, 1987).

The study area lies in the southwest physiographic area known as the Basin and Range Province. It is marked by relatively flat alluvial plains located between mountain ranges extending north and south. The basin is bounded on the north and east by the Santa Catalina, Tanque Verde, and Rincon Mountains, and west of I-10, by the Tucson Mountains. The mountains range in

elevation from 4,600 (1,402 m) to over 9,000 feet (2,743 m) above mean sea level. Valley floor elevations range from 2,200 to 2,800 feet (670 to 853 m).

Climate

Precipitation and temperature in the region surrounding the study area depend largely on altitude. Average annual precipitation ranges from approximately 11 inches at the lowest elevations to as much as 29 inches in the surrounding mountains. There are essentially two rainy seasons; one from July through September and the other during the winter. The mean maximum/minimum temperatures in January in the Tucson area (Tucson Airport, University of Arizona, Tucson Magnetic Observatory) are about 65/36 degrees Fahrenheit (18/2 degrees Celsius), while the same figures for July are 101/73 degrees Fahrenheit (38/23 degrees Celsius).

Geology

Tucson is located on an alluvial plain 10 to 20 miles wide and 30 miles long. The rocks that form the surrounding mountains are pre-Cambrian age metamorphosed granites and Tertiary age volcanics, with some Paleozoic age sedimentary limestone and sandstones. Detritus from the mountains compose the valley fill. Most of the fill is Pleistocene age materials known to exceed 1,000 feet in depth. More recently deposited alluvium is concentrated along the streams and attains an approximate maximum thickness of 100 feet. The older alluvium consists of mostly poorly sorted, coarse to fine sands and gravels, some layers of which also contain silt and clay. Near-surface beds cemented with caliche occur in some areas. The stream alluvium generally consists of loose sand and gravel covered with silt.

Groundwater and Subsidence

Groundwater levels in the study area are deep and continued drawdown may aggravate existing subsidence problems. No significant subsidence problems have been identified within the study area. Most concerns relative to subsidence focus on the perimeters of the valley where the long-term effects of lowering water tables are expected to be most severe.

Biological Characteristics

Vegetation in the Tucson area correlates directly with elevation, available moisture, and temperature. The desert plains support only the hardiest plant life, such as creosote bush/scrub, sagebrush, and catclaw. Saguaro and other cacti are found on the upland slopes of hills and mountains. Stands of mesquite, paloverde, and ironwood are found along intermittent creeks, washes, and rivers. Denser riparian vegetation occurs along flowing streams. Fir and yellow

pine grow in the watershed at elevations above 6,000 feet (1,810 m). Wildlife in the Tucson area is typical of that found in the desert and foothill regions of the Southwest. Common wildlife species include the grey fox, desert cottontail, rattlesnake, pocket mouse, desert horned toad, and the coyote.

Cultural Resources

Human occupation of the Tucson Basin is known to have occurred for over 10,000 years, which has been divided into four periods; the Paleoindian, Archaic, Formative, and Historic. The Paleoindian period is commonly associated with the late Pleistocene big-game hunters and gatherers and is represented in the Tucson Basin by only a few dispersed surface finds. It is believed that Paleoindian sites exist in the basin but are now buried deep below alluvial deposits. Predicting the location of these sites is now essentially impossible given the great change in land forms since they were deposited. The Archaic period, expressed locally as the Cochise Culture, is associated with post-Pleistocene hunters and gatherers. Archaic sites occur both on terraces above the rivers or as deeply buried sites along drainages. The inhabitants of the Formative period are known as the Hohokam. Although distinguished by ceramics and agriculture, the list of cultural attributes associated with this period is extensive and includes clay figurines, cremation, platform mounds, centralized towns, ball courts, and water-control systems. The Historic period began with the entrance of the Jesuit priest Eusebio Kino into the area in 1687. At this time Pima-Papago populations occupied the basin.

It was not until the American period that significant development occurred in southeast Arizona. Silver mines in the area helped finance the Federal Government during the Civil War. This activity motivated the development of area ranching and farming. In 1873 Fort Lowell was moved from Tucson to the Rillito River, affording new protection to the settlers in the area. Finally, the Southern Pacific Railroad arrived in 1880, opening the Tucson area to the rest of the country.

In the study area a Late Rincon phase Hohokam site, AZ:BB:9:54 (ASM), was excavated in 1982. This site is approximately 200 meters north of the Rillito River/Tanque Verde Wash confluence bisecting Craycroft Road. Field surveys of the area of potential effects by Corps archaeologists identified a potential prehistoric archeological site in the Pantano Wash/Tanque Verde Wash confluence area. The site, tentatively identified as COE_TV_99_1, appeared to be a potential pithouse profile with a midden. Section 106 consultation with the State Historic Preservation Officer (SHPO) and additional testing will be necessary for a determination on the eligibility of the site for listing in the National Register of Historic Places.

CHAPTER III
PRIOR STUDIES, REPORTS & EXISTING PROJECTS

A. Prior Studies and Reports

In November of 1945, the U.S. Army Corps of Engineers published the *Interim Report on the Survey of the Gila River and Tributaries in the Vicinity of Tucson, Arizona.* The Chief of Engineers' report, dated October 31, 1946, recommended the construction of a diversion channel and levee system for the protection of portions of Tucson. The project was authorized by the Flood Control Act of 1948 and was completed in 1966. The project protects residential areas along Julian Wash by diverting floodflows. It includes the 120 acre Ajo Detention Basin which is surrounded by a 20 foot high dike. The original approved plan was later modified to include recreation development in the detention basin area.

In the late 1960's, the Corps began a cooperative investigation of flooding and water resources problems in the Santa Cruz-San Pedro River Basins with the Bureau of Reclamation. The Corps studied flood-related problems along the Santa Cruz River and its principle tributaries, from the boundary of the United States and Mexico, north to its confluence with the Gila River. This was an interim study conducted under the Gila River and Tributaries, Arizona and New Mexico study authority. This study addressed flood-related problems on the Rillito River and tributaries and Airport Wash (among others). An economically justified plan of improvement along 10 miles of the Rillito River, from Swan Road downstream to the Interstate 10 bridge, providing 50-year protection, was identified. The plan included a combination of 10 miles of earth-bottom channel with stone-revetted banks and flood plain management. Although local interests were in favor of the proposed plan, they (Pima County) were unable to provide assurances that funds required from them for acquisition of required rights-of-way would be available. Without required local participation, the project could not be recommended for construction. In addition, a justified nonstructural plan for Airport Wash, which included flood plain zoning and floodproofing, was also identified that would reduce potential damages to future development, but was the responsibility of local interests to implement. Due to funding constraints, a final report for this study was never prepared.

In the mid 1970's, two Flood plain Information Reports were prepared by the Los Angeles District at the request of Pima County, under Section 206 of the 1960 Flood Control Act (Public Law 86-645), as amended. The first report addressed the Rillito River and Pantano Wash and was published in June 1973. The second report addressed Tanque Verde Creek and Tributaries

and was published in August 1975. The purpose of these reports was to identify those areas subject to possible future flooding. Although these reports did not provide solutions to flood problems, they did furnish a suitable basis for the adoption of land use controls to guide flood plain development, and thereby prevent intensification of future flood-related damages. These reports were utilized by Pima County to regulate flood plain development.

In 1976, the Mayor and Council of the City of Tucson, and the Pima County Board of Supervisors requested a study by the Corps of Engineers, Los Angeles District, of flooding and related water resources problems in the Tucson metropolitan area, under the Corps' Urban Studies Program. The Tucson Urban Study (TUS) was authorized through a Committee Resolution, Committee on Public Works and Transportation, U.S. House of Representatives, adopted on September 23, 1976. Funding was received in fiscal year 1978 and the TUS began in December 1977. The Final TUS Report was forwarded to the South Pacific Division for approval in May 1985. It recommended no further studies under the TUS authority, with detailed studies to be continued under the Rillito River and Associated Streams authority. The South Pacific Division and Board of Engineers for Rivers and Harbors concurred with this recommendation in July 1985 and November 1985, respectively.

In late 1983, as a result of major damages from flooding in October 1983 along the Rillito River, and at the request of Pima County, the Los Angeles District initiated a Section 14 (Emergency Streambank Protection) Initial Appraisal, in the vicinity of the Flowing Wells Road bridge, to examine the feasibility of protecting public property (utilities, bridge, fire station) from imminent damage from future channel bank erosion. The report recommended construction of 700 linear feet of soil cement revetment bank protection at a cost of $290,000. The report was approved in July 1984. Construction was completed in early 1986.

The authorized plan for the stabilization project for the Rillito River was developed by the U.S. Army Corps of Engineers in the 1986 Survey Report (revised in February 1987). The project includes approximately 10.8 miles of soil cement bank protection and 15 invert stabilizers. The bank protection is similar to that already constructed by local interests along several reaches. At the time of the final report there were no economically justified flood control solutions to the problems on Tanque Verde Creek, with the exception of Forty-Niners Country Club Estates (which was later studied by the Corps under the Section 205 of the Continuing Authorities Program).

In 1992, the Federal Emergency Management Agency completed a Flood Insurance Study which designated the flood hazard zones of the unincorporated areas of Pima County, Arizona.

The General Design Memorandum (GDM) for bank protection along the Rillito River was completed by the U.S. Army Corps of Engineers in October 1992. Construction of the Rillito River bank protection project was divided into three increments - Increments I and II for the flood control portion and Increment III for recreation and aesthetic treatment of the entire river reach. The project includes approximately 10.8 miles of soil cement bank protection and 15 invert stabilizers.

Since the publication of the revised Survey Report in 1987, severe flooding has demonstrated that there could be substantial damages to private property, public infrastructure, and existing riparian areas along Tanque Verde Creek, especially within the reach between Craycroft Road and Sabino Canyon Road. Therefore the Pima County Flood Control District has requested this re-evaluation study. Pima County published a report in 1996 detailing a proposed plan for bank stabilization and a riparian area preserve along Tanque Verde Creek.

B. Existing Projects

The Rillito River Project

The currently authorized project has been constructed along the Rillito River in eastern Pima County, Arizona. The southern portion of the Rillito River is within Tucson City limits, and originates at the confluence of Tanque Verde Creek and Pantano Wash, continuing for 11.2 miles in a northwesterly direction to the Santa Cruz River. The authorized project consists of soil cement, bank stabilization and a comprehensive recreation plan as identified in the May 1986 *Rillito River & Associated Streams Survey Report* and in the October 1992 *General Design Memorandum*. Construction of the Rillito River bank protection project has been divided into three increments - Increments I and II for the flood control portion and Increment III for recreation and aesthetic treatment of the entire river reach.

The Corps of Engineers initiated general design studies for the Rillito River bank protection project in June 1987 after receiving a letter of assurance, dated 6 May 1987, from the Pima County Department of Transportation and Flood Control District, the non-Federal sponsor of the project. In the letter, the County expressed their intent to cooperate with the Federal Government in constructing the authorized Rillito River project.

Technical, environmental, and economic studies addressed the following:

- Bank stabilization between Craycroft Road and Country Club Road and between La Cholla Boulevard and the Santa Cruz River;

- Invert stabilization for the entire river from Craycroft Road to the Santa Cruz River; and

- Recreation for the entire river.

The authorized plan for the stabilization project for the Rillito River was developed in the 1986 Survey Report (revised in February 1987). The project includes approximately 10.8 miles of soil cement bank protection and 15 invert stabilizers. The bank protection is similar to that already constructed by local interests along several reaches.

Tanque Verde Interceptor Extension

Pima County has awarded an engineering and design contract for the construction of the new 36" Tanque Verde Interceptor Extension sewer line on the south side of Tanque Verde Creek. This interceptor will parallel Tanque Verde Creek from Craycroft Road east to the Tucson Country Club.

CHAPTER IV

PROBLEMS AND OPPORTUNITIES

Problems and opportunities were identified, defined, and assessed through coordination with appropriate agencies, site assessments, interpretation of prior studies and reports, and review of existing projects. An initial screening of problems and opportunities included habitat preservation, flooding, and flood control. Specific problems and opportunities were based on an assessment of the existing and expected future without project conditions, as described in the following sections.

A. Historic Conditions

An evaluation of 60 years of photographic records was performed to determine erosion potential along the study area. The series of photographs used in the analysis were 1936, 1953, 1960, 1967, 1971, 1979, 1983, 1993, and 1996. USGS peak discharge records were used in an attempt to correlate movements of the channel or the banks to specific flow events. Records obtained for the Rillito River and Pantano Wash were also obtained to supplement missing records for Tanque Verde Creek. The following paragraphs provide a brief summary of the changes that occurred between the successive years of the photographic record.

1936 - 1953 The most significant change noted during this period was the abandonment of some of the secondary low-flow channels that hugged the south bank in favor of the low-flow channels along the north bank. However, at one location—immediately downstream of Sabino Canyon Road—the south bank appears to have shifted approximately 100 feet in a southwesterly direction. This change could probably be attributed to the December 1940 flow event that approximated the 10-year flood by today's standards.

1953 – 1960 In 1953, the width of the main channel ranged from 80 feet to 260 feet along the study reach. In 1960, channel widths ranged from 80 feet to 400 feet. During this 7-year period, a portion of the south bank migrated approximately 200 feet. This shift occurred within the midsection of the study reach. The lower half of the study reach remained relatively unchanged. Although no recorded flow data is available for Tanque Verde Creek during this period, it appears that several significant flow events occurred along Pantano Wash.

1960 – 1967 Again, little or no change was noted along the north bank during this time period. However, increased development was occurring along the south bank. By 1967, the width of the

main channel along the study reach ranged between 150 feet and 870 feet. The widest section was located in the midsection, where an island had formed due to overtopping flows from the main channel that existed in 1960. This bifurcation of the main channel relocated the active south bank approximately 650 feet from its original location. The lower half of the study reach remained relatively unchanged during this period. Flow records indicate only one significant flow event during this period. A peak discharge of 12,200 cfs was recorded on December 22, 1965.

1967 – 1971 Between 1967 and 1971, no significant change can be observed in the relative location of the respective banks. In addition, the relative width of the main channel remained unchanged. However, earlier attempts to straighten the active midsection proved successful in the sense that a well-defined straight channel predominated within this section of the study reach during the noted time period. Flow records indicate that no significant flow events occurred during this time period.

1971 – 1979 With the exception of a 100-foot lateral shift in the main channel at one isolated location, the channel geometry remained relatively unchanged during this time period. However, one significant flow event did take place on December 18, 1978. The peak discharge during this event was estimated to be approximately 12,700 cfs.

1979 – 1983 As previously mentioned one of the largest events to impact the Rillito River system occurred during this time period (October 1983). Although no flow records were available for Tanque Verde Creek, significant bank erosion was noted. A review of the flow records for the Rillito River and Pantano Wash suggests that the peak discharge on Tanque Verde Creek exceeded a 25-year event (i.e., ±17,000 cfs). Portions of the north and the south banks eroded between 100 and 200 feet. The largest shift occurred along the south bank adjacent to the Tucson Country Club Estates golf course. Since bank protection had been installed along the most upstream portion of the study reach, no erosion occurred in this area. However, the cause and effect relationship that typically surrounds localized bank-protection projects probably contributed to the increased erosion that occurred along the unprotected downstream banks. Most of the damage from the October 1983 flood was isolated to the dynamic midsection, since the downstream one-third of the study reach remained relatively unaffected by the flood. In 1983, the width of midsection channel increased to approximately 920 feet.

1983 – 1993 The largest flood on record (24,500 cfs) occurred during this time period (January 1993). Although the most extensive erosion noted–approximately 150 feet–occurred on the north bank just upstream of Craycroft Road bridge, approximately 100 feet of bank was lost along a portion of the south bank that had been reclaimed after the October 1983 flood. Since

the homes in this area were now located within 150 feet of the bank, and a major sewer line that traverses the area had been exposed, Pima County again reclaimed the bank and installed approximately 1,600 feet of soil-cement bank protection. After the January 1993 flood, the most constrictive width in the main channel became 200 feet.

Exhibit 4, "Channel Morphology Along Tanque Verde Creek," provides an illustrative summary of the changes that have occurred along the study reach between 1953 and 1993. The approximate location of the bank following the October 1983 flood is included, since some reclamation occurred between 1983 and 1993.

The results of the qualitative geomorphic analysis indicate that lateral shifts on the order of 650 feet in the banks of the main channel of the Tanque Verde Creek are not unusual over a 50-year time period. Since the main channel along the study reach continues to occupy the northern third of the geologic flood plain, this erosion rate could result in 650 feet of erosion relative to the south bank. However, erosion to the north bank would probably be limited to the northern boundary of the geologic flood plain. For the most part, the northern boundary of the geologic flood plain corresponds to the northern boundary of the 100-year flood plain, as defined by this study.

B. Existing Conditions

Geotechnical Investigation

The October 1992 General Design Memorandum (GDM) summarized geotechnical investigations that were conducted along the Rillito River from Craycroft Road to the Santa Cruz River in August and September 1988. The purpose of the investigations was to gather data and develop criteria for the design of the Rillito River project's bank protection and invert stabilizers. Design parameters for soil and soil cement construction were determined from the results of field investigations, laboratory tests, and engineering judgment. Subsurface investigations for the GDM consisted of drilling test holes in the invert to depths of up to 30 feet at proposed invert stabilizer locations, and excavating trenches to depths of up to 18 feet along the proposed bank protection alignment. Representative soil samples were collected for classification and for determining moisture-density and maximum-minimum density relationships. Standard penetration tests (SPT) were conducted in some test holes to determine in-situ density/consistency relationships, and moisture samples were collected where appropriate. Previously, subsurface investigations were conducted along the Rillito River during 1978 and 1988. Materials identified within the riverbed and banks of the project site were predominantly fine to coarse sand with silt and about 15 to 40 percent gravel. The fines content was mostly nonplastic and generally between 3 and 8 percent. Slight to medium plastic sandy clays and

sandy silts were also encountered, but with less frequency and cobbles of 5 to 8 inches diameter were found in about 30 percent of the area investigated. No significant difference in grain size gradations were noted between the riverbed and the banks. These soil conditions are considered suitable for embankment fills and backfills.

Stability analyses were performed to evaluate resistance to sliding and overturning of the soil cement revetment and the invert stabilizers. Slope stability of the riverbank that would support the soil cement revetment was also evaluated. The results indicated that adequate safety factors for sliding, overturning and slope stability could be achieved.

The GDM stated that regional subsidence resulting from groundwater depletion in the Tucson basin should result only in minor cracking, and should not compromise the integrity of the structures. The regional groundwater aquifer was estimated to be over 90 feet below ground surface, with shallower perched groundwater present within the flood plain. Foundation settlement along the project alignment was mentioned as not likely being a concern.

Based on these geotechnical findings, the similarity of conditions between Tanque Verde Creek and the immediately adjacent downstream reach of the Rillito River, and the fact that Pima County has made extensive use of locally-available materials for construction of levee slopes with soil cement throughout the county, it would appear that the materials within Tanque Verde are suitable for use in soil cement mixtures. Of course, as these areas are not directly within the project area, additional soil investigations would be necessary during the design phase of this project.

100-Year Flood Plain

An analysis of the 100-year flood plain was conducted using a 1993 topographic base map provided by Pima County in conjunction with the HEC-2 water-surface profile model. This analysis is further detailed in the *Feasibility Level Engineering Analysis* appendix to this report. Two assumptions were made during the course of the analysis which have for the most part provided a conservative estimate of the 100-year flood plain and associated water-surface elevations. The first assumption is related to the starting water-surface elevation that was used in the analysis. It is based on a backwater analysis relative to the confluence region that considers the combined effect of flows from Pantano Wash and Tanque Verde Creek. The entire flood plain model is based on a single discharge, 34,000 cfs, which is the current regulatory 100-year discharge for Tanque Verde Creek. The second assumption applies to the unprotected levee that exists along a portion of the south bank. It appears that this levee was intended to protect the Tucson Country Club golf course from inundation during moderate flow events. However, the results of preliminary analyses indicate that the levees are high enough to contain the 100-year

peak discharge under the assumption of stable levee conditions. Since the contained analysis produced higher water-surface elevations than the uncontained analysis, the flood plain was delineated using the water-surface elevations associated with the contained analysis. This approach provides the most conservative estimate of the limits of the 100-year flood plain. Further, not only is the 100-year peak discharge contained within the channel levees within the immediate study area, but the discharge is also contained within the protected banks of the upstream channel that would effectively act as an inlet to any project proposed herein. Therefore, upstream flanking of a proposed project by the design-flow would not occur and extension of the project upstream of Sabino Canyon Road is not necessary.

With the exception of what appears to be a secondary structure to the primary residence on a single lot, there are no residential structures located within the 100-year flood plain of Tanque Verde Creek. The Tucson Country Club Estates' golf course appears to be the only developed property located within the 100-year flood plain.

Scour and Degradation Potential

The results of the hydraulic analysis—in combination with the single-event scour analysis, the long-term degradation analysis, and the qualitative geomorphic analysis—indicate that the Craycroft Road bridge, the existing bank protection downstream of Craycroft Road, and the Sabino Canyon road bridge are stable under both existing (without project) and with-project conditions. The results of the overall analysis indicate that the south approach to the Craycroft Road bridge would not be undermined and damaged from channel migration along Tanque Verde Creek under existing (without-project) conditions.

Erosion Zone Inventory

The erosion zone consists of residential properties, an existing sewer line, a proposed sewer line, and the Tucson Country Club. There are 56 residential structures within the 1,100-foot erosion zone. Real estate values were determined by the Real Estate Division of the US Army Corps of Engineers, Los Angeles District. The estimate for total value (structure plus land) is $125 per square foot of structure. The estimated structure-only portion of total value is $85 per square foot. Content value was assumed to be 50 percent of structure value. Residential structures in the study area range from 1,800 to over 6,000 square feet in size, with the average being 3,439 square feet. The total value of residential property subject to the erosion threat is shown in **Table 4.1**.

Table 4.1 Erosion Zone Residential Inventory

(February 2000, price level)

Number of Structures	56
Average Structure Value	$292,315
Average Residential Lot Value	$137,560
Average Content Value	$146,158
Total Structure Value	$16,368,195
Total Lot Value	$7,702,680
Total Content Value	$8,184,098
Total Residential Inventory Value	**$32,254,973**

On the north side of Tanque Verde Creek, a 30" sewer line known as the North Rillito Interceptor runs along the base of the bluff. For the most part, the North Rillito Interceptor ranges from 300 feet to 600 feet from Tanque Verde Creek. However, immediately upstream of Craycroft Road, for a distance of approximately 1,550 feet, the North Rillito Interceptor is within 100 feet of the creek. If a line break should occur, it is impossible to close down flow without inducing sewer back-flow into residential properties due to the interceptor's gravity flow design. According to the Pima County Wastewater Management Department, it is likely that a line break during a storm event could produce a 20 million gallon release of wastewater prior to its containment. On the south side of Tanque Verde Creek, Pima County has awarded an engineering and design contract for the construction of the new 36" Tanque Verde Interceptor Extension sewer line. This interceptor will parallel Tanque Verde Creek from Craycroft Road east to the Tucson Country Club. This project was approved with the 1997 sewer system revenue bond ballot initiative. Bond funding for this project is $4,050,000. Erosion protection for this project is estimated to increase its overall cost to $5,800,000.

Tucson Country Club was incorporated in 1947 under the laws of Arizona. The club was organized in conjunction with one of the most prestigious subdivisions in Tucson. The clubhouse, tennis courts, swimming pool, and golf course cover approximately 200 acres. Erosion left unabated would damage the facilities and several golf course holes.

Biological Resources

Vegetation

Tanque Verde Creek is located within the Arizona Upland subdivision of the Sonoran Desert Scrub formation. Major plant communities in the region include creosote-bursage on the bajadas, palo verde-saguaro on well-drained upper slopes, saltbush scrub in the bottom lands where flooding and alkali soils occur, and desert riparian along watercourses. The creosote-bursage community is the dominant native association of vegetation in the Tucson region. In addition to the dominant creosote bush and common bursage, chain fruit cholla and cane cholla are frequently associated with this plant community in the Tucson vicinity.

In the immediate project area, the creosote-bursage vegetation has been largely replaced with urban and recreational development. Desert riparian habitat occurs along watercourses in the region, including Tanque Verde Creek, and is dependent on surface and ground water. In the project area, this plant community is best represented by the mesquite bosques at the upstream confluence of Pantano Wash and Tanque Verde Creek and in the proposed preserve area on the north bank of Tanque Verde Creek. A portion of the proposed mesquite bosque preserve was burned in a fire within the past few years.

In the more disturbed portions of the project area, the desert riparian plant community is represented by occasional Fremont cottonwood in the stream bed. Scattered mesquite, cottonwood, blue palo verde, Mexican elderberry (*Sambucus mexicana*), broom baccharis, and burrobush are found on the stream banks. Saltbush scrub is uncommon in the project area. Complete descriptions and distributions of these communities are contained in the **Environmental Assessment**.

Fish and Wildlife

A diversity of wildlife occurs in the project area, especially in the mesquite bosques. Mammals characteristic of the project area include kangaroo rats, pocket mice, wood rats, cottontail rabbits, blacktailed jackrabbits, raccoon, and coyote. Numerous bird species are found in the project area, especially in the mesquite bosque areas. The following birds have been identified in the project area:

Mallard	Says phoebe
Turkey vulture	Cliff swallow
Cooper's hawk	Common raven
Red-tailed hawk	Verdin
Swainson's hawk	Cactus wren
Harris hawk	Northern mockingbird
Gambel's quail	Curve-billed thrasher
Great blue heron	Black-tailed gnatcatcher
Rock dove	Phainopepla
White-winged dove	Starling
Mourning dove	Lucy's warbler
Roadrunner	Wilson's warbler
Great horned owl	Great-tailed grackle
Poor-Will	Brown-headed cowbird
Lesser nighthawk	Cardinal
Anna's hummingbird	House finch
Black-chinned hummingbird	Lawrence's goldfinch
Costa's hummingbird	Abert's towhee
Northern flicker	Lark sparrow
Gila woodpecker	Black-throated sparrow
Vermilion flycatcher	Chipping sparrow
Ash-throated flycatcher	White-crowned sparrow

Reptiles expected in the project area include Tucson banded gecko, western collared lizard, Gila monster, Sonoran gopher snake, and western diamondback rattlesnake. Few amphibians are expected in the project area due to prolonged periods of drought, but some species adapted to dry conditions, such as Couch's spadefoot toad and Great plains toad may be present. No fish are expected in the project area due to the lack of permanent water (Corps 1986, 1992; USFWS, 1993).

NEPA Compliance/Issues & Concerns

Fish and Wildlife Coordination Act

This project has been coordinated with the USFWS and the Arizona Game and Fish Department. The USFWS, Phoenix Ecological Services Field Office, has prepared a Final Coordination Act Report (CAR) in compliance with the Act. The final CAR is included in the **Environmental Assessment**.

Endangered Species Act of 1973, as amended

Endangered and Threatened species are protected under the Endangered Species Act of 1973 (as amended). If the Federal project sponsor determines that an action may affect a listed species, the agency is required to initiate formal consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Act. The Los Angeles District, U.S. Army Corps of Engineers requested in a letter dated July 16, 1998 that the USFWS provide updated Endangered and Threatened species information pursuant to Section 7 of the Endangered Species Act. The USFWS provided the requested information in a letter dated August 5, 1998. The response includes a total of eighteen (18) listed species and five (5) candidate species. The request and response are included in the **Environmental Assessment**. Subsequent to the preparation of the response, the American Peregrine Falcon (*Falco peregrinus anatum*) was removed from the Federal list of Endangered and Threatened species. The information provided with the response applies to all of Pima County, and is not project specific. The habitat in the project area is unsuitable for the majority of the species. The following listed Endangered and Threatened species potentially occur in the project area:

Bald Eagle (*Haliaeetus leucocephalus*), Threatened. It is estimated that 200 to 300 bald eagles winter in Arizona along rivers and reservoirs. A smaller number of resident birds nest in the state. The habitat in the project area is not suitable for nesting, and is probably unsuitable for foraging, as well. Bald eagles would be expected in the project area only as occasional migrants or transients.

Cactus Ferruginous Pygmy Owl (*Glaucidium brasilianum cactorum*), Endangered. The Cactus Ferruginous Pygmy Owl historically occurred throughout much of the Tucson area. Only a few documented sites are known where this species persists. Habitat consists of mature cottonwood/willow riparian woodland, mesquite bosques, and Sonoran desert scrub. The mesquite bosque habitats at the western end of the project area and the proposed preserve area on the north side of the project area appear to be marginally suitable habitat for this owl. Other areas along the project alignment may be marginally suitable, as well. Pygmy Owl surveys, under USFWS protocols, were conducted on March 17-19, 1999; April 21, 1999, and May 12-14, 1999, and no Cactus Ferruginous Pygmy Owls were detected. A March 11, 1999 search of the Arizona Game and Fish Department Heritage Data Management System revealed no recent observations within the Township and Ranges that include the project area. In addition, informal coordination with biologists indicates that it would be unlikely that the owl would be found on site in future surveys. The report documenting the findings of the surveys is included in the **Environmental Assessment**.

Candidate Species. Candidate species are those species under review for listing as Endangered or Threatened, but for which no formal listing proposal has been published. Candidate species are not protected by federal law, but the USFWS recommends that they be considered in the planning process in the event that they become listed or proposed for listing prior to project completion. The proposed project area appears unsuitable for all of the candidate species known in the Pima County, Arizona area.

Migratory Bird Treaty Act

The proposed project would not involve the taking, killing, harming, or possession of birds protected under the Act. The project is, therefore, in compliance.

Arizona Native Plant Law

This Law provides various levels of protection to many plants native to Arizona. The Law also requires that the Arizona Department of Agriculture be notified prior to removal of protected native plants. The proposed action would not affect any plants designated as "Highly Safeguarded" under the Native Plant Law, but some plants provided a lesser degree of protection, including mesquite, would be removed. The Arizona Department of Agriculture will be notified as required.

C. Expected Future Without-Project Conditions

Erosion/Meander Potential

The results of the qualitative geomorphic analysis indicate that lateral shifts on the order of 650 feet in the banks of the main channel of the Tanque Verde Creek are not unusual over a 50-year time period. This distance correlates very closely to the long-term migration distance (652 feet) computed using the building setback relationship contained in the City of Tucson's drainage standards (City of Tucson, 1989) in conjunction with a bankfull discharge of 17,000 cfs. Likewise, over the 50-year project life, an average annual erosion rate of approximately 13 feet per year appears to be a reasonable estimation of the erosion potential within the area. On a per-event basis, flow events even smaller than a 5-year event could cause bank migration of unprotected banks; the maximum historic migration that has been observed in the study area is 195 feet although the frequency associated with the event is unknown.

The limiting meander potential was determined to be either the boundary of the geologic flood plain or a distance equal to approximately 1,600 feet from the projected centerline of the meander loop. Along the project reach, the centerline of the loop corresponds to a straight line

projected upstream from the centerline of the Craycroft Road bridge crossing to the centerline of the channel at the downstream limit of the existing bank protection. And so, the limiting meander potential for the south bank is an imaginary line located approximately 1,600 feet south of this projected centerline of the meander loop. Since the south bank is located approximately 500 feet from this centerline, the limiting meander potential for the south bank is approximately 1,100 feet. A historical meander of Tanque Verde Creek exists within the 1,100 foot boundary limit that could potentially divert flows towards Pantano Wash and as far downstream as Alamo Wash that could circumvent the existing flood control structures beginning at Craycroft Road. For the north bank, the limiting meander potential corresponds to the northern boundary of the geologic flood plain.

The limit was further identified using soils information (Soil Conservation Service, 1974; University of Arizona, 1985) that shows approximate boundaries of soil types within the area. Two soil regions or zones exist, with the boundary between these two regions appearing to correspond to the northern 100-year flood plain limit. This boundary also represents the approximate line of demarcation between the valley floor and the steeper foothill region. Soils found in the channel region represent a composite of three soil associations that are typically found on flood plains: the Grave, Gila, and Pima associations. Soils found in the foothill region also represent a composite of three soil associations. These are the Pinaleno, Nickel, and Palos Verdes associations. The foothill region soils contain a higher percentage of particles within the coarse sand and gravel size ranges, and the erosion potential is less than that attributed to the channel soils. These physical distinctions in the soil types, the higher elevation, and the lack of a history of erosion within the foothill region supports the assumption that erosion along the north bank would be limited to the northern boundary of the geologic flood plain.

Future Without-Project Economic Damages

The exact nature of the frequency-erosion function is unknown and is dependent upon numerous variables. Yet it is still possible to develop a stylized or synthetic representation of the function. While there is still considerable uncertainty in this synthetic function, it is still a valuable tool to predict erosion behavior on Tanque Verde Creek, especially when combined with a sensitivity analysis.

The analysis uses the greatest historical erosion event of approximately 195 feet of erosion as the 0.0001 frequency event. It further defines the 0.01 frequency event as 90 feet of erosion based on the engineering analysis in the hydraulic appendix. Finally, a non-damaging frequency is defined as a 0.3-year frequency event. Iteratively, additional erosion rates for n-year events are identified in order to derive an erosion function within the HEC-EAD model whose expected annual rate is limited by the engineering analysis' estimate of 13 feet of erosion per year.

A distribution analysis was performed using a Risk and Uncertainty Model (R&U) that randomly generates erosion rates based on the erosion-frequency model and produces a stream of net annual losses for the duration of the study life. The R&U model is repeated 5,000 times, generating a statistically valid distribution of potential erosion outcomes. The following assumptions are taken into consideration by this model:

- Residential Structure and Land Loss - The random erosion process above applies to residential structure and land. The only modification to the process is the assumption of a 13-foot condemnation zone around the structure. In the analysis, if erosion has proceeded within 13 feet of the structure but has not yet destroyed the structure, the structure is deemed uninhabitable and lost.

- Residential Content Loss - Residential content loss applies the basic principles of the R&U model with one major exception. That is a loss only occurs when the streambank erodes from outside the 13-foot condemnation zone to beyond the structure's starting location within any annual period. This assures that contents are only lost when the structure is destroyed and not by condemnation.

- Sewer Line Loss - Sewer line loss applies the same principles of residential content loss. Damages to the sewer line occur when the random erosion process proceeds past the location of the sewer line.

North Rillito Interceptor

The North Rillito Interceptor has a replacement value of $4,611,600 as estimated by the Wastewater Management Department of Pima County. The first 1,550 feet of the interceptor east of Craycroft Road are considered in this analysis as vulnerable to erosion in the economic future of the project. Assuming that the value of this section is proportionate to the overall value of the interceptor, the value of the sewer line in the 1,550-foot section is $1,235,900. The Risk and Uncertainty model of random annual erosion shows that there is a 9% chance that the sewer line would be damaged prior to the provision of streambank protection in the project base year of 2004. It is further assumed that if the sewer line is damaged prior to the project, the entire 1,550-foot zone would be protected from future erosion damage. Under these assumptions, the amortized net present value of the weighted damage is $49,400 per year.

When a sewer line fails, wastewater is released into the environment. Previous Corps studies (most notably the *Emergency Streambank Protection Report* on Walnut Canyon Creek, City of Anaheim, California) have estimated the cleanup costs associated with sewer line failures. The estimated release of 20,000,000 gallons of wastewater due to a sewer line failure, as discussed in the Economic Appendix, would result in equivalent annual damages of $51,000.

Tanque Verde Interceptor Extension

The Tanque Verde Interceptor Extension project should be considered implemented for the without-project condition. The potential "damage" reduction for the extension project in a with-project condition is an avoided cost saving. With a Corps project in place prior to the construction of the extension project the need for the $1.74 million cost of erosion protection to the extension project would be eliminated. On an annual basis the avoided cost savings has a value of $120,100.

Tucson Country Club

The Tucson Country Club was incorporated in 1947 under the laws of Arizona. The club was organized in conjunction with one of the most prestigious subdivisions in Tucson. The clubhouse, tennis courts, swimming pool, and golf course cover approximately 200 acres. The golf course is unique to central and southern Arizona not only because of its size, but because of the significant number of trees which line the fairways. The 2000 trees estimated on the course make it unique in southern Arizona. The golf course could not be replaced elsewhere, because water laws now limit the number of acre-feet of water that new golf courses may utilize. Tucson Country Club is exempt from these stringent water use requirements.

The erosion of 1983 left the golf course without any flexibility to realign holes immediately adjacent to Tanque Verde Creek since sufficient land near the creek is no longer available, and the Country Club is land locked by development. Future erosion left unabated will require a redesign and reconstruction of the golf course to a less desirable configuration. In this case, it is reasonable to assume the corporation's value would decrease given the historical response to the 1983 flood.

Erosion left unabated would damage the facilities and several golf course holes. Given the extent of this potential damage, the use of 30% as the decline shown in 1983 may be considered conservatively low. A thirty percent loss in the "market value" of the Tucson County Club would be $3,825,000.

Economic reasonableness dictates the limiting of damages to the cost of streambank erosion protection since the cost of installing streambank protection along this reach is considerably less than potential damages in the absence of protection. The cost of streambank protection for the Tucson Country Club is $2.1 million. It would be economically more rational for the Tucson Country Club to expend $2.1 million to protect itself than to suffer the $3.8 million loss to

erosion. Therefore, erosion damages to the Tucson Country Club on a National Economic Development basis are limited to $2.1 million. On an annual basis, this loss is $144,500.

Residential Structures

The results of the 5,000 iteration runs for the Risk and Uncertainty model for structures, land and contents indicated a mean net present value (NPV) for structure and land damage of $4,620,091 and a mean NPV of $436,402 for content damage. Amortizing these NPVs at 6⅝ percent over 50 years yields annual damages of $319,000 for structures and land and $30,100 for contents, for a total of $349,100 per year.

Equivalent Annual Damage Summary

Table 4.2 presents a summary of the equivalent annual damages of the without-project condition.

Table 4.2 Equivalent Annual Damages
(February 2000, price level)

Category	Equivalent Damage
Residential Structures & Land	$319,000
Residential Contents	$30,100
North Rillito Interceptor	$49,400
Sewer Spill Cleanup Costs	$51,000
Tanque Verde Interceptor	$120,100
Tucson Country Club	$144,500
Total	**$714,100**

D. Specific Problems and Opportunities

The flood of 1993 resulted in significant damages along Tanque Verde Creek, and these damages prompted a renewed investigation into a project to reduce flood damages to private property, public infrastructure, and existing riparian areas. The following problems and opportunities have been identified in the reach of Tanque Verde Creek between Craycroft Road and Sabino Canyon Road.

Continued Erosion

The localized approach to bank protection in the study area has left large areas with little or no protection. These areas continue to experience rapid erosion during significant flow events. Two large gaps in the bank protection measuring 4,220 and 2,830 feet are currently found on the south bank of Tanque Verde Creek. These gaps are found along the outer edge of a broad bend in the creek and are subjected to continued erosion by low flows and flood flows on Tanque Verde Creek. Localized erosion is visible at the downstream termini of the existing bank protection. On the north bank, immediately upstream of the Craycroft Road Bridge, the existing bank continues to migrate north, and has begun to expose areas of soil cement that are keyed into the sideslope, thereby potentially compromising its integrity. The opportunity exists to provide bank protection between Craycroft Road and Sabino Canyon Road to halt the channel migration and protect existing structures, property, and riparian areas.

Destruction of Riparian Areas

The study area contains many areas of high quality desert riparian habitat. These areas are becoming increasingly scarce, due primarily to development encroachment. The opportunity exists to acquire the rights-of-way to a 500-foot-wide buffer along the north bank. Public ownership would prevent future development of this area, and would preserve the existing riparian values. A more natural bank could also be maintained in this area, since development would be kept at a distance. This would allow for some channel movement and occasional inundation of the riparian area. Riparian ecosystems require occasional inundation by floodflows to stimulate seed germination and provide flushing and cleansing benefits.

Other Potential Problems

Upstream of the Craycroft Road Bridge, an old meander bend extends south of the existing channel. This meander intersects Craycroft Road approximately 1,000 feet south of the bridge. Flood flows and subsurface flows tend to follow this meander and have resulted in the undermining of the roadway embankment in the past. Periodic repairs to the road surface and to an interceptor sewer line are required due to these flows. In the event of a catastrophic flood, flows could undermine and break through the roadway embankment, washing out the roadway and the sewer interceptor. Such an event could also cause inundation and erosion damages to houses and other development west of Craycroft Road, including within the Fort Lowell Historic District.

In addition, floodflows from Pantano Wash have the potential for causing damage. In the confluence area, floodflows would commingle with flow from Tanque Verde Creek, potentially

causing damage to property within the area between the two conveyances as well as to the Craycroft Road bridge and embankment. Since the design of the on the Tanque Verde Creek is for the lesser of the 100-year discharge or the existing bank height damages due to flooding were not quantified in the economic analysis as no additional flood inundation protection will be added. Any project implemented, therefore, would not include flood damage reduction benefits for an area that would still potentially experience residual flood damages from Pantano Wash. In addition, bank erosion and migration damages from Pantano Wash would be expected to advance towards the bank erosion caused by Tanque Verde Creek at approximately the same rate. However, the two creeks are far enough apart that the area being protected by a proposed project on Tanque Verde Creek would not be subject to erosion from Pantano Wash for at least the 50 years representing the life of the proposed project for which benefits were calculated.

CHAPTER V

PLAN EVALUATION

Plan formulation is an iterative analytical process which involves (1) establishing objectives, (2) delineating specific criteria, (3) identifying management measures, and (4) formulating alternative plans. Studies were accomplished in accordance with "Economic and Environmental Principals and Guidelines for Water and Related Land Resources Implementation Studies." For this Limited Reevaluation Report, a single alternative developed by Pima County for the study area (Pima County, 1996) was evaluated as the most desirable and cost effective plan.

A. Planning Objectives

The objective of water and related land resources project planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable Executive Orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services. Water and related land resources project plans are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

The following planning objectives were established to address the problems and realize the opportunities identified along Tanque Verde Creek, and to serve as guidelines for plan evaluation.

- Reduction of flood hazards damages along Tanque Verde Creek;
- Reduction of associated urban damages resulting primarily from streambed degradation and bank erosion and failure along Tanque Verde Creek;
- Protection and, where appropriate, enhancement of existing riparian and wildlife resources of the existing stream environments in conjunction with any proposed project without introducing significant additional recreational opportunities;
- Maintenance of existing open space and natural area resources located within the boundaries of any proposed project to the extent possible; and
- Protection of existing historical, cultural, and archaeological resources located within the boundaries of any proposed project.

B. Evaluation Criteria

Water and related land resources plans are to be formulated to alleviate problems and take advantage of opportunities that occur at the National, State, and local levels in ways that contribute to the NED objectives. These objectives have been redefined in terms of criteria relating to the problems and opportunities being investigated. These criteria provide the framework for consistent plan evaluation. The following is a list of these criteria:

Flood Control

- Any plan should be consistent with Pima County and City of Tucson general plans, particularly the County's Rillito Corridor Study (RCS) and the authorized Rillito River and Associated Streams Study;
- The selected plan should not worsen existing flood hazards for downstream developments without measures to compensate for the effects;
- The plan must be technically feasible using currently available engineering methods and techniques;
- The plan must be generally acceptable to the public (all non-Corps entities); and
- The selected plan should be complete and should not require additional improvements in the future.

Economic Criteria

- The benefits and costs should be expressed in comparable terms as fully as possible. Plan evaluation should be based on the same price level and the same interest rate for both benefits and costs, and a project life of at least 50 years;
- The selected plan must be "justified" in the sense that total beneficial effects associated with the objectives are equal to or exceed the total adverse effects associated with the objectives; and
- Project benefits should be based on analyses of conditions without and with a project, using methodologies described in "Principles and Guidelines" and Corps of Engineers regulations.

Environmental Criteria

- Plans should preserve and enhance the quality of the natural environment. To the extent practical, significant resources including wildlife, vegetation, land, air, water, open space, scenic, and aesthetic values should be preserved and enhanced;

- Detrimental environmental impacts should be avoided where possible and feasible mitigation for unavoidable impacts should be included;

- The relationship of the proposed action to land use plans should be considered, and the environmental impact of any proposed action should be evaluated. Any adverse environmental effects which cannot be avoided, if a proposal were implemented, should be delineated; alternatives to such proposed action should be identified; the relationship between local short-term uses and the maintenance or enhancement of long-term productivity should be determined; and any irreversible and irretrievable commitments of resources involved if a proposed action were implemented should be identified; and

- Consideration should be given to evaluating and preserving historical, archaeological, and other cultural resources.

Socioeconomic Criteria

- Consideration should be given to safety, health, community cohesion, and social well-being;

- Displacement of people should be minimized to the extent practicable;

- Effects of a project on regional developments including income, employment, business and industrial activity, population distribution, and desirable community growth should be considered; and

- The selected plan should be workable within the constraints of present and potential future government structure, function, relationships, and associations in the study areas.

C. Alternative Development and Evaluation Process

The Tanque Verde Creek limited reevaluation study consists of solutions to the defined flood problem based upon the study objectives and designed to address the opportunities while remaining within the limitations imposed by the previously discussed criteria. In broad terms, the general criteria each proposed alternative is required to meet are as follows:

Technical Feasibility: The solution must be technically capable of performing the intended function, have the ability to address the problem, and conform to Corps of Engineers technical standards, regulations, and policies;

Environmental Feasibility: The solution must comply with all applicable environmental laws, including the National Environmental Policy Act (NEPA);

Economic Feasibility: The solution must be economically justifiable in that the economic benefits must exceed the economic costs, in accordance with applicable regulations, policies, and procedures; and

Public Feasibility: The solution must be publically acceptable as evidenced by a cost sharing non-federal sponsor and further documented through an open public involvement process that incorporates the public's input.

Specific measures were developed to satisfy the four feasibility criteria above and the previously mentioned evaluation criteria. Measures are specific stand alone features, both structural and nonstructural, to address the defined problems. There are numerous specific measures that can be utilized to provide flood protection depending upon site location, technical considerations, environmental conditions, and a host of other factors. In determining the set of measures to be evaluated for this study, specific consideration was given to public input and suggestions, Corps experience with similar flooding situations, technical considerations based upon the specifics of the area, and environmental considerations for minimizing impacts.

D. Preliminary Alternatives

Structural Techniques - General

The Los Angeles District in its preparation of the *"Survey Report & Environmental Assessment, Rillito River & Associated Streams,"* conducted extensive analyses of the economic and engineering viability of various structural techniques on the Rillito River to which Tanque Verde Creek is a tributary. The Corps examined gabions, stone revetment, grouted stone, and soil cement revetment. The Corps determined that gabions and stone revetment were cost inefficient in comparison to grouted stone and soil cement revetment, and were dropped from further consideration. Current cost data suggest that the cost efficiencies of grouted stone and soil cement revetment still exist; gabions and stone revetment, therefore, are not considered viable candidates for evaluation. Grouted stone is economically viable; however, current costs and its requirement for additional land maintain its cost ineffectiveness in comparison to soil cement

revetment, as was determined in the Survey Report. Web cellular confinement systems were investigated as potential alternatives. These systems would require the addition of concrete into the cells as flow velocities exceed 15 feet per second (fps), thus defeating their intended environmental advantage. Soil cement revetment remains an engineering and economically viable solution.

Soil Cement Revetment Alternatives

The array of alternatives identified as satisfying all the criteria, in addition to the no-action plan, which have been carried forward for detailed analysis and evaluation are listed below.

Alternative 1: The no-action plan;

Alternative 2: This is the plan preferred by Pima County, and it fully addresses the identified problems along the Tanque Verde Creek between Sabino Canyon Road and Craycroft Road while including both structural and non-structural measures. The structural measures include installing soil cement bank protection in the existing gaps in bank protection on the south bank (two segments of approximately 4,220 and 2,830 linear feet), and installing approximately 1,550 feet of bank protection upstream of the Craycroft Road Bridge on the north bank (see **Exhibits 5-10**) requiring approximately 10.57 acres for their construction. The horizontal alignment of the proposed bank protection would be along smooth curves that generally follow the existing bank. Where applicable, the ends would match the existing soil cement. On the south bank, at the downstream end, the proposed soil cement would key into the bank just upstream of the confluence with Pantano Wash. On the north bank, at the upstream end, the soil cement would key into the existing bank and be tied back to high ground, as shown in **Exhibit 11, "Typical Cross Section of Bank Protection."** The soil cement would match the top of the existing bank, and the toedown would extend 10 feet below the existing thalweg.

The soil cement layer would be an 8-foot thick layer of soil and portland cement that is mixed and placed in 6-inch to 1-foot thick "lifts." The lifts are successively placed until the desired bank protection height is reached. Once compacted, the soil cement mixture provides a hard and durable surface that is expected to last well over the project life of 50 years.

The non-structural component (mitigation) of the proposed plan involves acquiring the rights-of-way to establish a permanent 500-foot buffer along the north bank (see **Exhibits 5 and 6**). Public ownership of this land (approximately 48 acres) would prevent additional development and the associated flood damages, while preserving the riparian values of this heavily vegetated area.

The proposed action would affect desert riparian habitat, including mesquite bosque habitat, along Tanque Verde Creek. A total of approximately 9.0 acres of habitat would be lost, including approximately 1.0 acre of high quality mesquite bosque habitat and 8.0 acres of disturbed desert wash habitat. Impacts to wildlife in the disturbed desert wash area will be minor because relatively few species inhabit these areas, and most are relatively common. Impacts to wildlife found in the mesquite bosque habitats would include temporary and permanent displacement and mortality of some wildlife that is unable to escape. Protection of the south bank would potentially accelerate erosion of the mesquite bosque habitat on the north bank.

Although the bald eagle may be an occasional visitor to the area, no impact to this species is anticipated because no nesting or breeding habitat would be affected, and the habitat would be used only occasionally, if ever, for foraging. Based on protocol surveys conducted in March, April, and May, 1999 the proposed action will not affect the Cactus Ferruginous Pygmy Owl because it does not occur in the project area.

Alternative 3: This plan would be identical to Alternative 2 except approximately 2,830 feet on the south bank just upstream of the Craycroft Road bridge would not receive bank protection. The protection on the south bank would instead tie into the existing protection upstream of the golf course and continue to just downstream of the golf course, beyond the site of the historic meander. The unprotected portion of the south bank would be allowed to erode naturally.

Environmental impacts of Alternative 3 would be the same as the impacts of Alternative 2, except that less habitat would be disturbed on the South Bank upstream of Pantano Wash. The mesquite bosque habitat immediately upstream of Craycroft Road would not be disturbed. About 0.5 acre of low to moderate quality desert riparian habitat would be replaced with soil cement immediately upstream of the golf course to just downstream of the golf course. A total of approximately 2.8 acres of habitat would be lost with this alternative, consisting of approximately 0.3 acre of mesquite bosque habitat and 1.5 acres of disturbed desert wash habitat.

Alternative 4: This plan would be identical to Alternative 2 except that the habitat area would receive erosion protection to eliminate erosion and thereby increase environmental benefits. This would be accomplished by constructing a low soil cement berm adjacent to the bank of the habitat area (approximately 5,000 feet). The berm would stabilize the slope yet be sized to allow overtopping from the 5-10 year flood so as to allow flushing flows. It is

estimated that the berm would be approximately 2 feet above ground with toe-down depths the same as with the upstream and downstream slope protection (approximately 10 feet).

Environmental impacts of Alternative 4 would include the impacts discussed for Alternative 2, as well as impacts of the erosion protection which would be provided on the north bank along the proposed preserve area. Total habitat losses for this alternative are estimated at approximately 9.9 acres, consisting of approximately 1.9 acre of moderate to high quality mesquite bosque habitat and 8.0 acres of disturbed desert wash habitat. Approximately 0.9 acre of moderate to high quality mesquite bosque habitat would be removed or disturbed at the top of the slope for construction of the erosion control berm. Approximately 1.1 acre disturbed desert wash habitat would be removed at the base of the slope for the toe-down. This estimate assumes a width of eight feet for the bank protection and to provide a smooth transition from the erosion protection to the natural bank and an additional ten feet of excavation for the toe-down. The toe-down of 10 feet would not cut off the ground water to the root zone of the mesquite trees. The berm would not be of sufficient height to allow development of the parcel.

E. Preliminary Alternative Economic Analysis

A preliminary non-M-CACES cost estimate for each of the soil cement revetment alternatives was prepared. This estimate in conjunction with the alternative's damage reduction potential was used as an initial screen on economic viability and its relative net damage reduction potential in comparison to other alternatives. An alternative (or alternatives) that showed the potential likelihood of satisfying NED criteria would be further analyzed using an M-CACES cost estimate. All alternatives were assumed to utilize the purchase of the north bank riparian land as mitigation in their cost estimate.

Alternative 2

The preliminary cost estimate for construction of soil cement bank protection and acquisition of the riparian habitat for mitigation is shown in **Table 5.1, "Preliminary Cost Estimate - Alternative 2."**

Table 5.1 Preliminary Cost Estimate - Alternative 2

Item	Units	Quantity	Unit Cost	Cost
Clearing and Grubbing	L.S.	1	$20,000.00	$20,000
Removal of Structures & Obstructions	L.S.	1	$20,000.00	$20,000
Diversion and Control of Water	L.S.	1	$20,000.00	$20,000
Dewatering	L.S.	1	$20,000.00	$20,000
Drainage Excavation	C.Y.	26,000	$3.00	$78,000
Compacted Fill	C.Y.	29,000	$3.50	$101,500
Soil Cement Bank Protection	C.Y.	43,000	$9.00	$387,000
Stabilizer for Soil Cement	Ton	8,400	$110.00	$924,000
Safety Hand Rail	L.F.	8,250	$12.00	$99,000
Subtotal				**$1,669,500**
Contingency (20% of Subtotal)				$333,900
Total Construction Cost				**$2,003,400**
Mobilization (3%)				$60,102
Design Engineering Cost (6%)				$120,204
Construction Admin. & Field Inspection (15%)				$300,510
Right-of-Way			$295,610.00	$295,610
Mitigation Land			$780,560.00	$780,560
TOTAL PROJECT COST				**$3,560,386**

Damage Reduction

The effect of the proposed streambank protection of Alternative 2 is that it would prevent the damages outlined earlier in **Table 4.2, "Equivalent Annual Damages."** Therefore, the average annual benefit of streambank protection is $714,100.

Economic Evaluation

The proposed streambank protection plan has a cost of $3,560,400. Assuming a one-year construction time frame, interest during construction (IDC) is estimated at $117,900, resulting in a project cost of $3,678,300. Amortizing total project cost over 50 years at an interest rate of 6⅝ percent yields an annual cost of $253,965. Including an annual OMRR&R cost of $17,900 increases total annual cost of the project to $271,865. With-project economics are shown in **Table 5.2**, below.

Table 5.2 Alternative 2 NED Economics

Annual			
NED Costs	NED Benefits	B/C Ratio	Net Benefits
$271,865	$714,100	2.63	$442,235

Alternative 3

The preliminary cost estimate for construction of soil cement bank protection and acquisition of the riparian habitat for mitigation is shown in **Table 5.3, "Preliminary Cost Estimate - Alternative 3."**

Table 5.3 Preliminary Cost Estimate - Alternative 3

Item	Units	Quantity	Unit Cost	Cost
Clearing and Grubbing	L.S.	1	$20,000.00	$20,000
Removal of Structures & Obstructions	L.S.	1	$20,000.00	$20,000
Diversion and Control of Water	L.S.	1	$20,000.00	$20,000
Dewatering	L.S.	1	$20,000.00	$20,000
Drainage Excavation	C.Y.	17,445	$3.00	$52,336
Compacted Fill	C.Y.	17,364	$3.50	$60,773
Soil Cement Bank Protection	C.Y.	29,600	$9.00	$266,400
Stabilizer for Soil Cement	Ton	5,800	$110.00	$638,000
Safety Hand Rail	L.F.	5,536	$12.00	$66,426
Subtotal				**$1,163,935**
Contingency (20% of Subtotal)				$232,787
Total Construction Cost				**$1,396,722**
Mobilization (3%)				$41,902
Design Engineering Cost (6%)				$83,803
Construction Admin. & Field Inspection (15%)				$209,508
Right-of-Way			$198,345.00	$198,345
Mitigation Land			$780,560.00	$780,560
TOTAL PROJECT COST				**$2,710,840**

Damage Reduction

Alternative 3 would not provide protection to the Tanque Verde Interceptor Extension from Craycroft Road upstream to the existing bank protection, a distance of approximately 2800 feet. Failure to provide protection in this area would result in the Wastewater Management Department of Pima County installing protection, as discussed in Chapter IV. The avoided cost saving decline for the construction of this 2830-foot element is estimated at $1,052,600 or $72,700 on an annual basis. Average annual benefits for Alternative 3 are $641,400.

Economic Evaluation

The proposed streambank protection plan has a cost of $2,710,840. Assuming a one-year construction time frame, interest during construction (IDC) is estimated at $89,800, resulting in a project cost of $2,800,640. Amortizing total project cost over 50 years at an interest rate of 6⅝ percent yields an annual cost of $193,400. Including an annual OMRR&R cost of $17,900 increases total annual cost of the project to $211,300. With-project economics are shown in **Table 5.4**, below.

Table 5.4 Alternative 3 NED Economics

Annual			
NED Costs	NED Benefits	B/C Ratio	Net Benefits
$211,300	$641,400	3.04	$430,100

Alternative 4

The preliminary cost estimate for construction of soil cement bank protection and acquisition of the riparian habitat for mitigation is shown in **Table 5.5, "Preliminary Cost Estimate - Alternative 4."**

Table 5.5 Preliminary Cost Estimate - Alternative 4

Item	Units	Quantity	Unit Cost	Cost
Clearing and Grubbing	L.S.	1	$20,000.00	$20,000
Removal of Structures & Obstructions	L.S.	1	$20,000.00	$20,000
Diversion and Control of Water	L.S.	2	$20,000.00	$40,000
Dewatering	L.S.	2	$20,000.00	$40,000
Drainage Excavation	C.Y.	29,000	$3.00	$87,000
Compacted Fill	C.Y.	29,000	$3.50	$101,500
Soil Cement Bank Protection	C.Y.	63,700	$9.00	$573,300
Stabilizer for Soil Cement	Ton	12,500	$110.00	$1,375,000
Safety Hand Rail	L.F.	8,250	$12.00	$99,000
Subtotal				**$2,355,800**
Contingency (20% of Subtotal)				$471,160
Total Construction Cost				**$2,826,960**
Mobilization (3%)				$84,809
Design Engineering Cost (6%)				$169,618
Construction Admin. & Field Inspection (15%)				$424,044
Right-of-Way			$295,610.00	$295,610
Mitigation Land			$780,560.00	$780,560
TOTAL PROJECT COST				**$4,581,600**

Damage Reduction

The effect of the proposed Alternative 4 streambank protection is that it would prevent the damages outlined earlier in **Table 4.2, "Equivalent Annual Damages."** Therefore, the average annual benefit of streambank protection is $714,100.

Economic Evaluation

Alternative 4 has a cost of $4,581,600. Assuming a one-year construction time frame, interest during construction (IDC) is estimated at $151,800, resulting in a project cost of $4,733,400. Amortizing total project cost over 50 years at an interest rate of 6⅝ percent yields an annual cost of $326,800. Including an annual OMRR&R cost of $17,900 increases total annual cost of the project to $344,700. With-project economics are shown in **Table 5.6**, below.

Table 5.6 Alternative 4 NED Economics

Annual			
NED Costs	NED Benefits	B/C Ratio	Net Benefits
$344,700	$714,100	2.07	$369,400

Summary of Alternatives

Table 5.7 summarizes the findings on the soil cement revetment alternatives.

Table 5.7 Summary - Soil Cement Revetment Alternatives

Alternative	Annual			
	NED Costs	NED Benefits	B/C Ratio	Net Benefits
Alternative 2	$271,865	$714,100	2.63	$442,235
Alternative 3	$211,300	$641,400	3.04	$430,100
Alternative 4	$344,700	$714,100	2.07	$369,400

Plan Selection

The data presented in Table 5.7 indicates all alternatives have the potential to be the NED plan. Further analysis of their environmental mitigation sufficiency and cost refinements are required for the determination of the NED plan.

Prior to these refinements Table 5.7 also indicates that the addition of the 2830-foot segment on the south bank of the Tanque Verde Creek is incrementally justified. A detailed analysis of this fact is presented in the Economic Appendix, as well as the incremental justification of the northern bank component. As described earlier, the difference between Alternative 2 and 3 is that Alternative 2 contains the 2830-foot protection on the southern bank. An examination of the change in net benefits between Alternatives 2 and 3 reveals a net benefit increase of $12,135 with the change in project scope from Alternative 3 to Alternative 2. These added positive net benefits are attributable to the 2830-foot segment.

If the incremental justification of the 2830-foot south bank segment is acknowledged, further detailed analysis of Alternative 3 would not be warranted as engineering analyses indicates protection for both the upstream and downstream ends of the existing soil-cement bank protection located midway along the south bank must be provided to completely eliminate its potential for flanking and the risk of re-establishing of the historical meander cutting through

Pantano Wash and as far downstream as Alamo Wash. For this reason continued analysis of Alternative 3 was not carried forwarded.

As a result of the preliminary findings on costs and benefits, Alternatives 2 and 4 remain as potential NED candidates. However, the environmental assessment of these plans, as detailed in Appendix B-5: Incremental Cost Analysis and Habitat Evaluation of the Environmental Assessment (EA), indicates that the acquisition of the 48-acre preserve area will not fully mitigate the environmental impacts associated with the construction of Alternative 2. Specifically, the EA states:

> *"The mitigation goal for the Recommended plan is to maintain a minimum of 40.46 AAHUs [average annual habitat units]. With the preserve, a deficiency of 1.6 AAHUs remains. The 48-acre preserve is, therefore, not adequate mitigation for Alternative 2."*

The EA further indicates that Alternative 4 exceeds the minimum goal of 40.46 AAHUs by 4.43 AAHUs (44.48 AAHUs in total) making Alternative 4 consistent with the goals of plan formulation. Alternative 4 is identified as the NED plan, for the above reasons, and is the plan selected for detailed cost (M-CACES) and benefit analysis.

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CHAPTER VI
SELECTED PLAN

The plan selected for recommendation is Alternative 4. This plan was selected because it most closely meets the planning objectives identified for this study, including:

- Provides reduction of flood hazards and associated inundation damages along Tanque Verde Creek;
- Provides protection and, where appropriate, enhancement of existing riparian and wildlife resources of the existing stream environments and does not introduce a recreation potential that would minimize this protection and enhancement;
- The selected plan is complete in and will not require additional improvements in the future;
- The selected plan is "justified" in the sense that total beneficial effects associated with the objectives are equal to or exceed the total adverse effects associated with the objectives; and
- The plan is generally acceptable to the public.

Chapter V, "Plan Formulation," provided the justification for the selection of Alternative 4 based on the preliminary cost estimate for this plan and its comparison to other alternatives based on estimates with the same degree of consideration. The following discussion presents Alternative 4 at a higher M-CACES level of consideration for analysis of its benefits and costs.

A. Plan Description

Project Description

The selected plan, Alternative 4, fully addresses the identified problems along the Tanque Verde Creek between Sabino Canyon Road and Craycroft Road while including both structural and non-structural measures. The structural measures include installing soil cement bank protection in the existing gaps in bank protection on the south bank, and installing approximately 1,550 feet of bank protection upstream of the Craycroft Road Bridge on the north bank. The horizontal alignment of the proposed bank protection would be along smooth curves that generally follow the existing bank. Where applicable, the ends would match the existing soil cement. On the

south bank, at the downstream end, the proposed soil cement would key into the bank just upstream of the confluence with Pantano Wash.

On the north bank, at the upstream end, the soil cement would key into the existing bank and be tied back to high ground. The soil cement would match the top of the existing bank, and the toedown would extend 10 feet below the existing thalweg. Land easements will be obtained for approximately 10.57 acres required for the construction of the structurally protective north and south bank soil cement segments. In addition, limited bank protection on the north bank will be constructed for the preserve area. This limited bank protection will be a low soil cement berm (approximately 5,000 feet in length) with "weep holes" to maintain the hydrologic connection between the creek and the preserve. The berm will stabilize the slope and allow for the continued overtopping of flood waters with events greater than approximately 10-years in size by its low 2-foot height.

The soil cement layer would be an 8-foot thick layer of soil and portland cement that is mixed and placed in 6-inch to 1-foot thick "lifts." The lifts are successively placed until the desired bank protection height is reached. Once compacted, the soil cement mixture provides a hard and durable surface that is expected to last well over the project life of 50 years.

The proposed project footprint would affect desert riparian habitat, including mesquite bosque habitat, along Tanque Verde Creek. A total of approximately 9.9 acres of habitat would be lost, including approximately 1.9 acres of moderate to high quality mesquite bosque habitat and 8.0 acres of disturbed desert wash habitat. Impacts to wildlife in the disturbed desert wash area will be minor because relatively few species inhabit these areas, and most are relatively common. Impacts to wildlife found in the mesquite bosque habitats would include temporary and permanent displacement and mortality of some wildlife that is unable to escape.

Mitigation of the proposed plan, in addition to the berm, involves acquiring the rights-of-way to establish a permanent 500-foot buffer along the north bank. Public ownership of this land (approximately 48 acres) would prevent additional development and the associated flood damages, while preserving the riparian values of this heavily vegetated area.

Project Performance and Residual Flooding

The soil cement bank stabilization will provide a hard and durable surface that is expected to last well over the project life of 50 years and will prevent future movement of the banks in the protected areas. As bank stabilization, the project elements will not affect the existing overflow characteristics of the flood plain and will not alter the current FEMA – FIS mapping of the area.

Alternative 4 will not increase nor decrease the current level of overbank flood protection. The 100- and 500-year overflows for the Tanque Verde Wash will remain as present.

B. Plan Benefits

The Selected Plan would prevent erosion damage to residential structures, the North Rillito Interceptor, and the Tucson Country Club; while providing for an avoided cost saving benefit to the construction of the Tanque Verde Interceptor Extension project and the prevention of cleanup costs associated with sewage releases. The equivalent annual damage prevented by the plan is $714,100, as shown below.

Table 6.1 Equivalent Annual Damage Prevention
(February 2000, price level)

Category	Damage Prevention
Residential Structures & Land	$319,000
Residential Contents	$30,100
North Rillito Interceptor	$49,400
Sewer Spill Cleanup Costs	$51,000
Tanque Verde Interceptor	$120,100
Tucson Country Club	$144,500
Total	**$714,100**

C. Detailed Cost Estimate

Table 6.2 presents a summary of the detailed M-CACES cost estimate, as detailed in the Cost Appendix, for the selected plan. The costs for all structural flood control elements, right-of-way, mitigation, and costs associated with operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the selected plan are included.

Table 6.2 Summary of Detailed Cost Estimate

(May 2000, price level)

Item	Cost
Clearing and Grubbing	$20,000
Removal of Structures & Obstructions	$20,000
Diversion and Control of Water	$40,000
Dewatering	$40,000
Drainage Excavation	$87,000
Compacted Fill	$101,500
Soil Cement	$573,300
Pozzolan, for Soil Cement	$1,375,000
Safety Hand Rail	$98,990
Subtotal	$2,355,790
Contingency (20% of Subtotal)	$471,160
Total Construction Cost	**$2,826,950**
Mobilization	$54,610
Design Engineering Cost	$170,916
Construction Admin. & Field Inspection	$452,944
Right-of-Way	$295,610
Mitigation Lands	$780,560
TOTAL PROJECT COST	**$4,581,590**
IDC	$151,765
Gross Investment	$4,733,355
Annualized Cost (50-yrs, $6^5/_8$%)	$326,800
OMRR&R	$17,900
Total Annual Cost	**$344,700**

The B/C ratio for the Selected Plan ($714,100/$344,700) is 2.1 with net positive NED benefits of $369,400.

CHAPTER VII
PLAN IMPLEMENTATION

This chapter summarizes cost-sharing requirements and procedures necessary to implement the flood control features of the selected plan.

A. Study Recommendation

The Selected Plan is a flood control project. Because of its positive contribution to National Economic Development, the selected plan is recommended for implementation.

B. Division of Plan Responsibilities

The Water Resources Development Act (WRDA) of 1986 (P.L. 99-662), WRDA of 1996 (P.L. 104-303), and other legislation have established the basis for the division of Federal and non-Federal responsibilities in the construction, maintenance, and operation of Federal water resource projects accomplished under the direction of the Corps of Engineers. This is discussed in detail below.

C. Cost Allocation

Cost sharing for construction of this project would be consistent with current Corps of Engineers policy whereby for flood control projects, the non-Federal sponsors shall provide all lands, easements and rights-of-way and dredged material disposal areas, provide relocations of bridges and roadways; provide alteration of utilities which do not pass under or through the project's structure; and maintain and operate the project after construction. Also, during the construction phase, the non-Federal sponsors shall contribute in cash any additional funds as are necessary so that the non-Federal contribution would be at least 35% of those costs assigned to the structural flood control measures. **Table 7.1** presents a summary of apportionment of project first costs between Federal and non-Federal interests for the Selected Plan.

Table 7.1 Cost Apportionment Table
Tanque Verde Wash, AZ - Bank Erosion Control Project

TPC Apportionment Before Consideration of Section 104 Credit			
Feature	Federal	Non-Federal	Total
Construction Costs			
South Bank (Note 1)			
4220' Upstream Segment (Potential 104 Credit)	$1,121,500		
2830' Downstream Segment	$752,100		
Total South Bank	$1,873,600		$1,873,600
North Bank – Flood Control	$411,900		$411,900
North Bank – Mitigation Berm	$1,219,900		$1,219,900
LERRDS Costs			
Flood Control		$295,600	$295,600
Mitigation		$780,600	$780,600
Subtotal	$3,505,400	$1,076,200	$4,581,600
5% of TPC as non-Federal Cash Contribution	-$229,100	$229,100	
Subtotal	$3,276,300	$1,305,300	$4,581,600
Percent of Total Project First Cost	71.5%	28.5%	
Additional Cash Required to 35% share	-$298,300	$298,300	
Subtotal	$2,978,000	$1,603,600	$4,581,600
Local Construction	-$1,121,500	$1,121,500	
Maximum Local Credit	$1,076,200	-$1,076,200	
Total	**$2,932,700**	**$1,648,900**	**$4,581,600**
% of Total Project Cost	64.0%	36.0%	
TPC Apportionment After Consideration of Section 104 Credit			
Feature	Federal	Non-Federal	Total
Construction Costs			
South Bank (Note 1)	$752,100	$1,121,500	$1,121,500
North Bank	$1,631,800	$0	$1,631,800
LERRDS Costs (Note 2)			
Construction	$295,600	$0	$295,600
Mitigation	$780,600	$0	$780,600
Subtotal	$3,460,100	$1,121,500	$4,581,600
5% of TPC as non-Federal Cash Contribution	-$229,100	$229,100	
Subtotal	$3,231,000	$1,350,600	$4,581,600
Percent of Total Project First Cost	70.5%	29.5%	
Additional Cash Required to 35% share	-$253,000	$253,000	
Total	**$2,978,000**	**$1,603,600**	**$4,581,600**
% of Total Project Cost	65.0%	35.0%	

Notes:

1. Construction costs associated with 4220 LF of protection along the southbank preliminarily approved for Section 104 credit consideration.

2. Section 104 Credit can only be applied to LERRDS needed for construction and mitigation measures.

D. Current and Future Work Eligible for Section 104 Credit

The Pima County Department of Transportation and Flood Control submitted to the Los Angeles District an application, dated June 5, 1998, for credit for implementing flood damage reduction measures pursuant to Section 104 of the Water Resources Development Act (WRDA) of 1986 (Appendix A). The application is for a credit to construct approximately 4,220 linear feet of soil cement bank protection along the south bank of the Tanque Verde Creek, beginning from the existing bank protection west of Sabino Canyon Road to the existing bank protection at the downstream end (gap on the upstream end of the south bank). This reach would begin at Station 39+67 and would end at Station 81+87, as shown on Exhibit 6 - Plan Sheets 1 & 2 found at the end of the Report.

On June 7, 1999, the Assistant Secretary of the Army for Civil Works granted conditional approval for the credit. Final approval and credit determination will be subject to the results of the LRR, Administration review and approval, project authorization, and other requirements of Section 104 of WRDA 1986.

Therefore, of the Recommended Plan two segments (the north bank and the 2,830' south bank segment upstream of Craycroft Road bridge to the existing bank protection) are to be constructed by the Corps and the above Section 104 Credit segment to be constructed by the local sponsor.

E. Institutional Requirements

Upon implementation of the cost-shared project, the non-Federal sponsor, the Pima County Department of Transportation and Flood Control, will prepare the following preliminary financial analysis:

(1) Assess project-related yearly cash flows (both expenditures and receipts where cost recovery is proposed), including provisions for major rehabilitation and operational contingencies and anticipated but uncertain repair costs resulting from damages from natural events;

(2) Demonstrate ability to finance their current and projected-future share of the project cost and to carry out project implementation operation, maintenance, and repair/rehabilitation responsibilities;

(3) Investigate the means for raising additional non-Federal financial resources including but not limited to special assessment districts; and

(4) Complete any other necessary steps to ensure that they are prepared to execute their project-related responsibilities at the time of project implementation.

In addition, as part of any Project Cooperation Agreement (PCA), the non-Federal sponsor would be required to undertake to hold and save the Federal Government free from damages due to construction, operation, and maintenance of the project, excluding damages due to the fault or negligence of the Federal Government or its contractors.

F. Environmental Requirements

The Clean Water Act governs discharge or dredge of materials in the waters of the United States and it governs pollution control and water quality of waterways throughout the U.S. Its intent, in part, is to restore and maintain the biological integrity of the nation's waters. The goals and standards of the Clean Water Act are enforced through permit provisions. Sections 404, 401 and 402 of the Clean Water Act pertain directly to the proposed project. Section 404 outlines the permit program required for dredging or filling the nation's waterways.

The Corps does not issue itself a permit for civil works projects; therefore, to comply with Section 404 of the act, a 404(b)(1) analysis has been performed and is included in the **Environmental Assessment**. Section 230.10(a)(2) of the 404(b)(1) guidelines states that "an alternative is practicable if it is available and capable of being done after taking into consideration costs, existing technology and logistics in light of overall project purposes."

The Selected Plan would result in discharge of fill material into waters of the United States during the period of construction. It also may result in discharges associated with operation and maintenance activities.

The proposed bank stabilization would occur along Tanque Verde Creek and at the confluence of Pantano Wash. The proposed project would be coordinated with the Arizona Department of Environmental Quality (ADEQ). A State of Arizona water quality form WQMS - 404 003 shall be prepared and submitted to the ADEQ in compliance with regulations. The Corps would submit to ADEQ the required ADEQ/WQD form 404-003. A request for a Section 401 Water Quality Certification with form 404-015 application would be submitted to ADEQ with the Draft EA. Prior to project construction a Section 401 Water Quality Certification shall be obtained. In addition, a NPDES permit would also be required for any water discharged to the river.

The non-Federal sponsor would be required to obtain a Section 404 permit for future O&M activities. Should there be a change in conditions not anticipated during this investigation or

O&M requirements need modification, then an appropriate NEPA document would need to be prepared to modify the O&M activities and determine the need for any mitigation.

An archeological field survey of the proposed project Area of Potential Effects (APE) has been conducted in accordance with the Section 106 of National Historic Preservation Act of 1966 (36 CFR 800). At this time, Section 106 consultation has not been coordinated with the State Historic Preservation Officer (SHPO). The prehistoric archeology site COE_TV_99_1 appears to be only associated with transport from extended high velocity stream flows. However, additional subsurface testing would indicate the site's composition and whether the site is part of AZ:BB:9:54.

The project is currently not in compliance with Section 106 of the National Historic Preservation Act. Informal consultation has been initiated with the Arizona Office of Historic Preservation. Current survey information is insufficient to determine the National Register eligibility of the site. To conform to the requirements of Section 106, a site number needs to be acquired from the Arizona State Museum. A survey report needs to be filed and transmitted to the SHPO and subsurface testing of the site needs to be completed. If the tests indicate that the site has the potential ability to answer significant questions on the prehistory of the Tucson Basin, the site will be eligible for listing in the National Register of Historic Places. If the site is determined to be eligible for listing, a Memorandum of Agreement (MOA) will be required between the Corps of Engineers, the SHPO, interested Native Americans, Pima County, and potentially the Advisory Council on Historic Preservation prior to the mitigation of any adverse effects to the site by the project. The MOA will contain stipulations that will guide mitigation. When the MOA is executed, the project will be in compliance with Section 106 and may proceed. The processes necessary for Section 106 compliance will be conducted during PED.

G. Non-Federal Responsibilities

The presently estimated non-Federal share of the total first cost of the project is $1,603,600, 35.0% of total first cost. The non-Federal share includes $0 in lands and damages.

Requirements of non-Federal cooperation are specified below:

(1) As required by Public Law 99-663, the Water Resources Development Act of 1986, as amended by Section 202 of Public Law 104-303, the Water Resources Development Act of 1996, provide 35 percent of total project costs assigned to flood control, as further specified below:

a. Provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project.

b. Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, and maintenance of the project. Such improvements may include, but are not necessarily limited to, retaining dikes, waste weirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes.

c. Provide any additional amounts as are necessary to make its total contribution equal to 35 percent of total project costs assigned to flood control.

d. Enter into an agreement which provides, prior to construction, 25 percent of preconstruction engineering and design (PED) costs.

e. Provide, during construction, any additional funds needed to cover the non-Federal share of PED costs.

(2) For so long as the project remains authorized, operate, repair, replace, rehabilitate and maintain the completed project and hydraulic integrity of the system, along with any required long-term dredged or excavated material disposal areas, in a manner compatible with the project's authorized purposes, and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

(3) Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(4) Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with

applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

(5) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

(6) Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the project and any betterment, except for damages due to the fault or negligence of the United States or its contractors.

(7) Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments in 32 CFR Section 33.20.

(8) Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the project. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

(9) Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project.

(10) To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

(11) Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

(12) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(13) Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

(14) Provide 35 percent of that portion of total cultural resource preservation mitigation and data recovery costs attributable to flood control that are in excess of 1 percent of the total amount authorized to be appropriated for flood control.

(15) Comply with Executive Order 11644, "Use of Off-Road Vehicles on the Public Lands", dated 8 February 1972 as amended by Executive Order 11989, dated 24 May 1977, which established policies and provides for procedures to ensure that the use of off-road vehicles on public land is controlled to protect the resources, promote safety of all users, and minimize conflicts among the various uses.

(16) Participate in and comply with applicable Federal flood plain management and flood insurance programs.

(17) Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

(18) Full compliance with US Code 33 USC 1251 et seq Costal for the attainment of Section 404 permits for OMRR&R activities of the project.

H. Sponsorship Agreements

The Pima County Department of Transportation and Flood Control has indicated its support for the selected plan and has provided a Letter of Intent acknowledging sponsorship requirements for the Selected Plan (Appendix A). Prior to the start of construction, the non-Federal sponsor will be required to enter into an agreement with the Federal Government that it will comply with Section 221 of the Flood Control Act of 1970 (P.L. 91-611), and the Water Resources Development Act of 1986 (P.L. 99-662) as amended.

I. Procedures for Implementation

Future actions necessary for authorization and construction of the selected plan is summarized as follows:

(1) This report will be reviewed by the Headquarters of the U.S. Army Corps of Engineers, Washington D.C.

(2) The Chief of Engineers will seek formal review and comment by the Governor of the State of Arizona and interested Federal agencies.

(3) Following State and Agency review, the report will be sent to the Assistant Secretary of the Army for Civil Works.

(4) Upon approval of the Assistant Secretary, the report will be forwarded to the Office of Management and Budget (OMB) to obtain the relationship of the project to programs of the President.

(5) The final report of the Chief of Engineers will then be forwarded by the Assistant Secretary of the Army for Civil Works to Congress.

(6) Congressional review of the feasibility report and possible authorization of the project would follow.

(7) Pending project authorization for construction, the Chief of Engineers could include funds where appropriate, in his budget requests for preconstruction engineering and design of the project. The objective is to ready each project for a construction start established with the feasibility study.

(8) Following receipt of funds, preconstruction engineering and design would be initiated and surveys and detailed engineering designs would be accomplished.

(9) Following Congressional authorization of the project, plans and specifications would be accomplished by the District Engineer.

(10) Subsequent to appropriation of construction funds by Congress, but prior to construction, formal assurances of local cooperation would be required from non-Federal interests.

(11) Bids for construction would be initiated and contracts awarded.

CHAPTER VIII
RECOMMENDATIONS

I recommend that the Rillito River and Associated Streams project authorization be further modified to authorize the recommended plan herein for the purpose of bank protection and related measures. The total first cost of the project is currently estimated at $4,581,600 under May 2000 prices. The Federal share is currently estimated at $2,978,000.

My recommendation is subject to cost sharing, financing, and other applicable requirements of Federal and State laws and policies, including Public Law 99-663, the Water Resources Development Act of 1986, as amended by Section 202 of Public Law 104-303, the Water Resources Development Act of 1996, and in accordance with the following requirements which the non-Federal sponsor must agree to prior to project implementation.

(1) As required by Public Law 99-663, the Water Resources Development Act of 1986, as amended by Section 202 of Public Law 104-303, the Water Resources Development Act of 1996, provide 35 percent of total project costs assigned to flood control, as further specified below:

a. Provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project.

b. Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, and maintenance of the project. Such improvements may include, but are not necessarily limited to, retaining dikes, waste weirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes.

c. Provide any additional amounts as are necessary to make its total contribution equal to 35 percent of total project costs assigned to flood control.

d. Enter into an agreement which provides, prior to construction, 25 percent of preconstruction engineering and design (PED) costs.

e. Provide, during construction, any additional funds needed to cover the non-Federal share of PED costs.

(2) For so long as the project remains authorized, operate, repair, replace, rehabilitate and maintain the completed project and hydraulic integrity of the system, along with any required long-term dredged or excavated material disposal areas, in a manner compatible with the project's authorized purposes, and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

(3) Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(4) Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project, including mitigation features without cost to the Government, in a manner compatible with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto.

(5) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

(6) Hold and save the United States free from all damages arising from the construction, operation, and maintenance of the project and any betterment, except for damages due to the fault or negligence of the United States or its contractors.

(7) Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail

as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments in 32 CFR Section 33.20.

(8) Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, and maintenance of the project. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

(9) Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project.

(10) To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

(11) Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

(12) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(13) Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

(14) Provide 35 percent of that portion of total cultural resource preservation mitigation and data recovery costs attributable to flood control that are in excess of 1 percent of the total amount authorized to be appropriated for flood control.

(15) Comply with Executive Order 11644, "Use of Off-Road Vehicles on the Public Lands", dated 8 February 1972 as amended by Executive Order 11989, dated 24 May 1977, which established policies and provides for procedures to ensure that the use of off-road vehicles on public land is controlled to protect the resources, promote safety of all users, and minimize conflicts among the various uses.

(16) Participate in and comply with applicable Federal flood plain management and flood insurance programs.

(17) Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

(18) Full compliance with US Code 33 USC 1251 et seq Costal for the attainment of Section 404 permits for OMRR&R activities of the project.

The plans presented herein are recommended with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the non-Federal sponsors, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Richard G. Thompson
Colonel, Corps of Engineers
District Engineer

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CHAPTER IX
REFERENCES

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Exhibits

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APPENDIX A

PIMA COUNTY
DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT
201 NORTH STONE AVENUE, FOURTH FLOOR
TUCSON, ARIZONA 85701-1207

KURT WEINRICH, P. E.
DIRECTOR

(520) 740-6410
FAX (520) 620-1933

August 13, 2002

Colonel Richard G. Thompson
District Engineer
United States Army Corps of Engineers
Los Angeles District
911 Wilshire Blvd.
Los Angeles, CA 90017

Re: Tanque Verde Creek Project

Dear Colonel Thompson:

Pima County Flood Control District hereby confirms its support for the construction of the Tanque Verde Creek, Craycroft to Sabino Canyon Project. Bank stabilization and environmental restoration along the Tanque Verde project reach would be of great benefit to the County and community. We understand the cost sharing requirement for the construction of the project: 65% by the Federal government and 35% by the local sponsor. Pima County Flood Control District would provide the necessary funding through flood control levy funds.

We appreciate the cooperation and support you have provided for this and other projects in Pima County and look forward to successful completion of this project.

Sincerely,

Suzanne Shields
Deputy Director, Flood Control

c: Kurt Weinrich, Director
Leo Smith, Division Manager
Larry Robison, Design Manager

Scanned Copy of Non-Federal Letter of Support

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DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P. O. Box 532711
LOS ANGELES, CALIFORNIA 90053-2325

July 2, 1999

REPLY TO
ATTENTION OF:

Office of the Chief
Plan Formulation Branch

Mr. Brooks Keenan
Director
Pima County Flood Control District
210 North Stone Avenue
Tucson, Arizona 85701

Dear Mr. Keenan:

I am pleased to inform you that the Pima County Department of Transportation and Flood Control District's request for a potential credit under Section 104 of WRDA 1986 regarding construction of soil-cement bank protection along the south bank of the Tanque Verde Creek has been approved.

As you may be aware, this is a conditional approval and is not an assurance that specific credit will be given against the non-Federal share of the flood damage reduction project. The final approval and credit determination will be subject to the results of the Limited Reevaluation Report (LRR), Administration review and approval, project authorization and other requirements of Section 104 of WRDA 1986. Also, it is important to note that while the Corps may recommend the overall project as a flood damage reduction project, the Office of Management and Budget has historically considered this type of project as bank erosion protection, and not the responsibility of the Corps. Thus, this conditional approval should not be interpreted as a commitment to recommend the project for authorization, or for reimbursement if a Federal project is not undertaken.

The preparation of the LRR was initially scheduled for completion in June 1999. Several issues have arisen creating the necessity to extend that schedule. These issues include a delay in acquiring access to private properties in order to perform the endangered species survey and the discovery of a significant cultural resource site within the project area. This site requires extended coordination with the resources agencies. In light of the above we are extending the completion of the LRR and the environmental document to January 2000.

Please contact me at (213) 452-3964 or have your Staff call me or Mr. Dan Young at (213) 452-3794 for any questions.

Sincerely,

John P. Carroll
Colonel, Corps of Engineers
District Engineer

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

REPLY TO
ATTENTION OF

7 JUN 1999

MEMORANDUM FOR THE DIRECTOR OF CIVIL WORKS

SUBJECT: Tanque Verda Creek, Arizona – Section 104 Credit

This is in response to your April 14, 1999, memorandum requesting approval of the Pima County Department of Transportation and Flood Control District's application for credit for implementing flood damage reduction measures pursuant to Section 104 of the Water Resources Development Act (WRDA) of 1986.

The Pima County Department of Transportation and Flood Control District's application is dated June 5, 1998. The South Pacific Division and Los Angeles District have reviewed the application and certify that the proposed work meets the requirements for application for a credit under Section 104 of WRDA 1986. The application is for a credit to construct approximately 4,000 linear feet of soil cement bank protection along the south or left bank of the Tanque Verde Creek. We understand that Pima County plans to initiate this work prior to the completion of the Corps Limited Reevaluation Report (LRR) which will be used to seek authorization of a larger project along Tanque Verde Creek. The Los Angeles District estimates that the cost of the work for which the credit has been requested is about $1,300,000. Your April 14, 1999, memorandum indicates that the Corps has determined that the work is separately useful for flood damage reduction, integral to the plan that may be proposed in the LRR, economically justified, environmentally acceptable, and urgently needed. We also understand that the final LRR is scheduled to be completed by the Los Angels District in June 1999.

The Pima County Department of Transportation and Flood Control District's request for a potential credit is approved. This conditional approval should not be interpreted as an assurance regarding later approval of a specific credit against the non-Federal share of an authorized flood damage reduction project. Final approval and credit determination will be subject to the results of the LRR, Administration review and approval, project authorization, and other requirements of Section 104 of WRDA 1986.

CECW-PF

Upon notification of this approval, the Los Angeles District Engineer should notify Pima County of the conditions upon which this conditional approval is being made. While we realize that the Corps may recommend the overall project as a flood damage reduction project, the Office of Management and Budget has historically considered projects of this type as bank erosion protection, and not the responsibility of the Corps. Thus, one of the conditions that should be specifically noted to the sponsor is that this conditional approval should not be interpreted as a commitment to recommend the project for authorization, or for reimbursement if a Federal project is not undertaken.

Joseph W. Westphal
Assistant Secretary of the Army
(Civil Works)

CESPD-ET-P (CESPL-PD-WA/4 Feb 99) (1105) 1st End Mr. Frentzen/415-977-8164
SUBJECT: Application for Consideration of Section 104 Credit, Tanque Verde Creek Project, AZ

DA, South Pacific Division, Corps of Engineers, 333 Market Street, Room 923
San Francisco, CA 94105-2195

17 FEB 1999

FOR CDR HQUSACE, CECW-PE, 20 Mass. Ave., NW., Wash, DC 20314-1000

CDF/tjm
CESPD-ET-P
enrillito
7-8164
10 Feb 99

1. The Los Angeles District is preparing the final Limited Reevaluation Report (LRR) for Tanque Verde Creek in accordance with the requirements set forth in 1998 Appropriations Act language. The act language directs the Corps of Engineers to accomplish the LRR for Tanque Verde Creek, within the area encompassed by the Rillito River Project.

JWWB
CESPD-ET-P

2. Previous correspondence between this office and HQUSACE has led to the finding that the decision document (LRR) for Tanque Verde Creek will require Congressional Authorization.

JEF
CESPD-ET-E

3. The Section 104 Credit request for Tanque Verde Creek has been prepared at the request of the Pima County Flood Control District (non-Federal local sponsor) consistent with Corps of Engineers Regulations (ER 1165-2-29). The proposed work by the local sponsor is separately useful for flood damage reduction, compatible with the Federal Plan, economically and environmentally feasible, and urgently required to mitigate flood damages.

DPD
CESPD-ET-R

SLS
CESPD-ET

4. Accordingly, I concur with the District Engineer's recommendation to approve Pima County's request for Section 104 Credit for their construction work on Tanque Verde Creek.

WRD
CESPD-PM

FR
CESPD-XA

Encl
nc

PETER T. MADSEN
COL (P), EN
Commanding

PAT
CESPD-DD

CF:
CESPL-PM
CESPL-PD
CESPD-PM
CESPD-ET-E
CESPD-ET-R
CESPD-OC
CESPD-ET-P
CESPD-ET-P rf

PTM
CESPD-DE

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P. O. Box 532711
LOS ANGELES, CALIFORNIA 90053-2325

REPLY TO
ATTENTION OF:

CESPL-PD-WA (1105-2-10a) 4 February 1999

MEMORANDUM FOR Commander, South Pacific Division, ATTN: CESPD-ET-P (Frentzen)

SUBJECT: Application for Consideration of Section 104 Credit, Tanque Verde Creek Project, AZ

1. The enclosed letter from the Pima County, Department of Transportation and Flood Control District, dated 5 June 1998, requests that consideration for credit under Section 104 of Public Law 99-662 be approved. The Water Resources Development Act of 1986 provides a mechanism for the Department of the Army to determine whether work carried out by local interests is compatible with a project for flood control. It further gives the Secretary the authority to conditionally approve credit for the cost of said work to alleviate flood damages, while providing assurance that the local interests will not be adversely affecting the project's economic feasibility.

2. The following authorities and documents apply to this application:

a. Public Law 761, Seventy-fifth Congress, known Section 6 of the Flood Control Act of 1938. This act authorizes an examination of the flood potential for the Gila River and Tributaries, Arizona, area.

b. Water Resources Development Act of 1986, Section 601(b), which authorized a project for the Rillito River in the vicinity of Tucson, Arizona and stated that Section 104 of this act will apply to the project.

c. Energy and Water Development Appropriations Bill of 1998, Report 105-190, accompanying House Resolution 2203. This authorization directed the Corps of Engineers to accomplish a limited reevaluation report for Tanque Verde Creek, which is encompassed within the area of the authorized Rillito River Project.

d. Draft of the Limited Reevaluation Report (LRR) for Tanque Verde Creek, Pima County, Arizona, dated September 1998.

e. Section 104 Credit application, dated 5 June 1998 and amendment letter, dated 26 October 1998, both from the Pima County Flood Control District.

3. The LRR has been charged with determining the advisability of extending the bank

protection and related measures for that portion of Tanque Verde Creek immediately upstream of its confluence with Rillito Creek, between the Craycroft Road and Sabino Canyon Road Bridges. This area has been subject to severe flooding and resultant damages to public infrastructure and private property.

4. The proposed project as defined in the LRR, covers the river length between the Craycroft Road and the Sabino Canyon Road Bridges. It will include the construction of approximately 7,049 feet of soil cement bank protection in two existing gaps of the bank protection along the south bank of the creek, and approximately 1,549 feet of the bank protection along the north bank of the creek. In addition, the length of the creek along the north side that has no bank protection will either be left in its existing condition, or if it is determined that the Corps project will induce damages along this reach, then, this property will either be protected or be acquired.

5. Pima County has awarded a contract for the design of a new 36-inch interceptor sewer line, which will be located along the south side of Tanque Verde Creek. It will parallel the creek between Craycroft Road and the Tucson Country Club located upstream of the road. If Pima County has the opportunity to receive Section 104 credit for bank stabilization in conformity with the Rillito River project and the LRR for Tanque Verde Creek, they estimate that this segment of the Rillito Creek project will remove the need to budget and fund a project for bank stabilization in this immediate area.

6. It is their desire to provide flood protection now to prevent recurring, substantial flood and erosion damages to private properties and infrastructures and protect the interceptor sewer line discussed in 5. above. In addition, significant benefits result from preventing recurring substantial flood and erosion damages to private properties and public infrastructure in this area. The largest flood on record (24,500 cfs) occurred in January 1993, causing extensive erosion along both the north and south banks in this area.

7. Pima County has specified that the Section 104 credit be applied to the work that will be performed to build the portion of the Corps project along the south side, beginning from the existing bank protection west of Sabino Canyon Road to the existing bank protection at the downstream end (gap on the upstream end of the south bank). This would include approximately 4000 LF of soil-cement bank protection. According to the draft LRR the cost to construct this feature would be approximately $1.3 Million.

8. According to the draft LRR, the estimated cost of the project is $2,850,477, with an annual cost for operations and maintenance projected at $17,900. The with-project economic analysis indicates a national economic development (NED) annual cost of $235,186 with related benefits of $697,702. This translates into net benefits of $462,516 and a benefit/cost ratio of 2.97.

CESPL-PD-WA
SUBJECT: Application for Consideration of Section 104 Credit, Tanque Verde Creek Project

9. Pima County's letter of request states that their project cost estimate is estimated at $3,500,000. Based on the scope of the application made by Pima County, we have been able to evaluate its relationship to the Federal plan and believe many aspects of their project are in line with the LRR and the overall Rillito Creek Project as authorized by Congress.

10. Major cost variations between the LRR project and Pima County projects are illustrated in Table 1. The resolution of these differences and the true costs eligible for Section 104 credit will be accomplished when detailed plans are developed by Pima County and reviewed by this District.

11. Since the subject work would be constructed by Pima County Flood Control District, a Section 404 regulatory Permit is assumed to be required under the Clean Water Act. The work would also require NEPA documentation. If an individual Section 404 Permit is required, NEPA documentation would be required as part of the permit process. If the work is determined to be exempt from individual Section 404 permit requirements, it will still be subject to NEPA requirements to be eligible for credit under a Federal program. This work would also be subject to the Endangered Species Act and the National Historic Preservation Act requirements.

12. Although the Environmental Assessment as part of the current Corps study has not been completed to date, preliminary Corps assessment indicates that the proposed work for this project reach will have no significant environmental impacts.

13. The environmental document is currently scheduled to be completed in March 1999 and the final LRR would be ready in June 1999. The schedule could potentially be impacted by the delay being experienced in acquiring the rights-of -entry in order to perform the Endangered Species survey, which must be performed during a specific window. Pima County is actively pursuing the remaining rights-of-entry.

14. I recommend that the Assistant Secretary of the Army (Civil Works) approve Pima County's request for consideration of Section 104 credit for their proposed construction work. Please approve our recommendation and forward it on to headquarters with your concurrence at your earliest convenience.

15. Enclosed with this forwarding letter are copies of the application letter and its associated attachments for your review. The Los Angeles District will notify Pima County if and when approval is granted. Actual approval of credit will follow upon Congressional authorization of the project.

Encls

CHARLES V. LANDRY
LTC, EN
Acting Commander

TABLE 1

ITEM	ENTITY	QUANTITY	UNIT COST	COST
Drainage Excavation	LRR	13,300 cy	$3	$39,900
	Pima County	116,000 cy	$2	$232,000
Compacted Fill	LRR	29,000 cy	$7	$188,500
	Pima County	0 cy		$0
Sewer Relocation	LRR	0		$0
	Pima County			$152,000
Soil Cement Bank Protection	LRR	40,500 cy	$9	$364,500
	Pima County	49,000 cy	$8	$392,000
Contingencies (20%)				
(Mobilization is line item)	LRR			$298,720
(Mobilization is % of subtotal)	Pima County			$321,900
Right-of-way	LRR			$628,000
	Pima County			$1,120,000
TOTALS FOR	LRR			$2,850,477
INDIVIDUAL PROJECTS	Pima County			$3,456,994

PIMA COUNTY
DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT
201 NORTH STONE AVENUE, THIRD FLOOR
TUCSON, ARIZONA 85701-1207

BROOKS A. KEENAN, P.E.
DIRECTOR

(520) 740-6410
FAX (520) 620-1933

October 26, 1998

Mr. Eshan Eshraghi
Project Manager
U.S. Army Corps of Engineers
Los Angeles District
911 Wilshire Blvd.
Los Angeles, CA 90017

Subject: Tanque Verde Creek Project - Section 104 Credit

Dear Mr. Eshraghi:

We submitted a Section 104 Credit Application for the Tanque Verde Creek Project on June 5, 1998. The project feature included in the Section 104 Credit application consists of approximately 4000 feet of soil cement bank protection on the southbank, extending from the end of the existing bank protection west of Sabino Canyon Road to the existing bank protection at the downstream end.

If there are any questions regarding this matter, please call me at (520) 740-6378.

Sincerely,

Zbig Osmolski, Manager
Flood Control Engineering

c: Brooks A. Keenan

ENCL

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

18 SEP 1998

REPLY TO
ATTENTION OF:

Planning Division
East-West Planning Management Branch

Honorable Ed Pastor
House of Representatives
Washington, DC 20515-0302

Dear Mr. Pastor:

This is in response to your letter of August 27, 1998, to Lieutenant General Joe N. Ballard, Chief of Engineers, regarding the status of Pima County's request for credit, pursuant to Section 104 of Public Law 99-662, for the design and construction of the flood damage reduction improvements along Tanque Verde Creek in Tucson, Arizona.

The U.S. Army Corps of Engineers Los Angeles District has received an inquiry from Pima County regarding section 104 credit on the proposed Tanque Verde Creek project. In response to this inquiry a meeting will be held in Phoenix, Arizona, on October 1, 1998, between the Pima County Flood Control District and the Corps to clarify the requirements and identify the most expeditious facilitation of the request. This meeting will be attended by representatives from the Corps Headquarters staff.

We recognize the urgency of Pima County's request and will work with Pima County to process their application for credit in an expeditious manner. I have asked Colonel Robert L. Davis, Los Angeles District Engineer, to advise you of the results of the meeting and to keep you apprised of the status of this action.

Sincerely,

Alfred H. Foxx
Colonel, U.S. Army
Assistant Director of Civil Works,
Pacific Region

PIMA COUNTY
DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT
201 NORTH STONE AVENUE, THIRD FLOOR
TUCSON, ARIZONA 85701-1207

BROOKS A. KEENAN, P.E.
DIRECTOR

(520) 740-6410
FAX (520) 620-1933

June 5, 1998

Colonel Robert L. Davis
District Engineer
U.S. Army Corps of Engineers
Los Angeles District
911 Wilshire Blvd.
Los Angeles, CA 90017

Subject: Tanque Verde Creek Project, Craycroft Road to Sabino Canyon Road
Section 104 Credit Application

Dear Colonel Davis:

The Corps of Engineers is currently preparing the Limited Reevaluation Report (LRR) for the Tanque Verde Creek Project (Craycroft Road to Sabino Canyon Road). The LRR is being prepared on the basis of the Corps' original (1987) report "Survey Report and Environmental Assessment for the Rillito River and Associated Streams" which investigated flooding problems on the Rillito River and its major tributaries, including the Tanque Verde Creek.

We understand that this evaluation process by the Corps and the subsequent procedures will take some time for completion. However, in the interest of public need and welfare, implementation of this project is urgently needed in order to prevent recurring substantial flood and erosion damages to private properties and public infrastructures located along the river reach. Additional factors which make the early implementation of this project even more important are as follows. Construction of the interceptor sewer line to be located along this river reach was approved in the Bond election held in May 1997. As this interceptor line is a critical segment of the sewer network, the Wastewater Department (WWD), one of the public works departments of Pima County, initiated engineering design of the sewer line, which will be completed in nine to twelve months to be followed by construction bid. Construction of the interceptor sewer line will require the simultaneous installation of bank protection or comparable interim measures for protection against flood/erosion hazards. Separate implementation of these two elements (sewer line and bank protection) will result in additional cost compared to combining them and the residents in the neighborhood will experience twice the inconvenience/disruption due to construction activities.

ENCL

In view of the preceding considerations, the Pima County Flood Control District hereby requests credit under Section 104 of Public Law 99-662 for design and construction of the Tanque Verde Creek bank protection project. The proposed plan for which credit is being sought consists of soil cement bank protection along both banks of the river reach and a 500-feet width buffer area for riparian reserve along the north bank. The total cost for the project is estimated as $3.5 million. Project description, cost estimate, and preliminary plans and profiles are given in the attached documents.

Pima County Flood Control District, as the local sponsor, is familiar with cost sharing and the Section 104 requirements. Pima County Flood Control District successfully completed (in 1996) construction of the Randolph South detention basin under Section 104 credit as part of the ongoing Tucson Drainage Area Project. We are familiar with the federal standards and requirements for design, and plans and specifications will be prepared accordingly.

Pima County Flood Control District requests favorable consideration and quick approval of the Section 104 credit for the project, which will provide critical flood/erosion protection and environmental benefits to the community. We value and appreciate your active cooperation in many Pima County projects and believe that this project will represent another successful example of our cooperative efforts.

Sincerely,

Brooks A. Keenan
Director

xc: Charles H. Huckelberry, County Administrator
George Brinsko, Director, Wastewater Department

ATTACHMENT 1

Tanque Verde Creek Project

Project Description

The proposed project consists of constructing soil cement bank protection along the Tanque Verde Creek between Craycroft Road and Sabino Canyon Road. Project features also include purchase of lands along the northern bank of the Creek to establish a riparian/floodplain mitigation area. The Corps of Engineers' original (1987) report "Survey Report and Environmental Assessment for the Rillito River and Associated Streams" investigated flooding problems on the Rillito River and some of its tributaries, including the Tanque Verde Creek. Project development for the Tanque Verde Creek was not included due to lack of economic justification at that time. Since then, several floods have occurred and caused substantial damages to private properties, public infrastructure and existing riparian areas along the Tanque Verde Creek, especially within the reach between Craycroft Road and Sabino Canyon Road. The January 1993 Flood (peak discharge of 24,500 cfs, compared to 100-year discharge of 28,000 cfs) caused significant lateral bank erosion (up to 100 feet) along this Tanque Verde reach and exposed an existing 8" sanitary sewer line on the south bank of the creek. Severe bank erosion (up to 140 feet) occurred on the north bank of the creek and exposed the bridge caissons under the north abutment of the Craycroft Road bridge.

In addition to these recent damages, there is a significant potential for future damages due to the existence of an old meander bend near the Craycroft bridge. Flood flows and subsurface flows follow this meander and have resulted in undermining of the roadway embankment, requiring periodic repair of the road surface and shoring up of an interceptor sewer line. A major flood could undermine and break through the embankment, washing out the roadway and the sewer interceptor and causing innundation and erosion damages to a number of subdivisions located within the meander. Bank stabilization of this river reach and riparian area preserve, as included in the proposed project, are required to prevent substantial damages that occurred during the recent 1993 flood and even more catastrophic flooding and erosion damages that may occur in the event of larger floods in the future.

Proposed project features include : (1) 1700 feet of bank protection on the north bank; (2) Soil cement bank protection between the two large gaps of existing bank protection on the south bank; and (3) 500-foot width buffer area for riparian habitat along the north bank. Cost estimate for the project is $3.5 million, as summarized in Attachment 2. Project location map and plans and profiles are included in the attached documents.

ATTACHMENT 2

Tanque Verde Creek Project

Project Cost Estimate

Item	Units	Quality	Unit Cost	Cost
Clearing & Grubbing	L.S.	1	$20,000.00	$20,000.00
Removal of Structures & Obstructions	L.S.	1	$20,000.00	$20,000.00
Mobilization	L.S.	1	$50,000.00	$50,000.00
Diversion and Control of Water	L.S.	1	$20,000.00	$20,000.00
Drainage Excavation	C.Y.	116,000	$2.00	$232,000.00
Sewer Relocation	L.S.	1	$152,500.00	$152,500.00
Soil Cement Bank Protection	C.Y.	49,000	$8.00	$392,000.00
Stabilizer for Soil Cement	Ton	8,000	$80.00	$640,000.00
Safety Hand Rail	L.F.	8,300	$10.00	$83,000.00
Subtotal				$1,609,500.00
Contingency (20% of subtotal)			$321,900.00	$321,900.00
Total Construction Cost				$1,931,400.00
Engineering Design (6%)			$115,884.00	$115,884.00
Construction Admin. & Field Inspect. (15%)			$289,710.00	$289,710.00
Right of Way			$1,120,000.00	$1,120,000.00
TOTAL PROJECT COST				$3,456,994.00

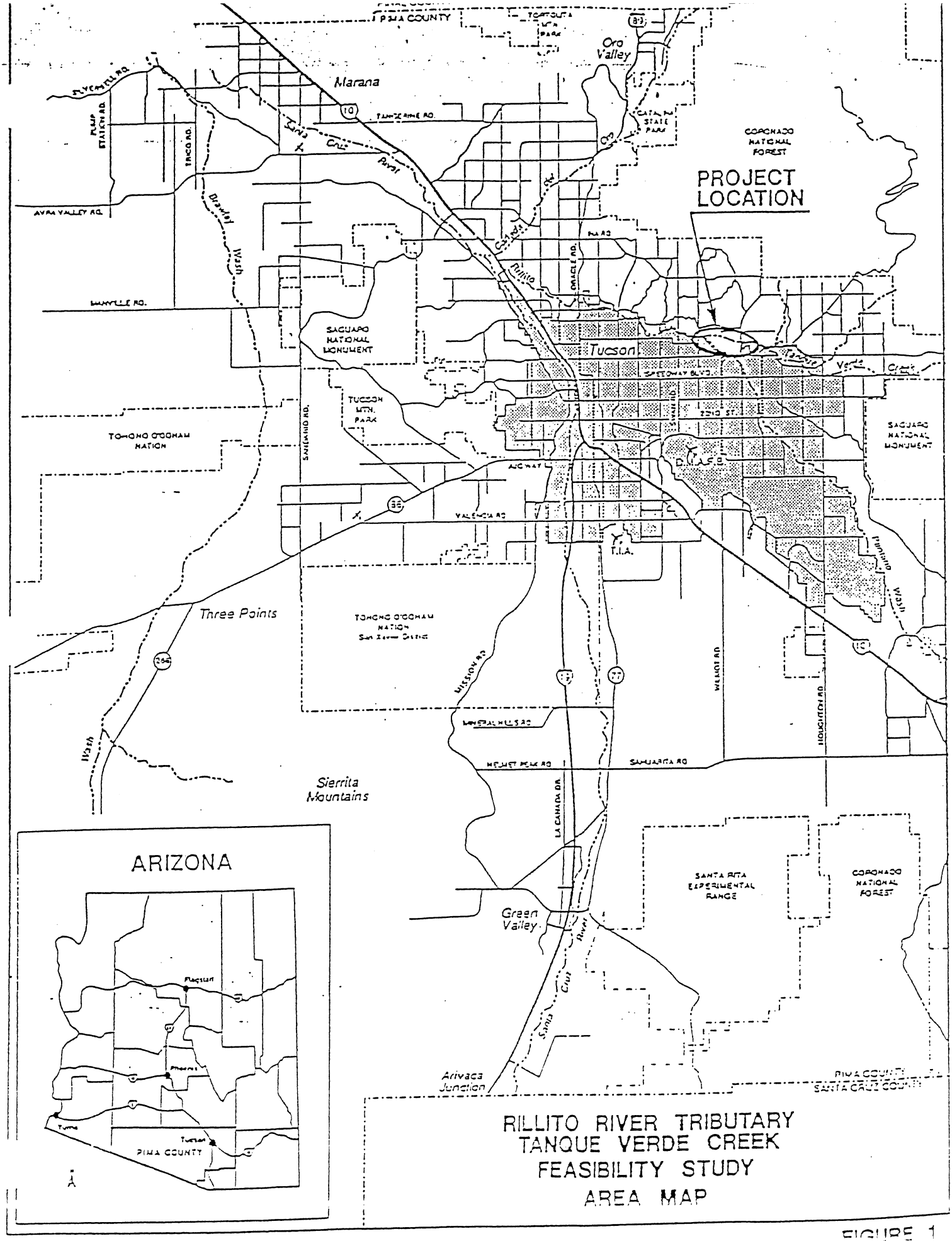
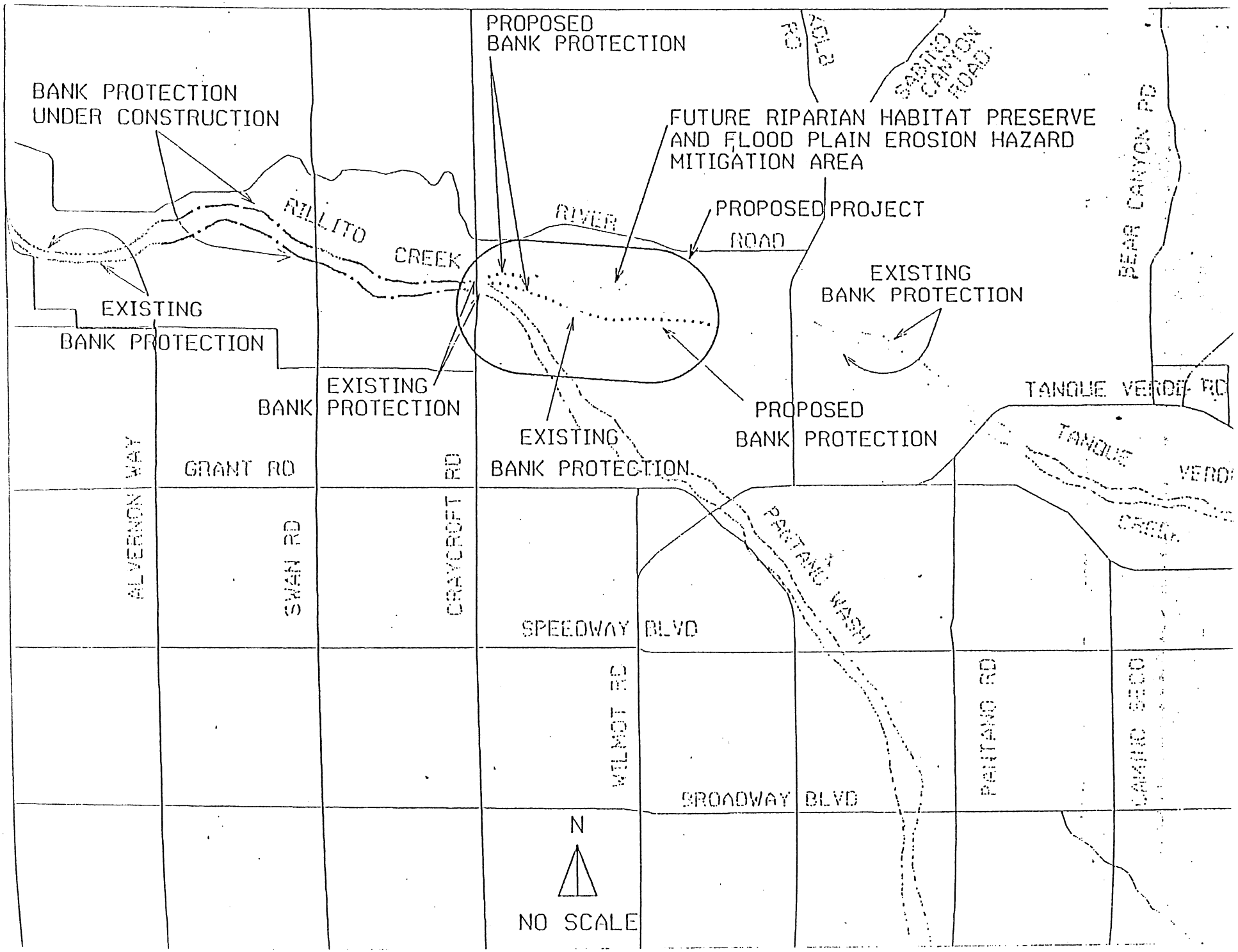

PROJECT LOCATION
Marana
Oro Valley
Tucson
Three Points
Sierrita Mountains
Green Valley
Arivaca Junction
SAGUARO NATIONAL MONUMENT
TOHONO O'ODHAM NATION
CORONADO NATIONAL FOREST
SANTA RITA EXPERIMENTAL RANGE
TUCSON MTN. PARK
CATALINA STATE PARK
T.I.A.
INTERSTATE 10
INTERSTATE 19
INTERSTATE 8
INTERSTATE 15
ARIZONA
PIMA COUNTY
Flagstaff
Phoenix
Yuma
Tucson
PIMA COUNTY
SANTA CRUZ COUNTY
RILLITO RIVER TRIBUTARY
TANQUE VERDE CREEK
FEASIBILITY STUDY
AREA MAP

FIGURE 1


PROPOSED
BANK PROTECTION
AGUA
RD
SABINO
CANYON
ROAD
BANK PROTECTION
UNDER CONSTRUCTION
FUTURE RIPARIAN HABITAT PRESERVE
AND FLOOD PLAIN EROSION HAZARD
MITIGATION AREA
RILLITO
CREEK
RIVER
PROPOSED PROJECT
ROAD
BEAR CANYON RD
EXISTING
BANK PROTECTION
EXISTING
BANK PROTECTION
EXISTING
BANK PROTECTION
PROPOSED
BANK PROTECTION
TANQUE VERDE RD
TANQUE
VERDE
CREEK
EXISTING
BANK PROTECTION
ALVERNON WAY
GRANT RD
SWAN RD
CRAYCROFT RD
PANTANO WASH
SPEEDWAY BLVD
WILMOT RD
BROADWAY BLVD
PANTANO RD
N
NO SCALE

Exhibits

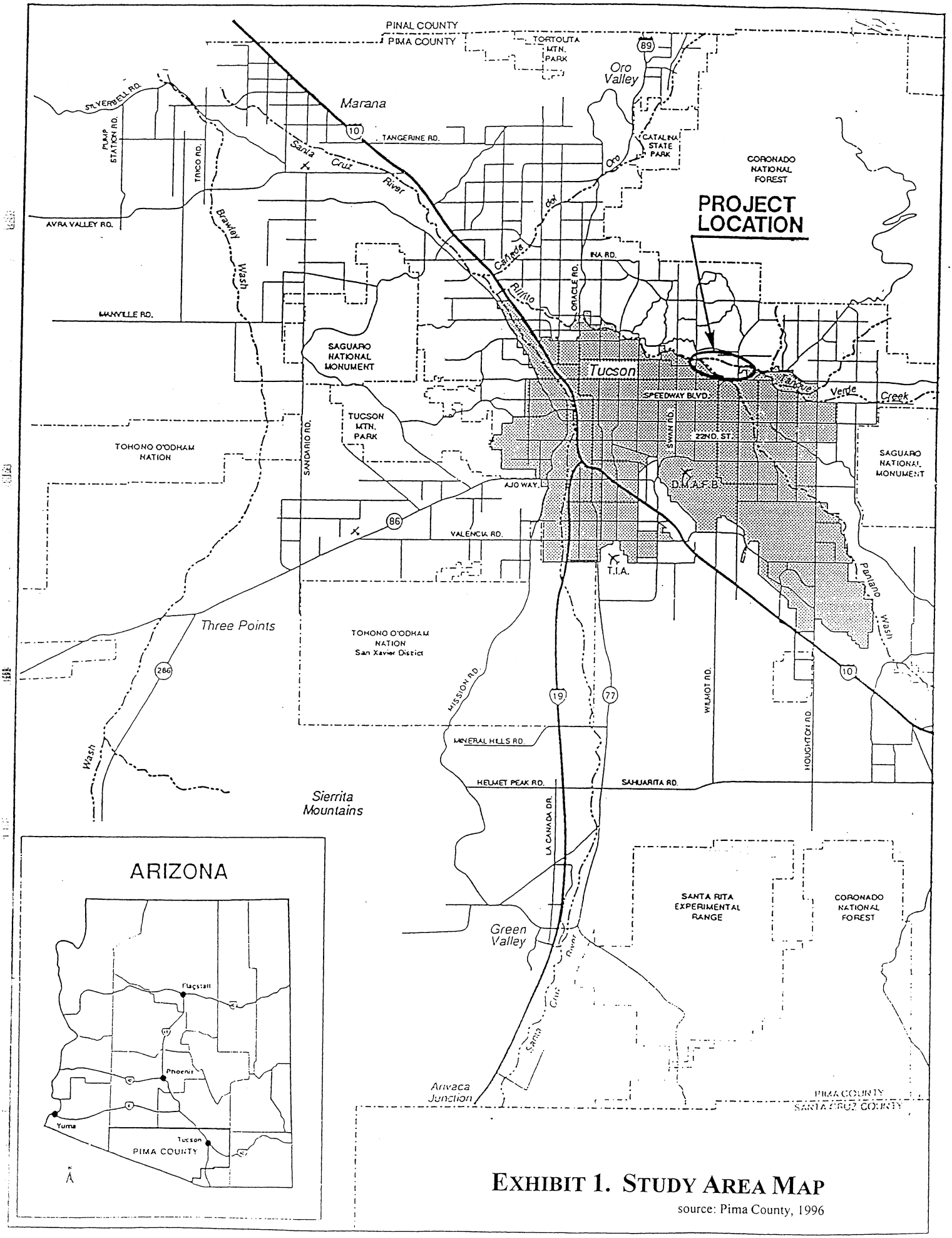


EXHIBIT 1. STUDY AREA MAP

source: Pima County, 1996

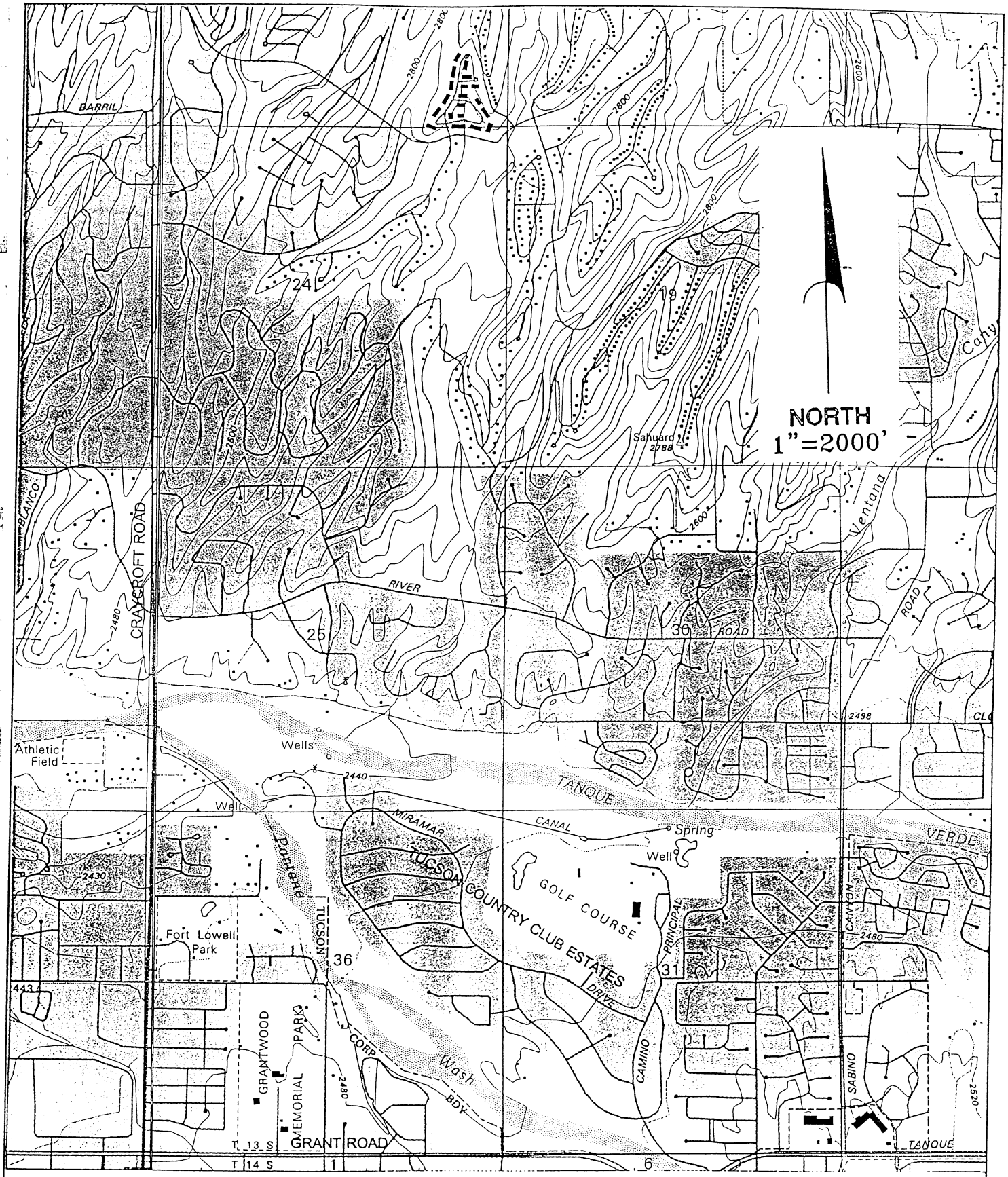
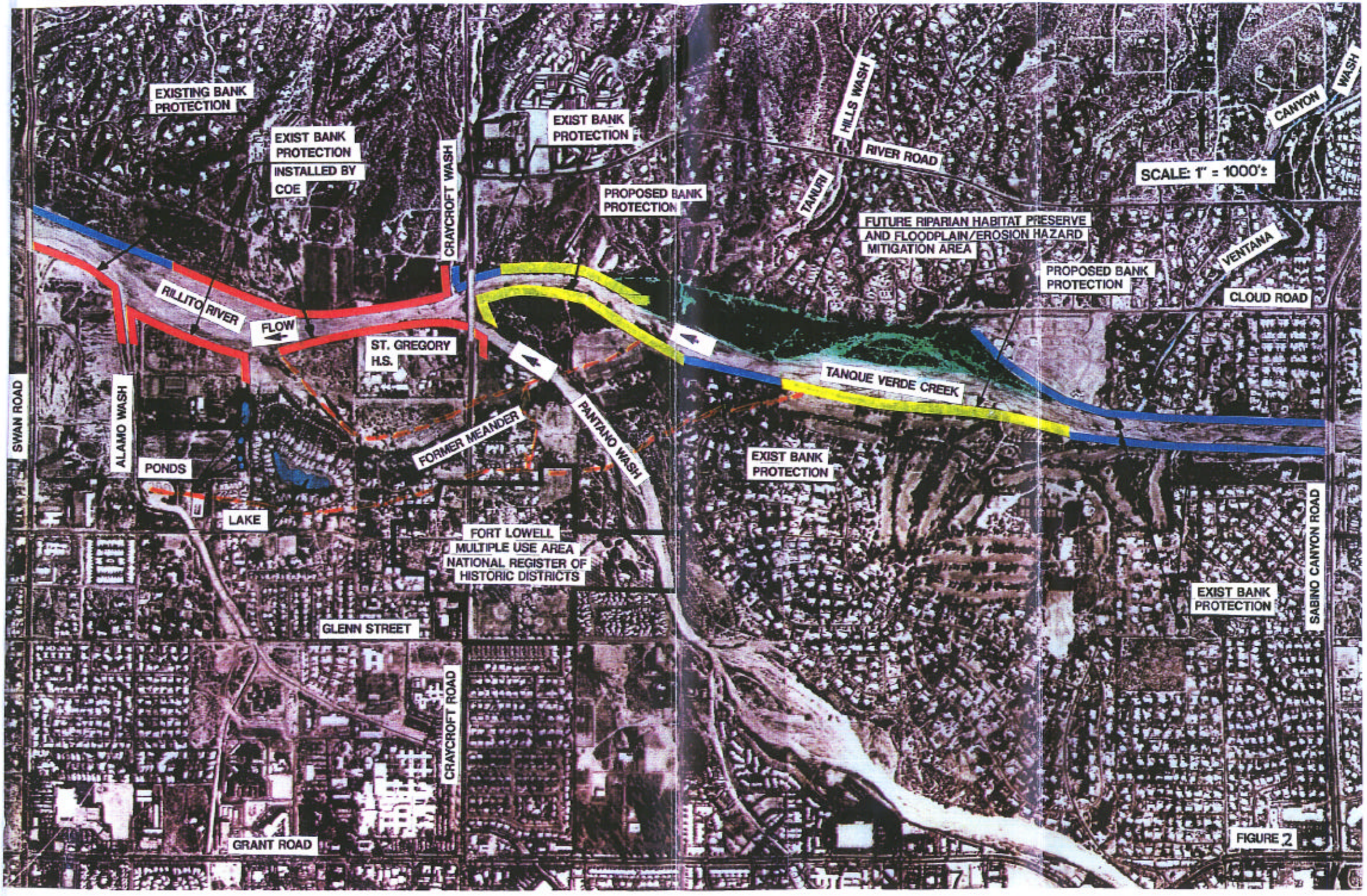
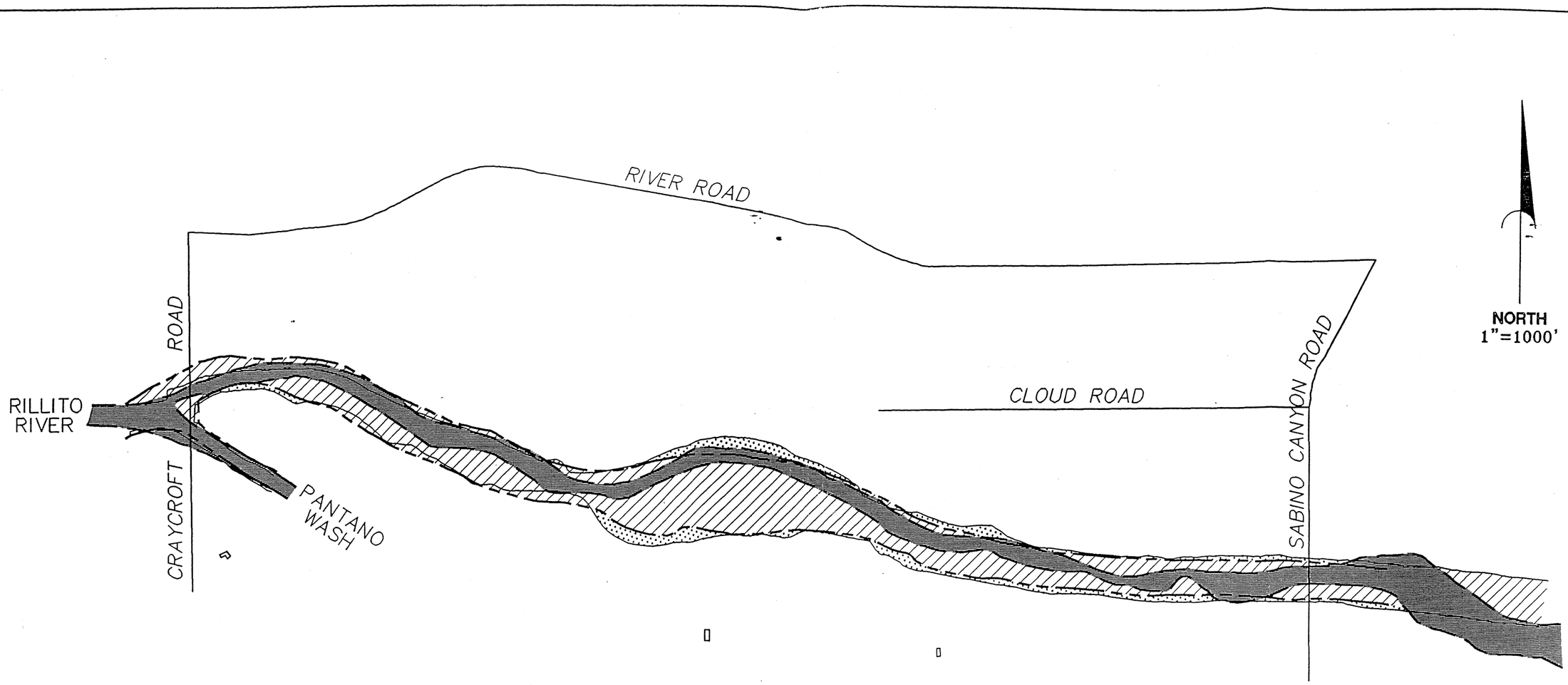


EXHIBIT 2. STUDY AREA VICINITY


EXISTING BANK PROTECTION
EXIST BANK PROTECTION INSTALLED BY COE
EXIST BANK PROTECTION
PROPOSED BANK PROTECTION
CRAYCROFT WASH
HILLS WASH
RIVER ROAD
TANURI
CANYON WASH
SCALE: 1" = 1000'±
FUTURE RIPARIAN HABITAT PRESERVE AND FLOODPLAIN/EROSION HAZARD MITIGATION AREA
PROPOSED BANK PROTECTION
VENTANA
CLOUD ROAD
RILLITO RIVER
FLOW
ST. GREGORY H.S.
TANQUE VERDE CREEK
SWAN ROAD
ALAMO WASH
FORMER MEANDER
PANTANO WASH
PONDS
LAKE
FORT LOWELL MULTIPLE USE AREA NATIONAL REGISTER OF HISTORIC DISTRICTS
EXIST BANK PROTECTION
SABINO CANYON ROAD
GLENN STREET
CRAYCROFT ROAD
EXIST BANK PROTECTION
GRANT ROAD
FIGURE 2

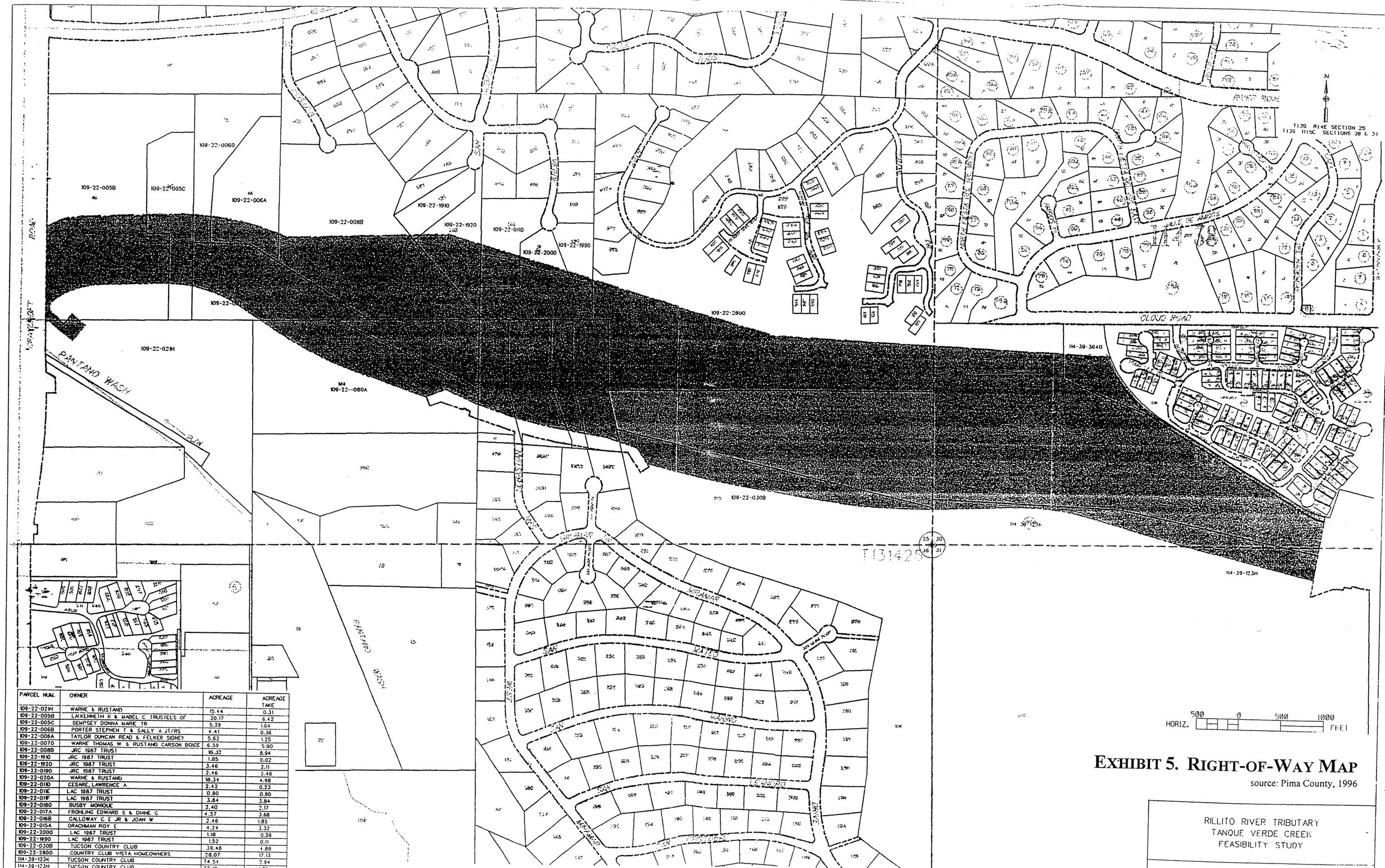


LEGEND

- 1953 CHANNEL ALIGNMENT
- 1983 BANK AND CHANNEL ALIGNMENT
- 1993 BANK AND CHANNEL ALIGNMENT
- REDUCED (OR RECLAIMED) AREAS BETWEEN 1953 OR 1983 & 1993
- ENLARGED AREAS BETWEEN 1953 & 1993

EXHIBIT 4. CHANNEL MORPHOLOGY ALONG TANQUE VERDE CREEK

sla SIMONS, LI & ASSOCIATES, INC.



PARCEL NUM.	OWNER	ACREAGE	ACREAGE TAKE
109-22-021H	WARNE & RUSTAND	15.44	0.31
109-22-005B	LAIKENNETH K & MABEL C TRUSTEES OF	20.17	6.42
109-22-005C	DEMPSEY DONNA MARIE TR	5.29	1.64
109-22-006B	PORTER STEPHEN T & SALLY A JT/RS	4.41	0.36
109-22-006A	TAYLOR DUNCAN READ & FELKER SIDNEY	5.62	1.25
109-22-0070	WARNE THOMAS W & RUSTAND CARSON BOICE	6.59	5.90
109-22-008B	JRC 1987 TRUST	16.32	8.94
109-22-1910	JRC 1987 TRUST	1.85	0.02
109-22-1920	JRC 1987 TRUST	3.46	2.11
109-22-0190	JRC 1987 TRUST	2.46	2.46
109-22-020A	WARNE & RUSTAND	18.34	4.98
109-22-0110	CESARE, LAWRENCE A	2.42	0.23
109-22-011E	LAC 1987 TRUST	0.90	0.90
109-22-011F	LAC 1987 TRUST	3.84	3.84
109-22-0180	BUSBY MONIQUE	2.40	2.17
109-22-017A	FROHLING EDWARD S & DIANE C	4.57	3.68
109-22-0168	CALLOWAY C E JR & JOAN W	2.46	1.85
109-22-015A	DRACHMAN ROY E	4.24	3.32
109-22-2000	LAC 1987 TRUST	1.18	0.26
109-22-1990	LAC 1987 TRUST	1.52	0.11
109-22-0308	TUCSON COUNTRY CLUB	39.48	4.89
109-22-2800	COUNTRY CLUB VISTA HOMEOWNERS	28.07	17.13
114-39-123K	TUCSON COUNTRY CLUB	74.54	2.94
114-39-123H	TUCSON COUNTRY CLUB	77.10	1.76
114-39-3640	WESOLITE CREEK HOME OWNERS ASSOC.	38.57	33.08

EXHIBIT 5. RIGHT-OF-WAY MAP

source: Pima County, 1996

RILLITO RIVER TRIBUTARY
TANQUE VERDE CREEK
FEASIBILITY STUDY

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

FIGURE 6

TANQUE\FEASIBILITY\AN_DIST.DGN

EXISTING SOIL-CEMENT TO REMAIN

STA. 101+49 LT SIDE BEGIN PROPOSED SOIL-CEMENT. MATCH TO EXISTING

STA. 116+98 LEFT SIDE END PROPOSED SOIL-CEMENT

FUTURE RIPARIAN HABITAT PRESERVE AND FLOOD EROSION HAZARD MITIGATION AREA

STA. 00+00 RT SIDE BEGIN PROPOSED SOIL-CEMENT.

EXISTING SOIL-CEMENT TO REMAIN

STA. 23+29 END PROPOSED SOIL-CEMENT. MATCH TO EXISTING SOIL-CEMENT

STA. 39+67 BEGIN PROPOSED SOIL-CEMENT. MATCH TO EXISTING SOIL-CEMENT

TANQUE VERDE WASH

PANTANO WASH

CRAYCROFT ROAD

BEGIN PROJECT LIMITS

VERDE

VISTA

DR.

SAN SEBASTIAN

MIRAMAR

SAN MATEO

TUCSON COUNTRY CLUB

PIMA COUNTY

FLOW

N 464000

N 463000

N 462000

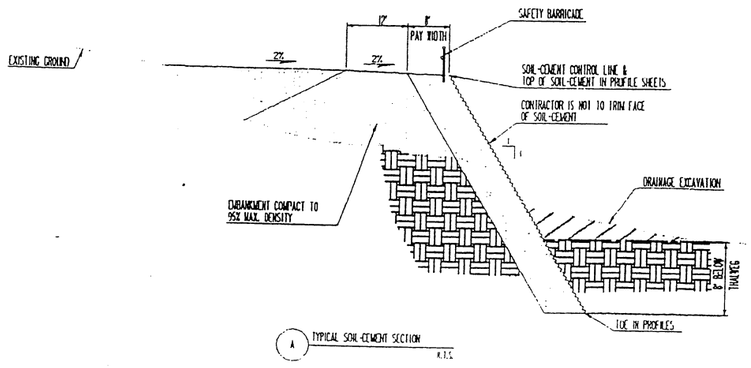
E 102600

E 102700

E 102800

T13S R14E SECTION 25
T13S R15E SECTIONS 30 & 31

MATCH WITH PLAN SHEET #2



LEGEND

EXISTING SOIL-CEMENT

FUTURE RIPARIAN AREA

PROPERTY LINES

Q100 FLOODPLAIN

EXISTING HOUSES

PROPOSED R/W LINES

HORIZ. 400 0 400 800 FEET

EXHIBIT 6. PLAN SHEET #1

source: Pima County, 1996

RILLITO RIVER TRIBUTARY
TANQUE VERDE CREEK
FEASIBILITY STUDY

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

FIGURE 1

FUTURE RIPARIAN HABITAT PRESERVE AND FLOOD PLAIN MITIGATION AREA

EXISTING SOIL-CEMENT TO REMAIN

STA. 81+87 (1.53mi)
END PROPOSED SOIL-CEMENT. MATCH TO EXISTING SOIL-CEMENT

END PROJECT LIMITS

TANQUE VERDE WASH

FLOW

CLOUD ROAD

DEL HACIENDA

BACOBA DR.

TONTO PL.

RIVERBEND

VENTANA PL.

DRAINAGEWAY

CALLE RIBADEO

CALLE TOLOSA

CALLE ORTEGA

CALLE MODENA

CALLE TABARA

SABINO CANYON ROAD

BOUQUET CANYON

WOOD CANYON

CRIMSON CANYON

FOREST FLOWER DR.

BLUE SPRUCE DR.

WHITE FEATHER PL.

POTAWATAMI DRIVE

TECUMSEH CIRCLE

LADERA

MESA GRANDE

TUCSON COUNTRY CLUB

N 463000
N 462000
N 461000
E 1029000
E 1028000
E 1030000
E 1031000
E 1032000

T13S R14E SECTION 25
T13S R15E SECTIONS 30 & 31

LEGEND

- EXISTING SOIL-CEMENT
- FUTURE RIPARIAN AREA
- PROPERTY LINES
- Q100 FLOODPLAIN
- EXISTING HOUSES
- PROPOSED R/W LINES

HORIZ. 400 0 400 800 FEET

EXHIBIT 7. PLAN SHEET #2

source: Pima County, 1996

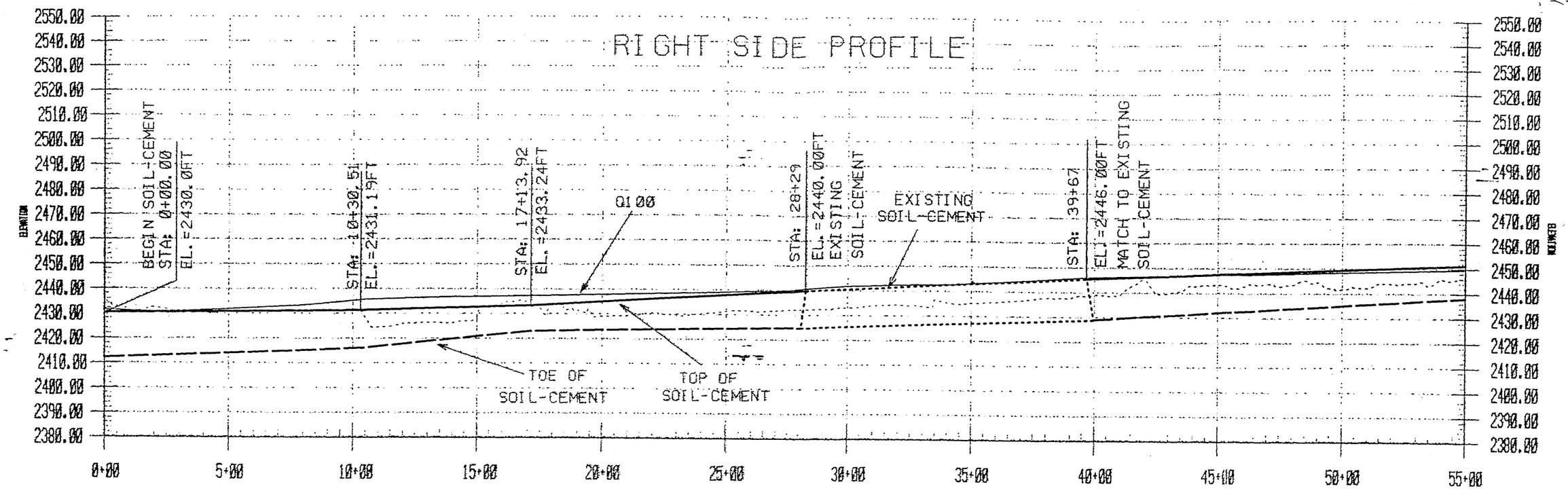
RILLITO RIVER TRIBUTARY
TANQUE VERDE CREEK
FEASIBILITY STUDY

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

FIGURE 8

DECEMBER 1996

ANQUE\FEASIBILITY\FIG_DIST.DGN



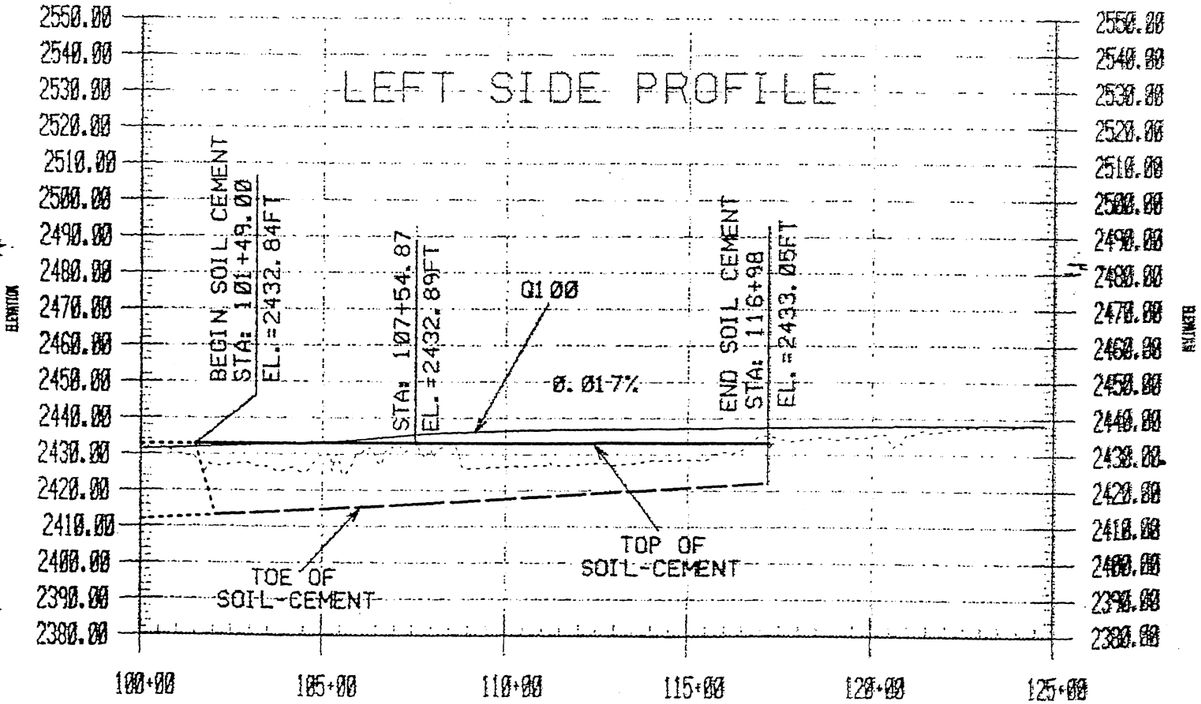


EXHIBIT 8. PROFILE SHEET #1

source: Pima County, 1996

RILLITO RIVER TRIBUTARY
TANQUE VERDE CREEK
FEASIBILITY STUDY

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT
DECEMBER 1996

FIGURE 9

PREL:\TANQUE\FEASIB\TAN_DIST.DGN
DATE: 19-Dec-96 15:30

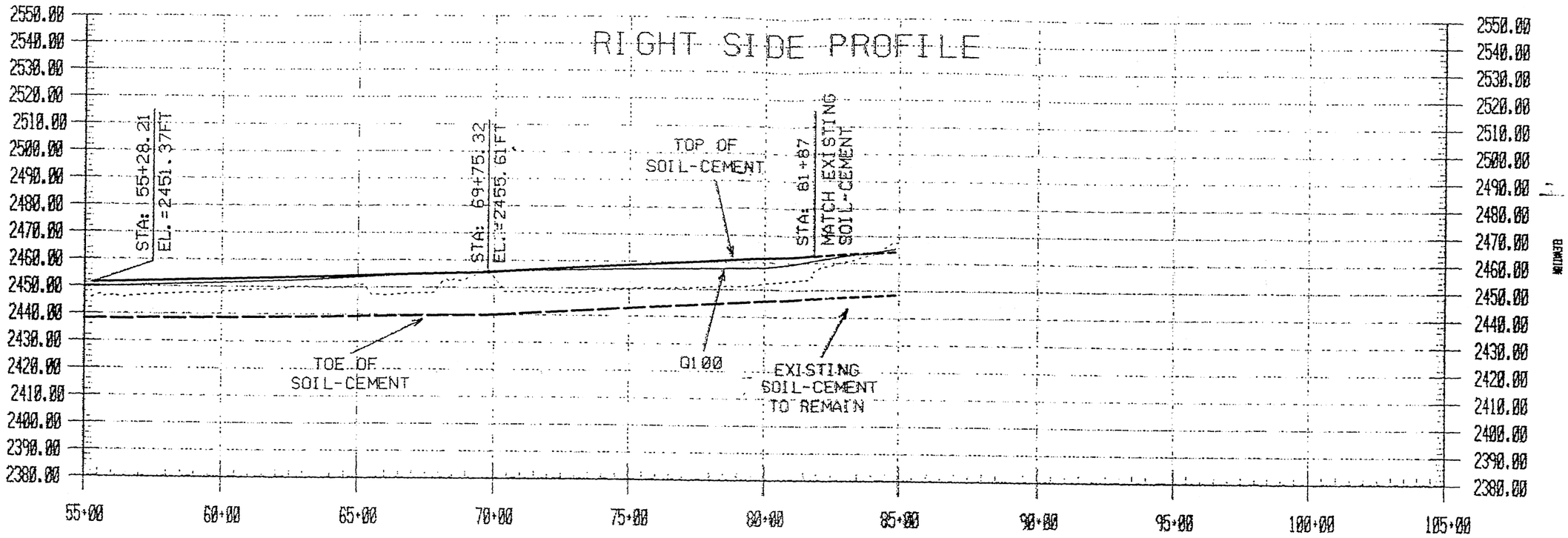


EXHIBIT 9. PROFILE SHEET #2

source: Pima County, 1996

RILLITO RIVER TRIBUTARY
TANQUE VERDE CREEK
FEASIBILITY STUDY

PIMA COUNTY DEPARTMENT OF TRANSPORTATION
AND FLOOD CONTROL DISTRICT
DECEMBER 1996

FIGURE
10

\TANQUE\FEASIB\TAN_DIST.DGN
DEC-96 15:30

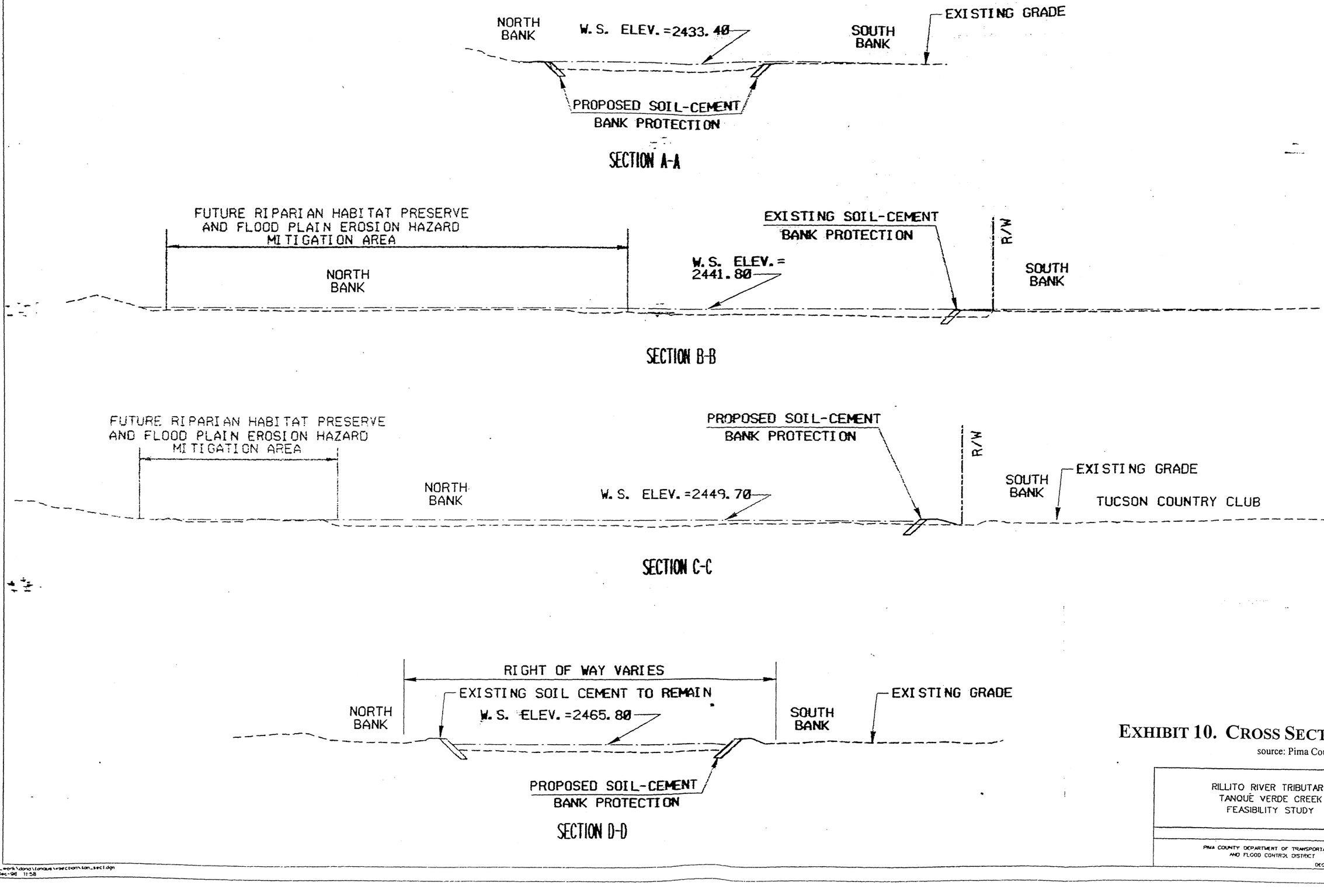


EXHIBIT 10. CROSS SECTIONS

source: Pima County, 1996

RILLITO RIVER TRIBUTARY
TANQUE VERDE CREEK
FEASIBILITY STUDY

PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND FLOOD CONTROL DISTRICT

FIGURE 11

DECEMBER 1996

FILE: c:\dot_work\dana\tanque verde\xsection_sect.dgn
DATE: 24-Dec-96 11:58

TYPICAL CROSS SECTION

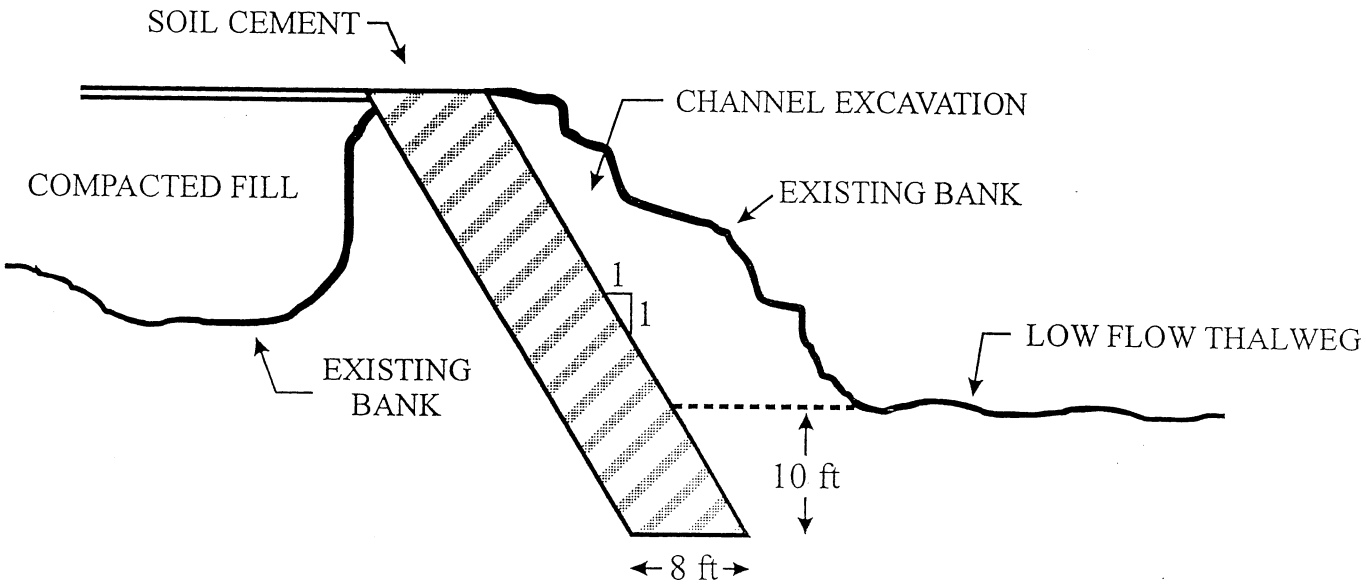
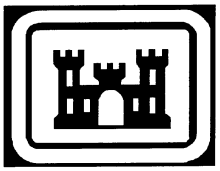


EXHIBIT 11. TYPICAL CROSS SECTION OF BANK PROTECTION



US Army Corps
of Engineers
Los Angeles District

FINAL

ENVIRONMENTAL ASSESSMENT

TANQUE VERDE CREEK, PIMA COUNTY, ARIZONA
CRAYCROFT ROAD TO SABINO CANYON ROAD BANK PROTECTION

AUGUST 2002

LOS ANGELES DISTRICT, CORPS OF ENGINEERS
PLANNING DIVISION, WATER RESOURCES BRANCH
P.O. BOX 532711
LOS ANGELES, CALIFORNIA 90053-2325

FINDING OF NO SIGNIFICANT IMPACT

TANQUE VERDE CREEK
CRAYCROFT ROAD TO SABINO CANYON ROAD
BANK PROTECTION AND RIPARIAN PRESERVE PROJECT
PIMA COUNTY, ARIZONA

I have reviewed the attached Environmental Assessment (EA) prepared for the Tanque Verde Creek, Craycroft Road to Sabino Canyon Road, Bank Protection Project, Pima County, Arizona. This EA addresses impacts related to bank stabilization along Tanque Verde Creek, Arizona.

The proposed project consists of stabilizing unprotected creek banks between Craycroft Road Bridge and Sabino Canyon Road Bridge with soil cement, and acquiring an area supporting desert riparian vegetation as a preserve along the north bank. The project reach is approximately two miles long. Currently, approximately 8,800 linear feet of existing bank within the project reach have been stabilized. Bank stabilization has occurred in four segments (See Figure 2 of the EA). Bank stabilization for the preferred alternative includes: 1,550-feet of soil cement bank stabilization along the north bank upstream of Craycroft Road, approximately 5,000 feet of modified bank stabilization along the preserve area, and a total of about 7,050-feet along the south bank, in two segments.

The primary purpose of the proposed project is reduction of lateral erosion and flood damages along Tanque Verde Creek and provision of protection to private property, public infrastructure, and existing riparian areas between Craycroft Road and Sabino Canyon Road.

The U.S. Army Corps of Engineers environmental staff conducted environmental resource surveys for biological, cultural, water resources, air quality, land use, esthetics, noise, and traffic along the project reach.

The proposed construction of the bank stabilization would not result in significant impacts to the resources identified above. Due to implementation of the preferred Alternative, a total of approximately 9.0 acres of habitat would be directly removed, including approximately 1.0 acre of high quality mesquite Bosque habitat and 8.0 acres of disturbed desert wash habitat. Based upon the Modified HEP Analysis, acquisition and protection of the 48-acre riparian area along the north bank would provide the appropriate level of mitigation needed for project impacts. The Incremental Analysis included the preserve area to determine habitat quality and habitat units to compare with the habitat affected due to project implementation. A total of 2.38 Average Annual Habitat Units (AAHUs) will be lost due to implementation of the Recommended Plan. Based upon the HEP Analysis, acquisition, maintenance, and protection of the 48-acre mesquite bosque area along north bank would provide a net increase of 4.43 AAHUs over without-project conditions, more than offsetting the impacts to the construction area. Since the mitigation plan provides a slight increase in AAHUs (about 10%) over without-project conditions, acquisition and protection of the 48-acre preserve is recommended as adequate and appropriate mitigation.

The Corps conducted a lateral migration analysis to investigate erosion along the Tanque Verde Creek banks. This analysis indicated that lateral shifts on the order of 650 feet in the banks of the main channel are not unusual over a 50-year time period. Over the 50-year period of analysis, an average annual erosion rate of approximately 13 feet per year appears to be a reasonable estimation of the erosion potential within the area (see details in Appendix A of the EA). The majority of this lateral erosion of would occur as the result of one or a few catastrophic flood events rather than at a constant rate.

Short-term construction related impacts would be minimized by implementation of the environmental commitments identified in this EA. No construction would occur during the summer monsoon season, or during heavy rain, to avoid impacts to water quality. Watering of the construction site would be conducted to minimize fugitive dust.

A prehistoric archeological site is located within the project's area of potential effects. The site is potentially eligible for listing in the National Register of Historic Places. The Corps will perform evaluation studies on the site. If the site is eligible for listing and cannot be avoided by construction of the project, a memorandum of agreement (MOA) stipulating mitigation measures will be executed in consultation with the Arizona State Historic Preservation Officer, Pima County and interested Native American tribes. Site avoidance is the preferred alternative. Otherwise, data recovery excavations are typically implemented for the purpose of documenting the important information contained within the archeological sites. A burial agreement will be negotiated with interested tribes and artifacts will be curated in an approved facility. Proper implementation of all mitigation measures stipulated in the MOA prior to construction will reduce adverse effects to levels of insignificance.

I have considered the available information contained in the EA. It is my determination that impacts resulting from the proposed modifications to Tanque Verde Creek will not have a significant adverse effect upon the existing environment or the quality of the human environment. Therefore, preparation of an Environmental Impact Statement is not required.

12 SEP 2002
DATE

Richard G. Thompson
Colonel, Corps of Engineers
District Engineer

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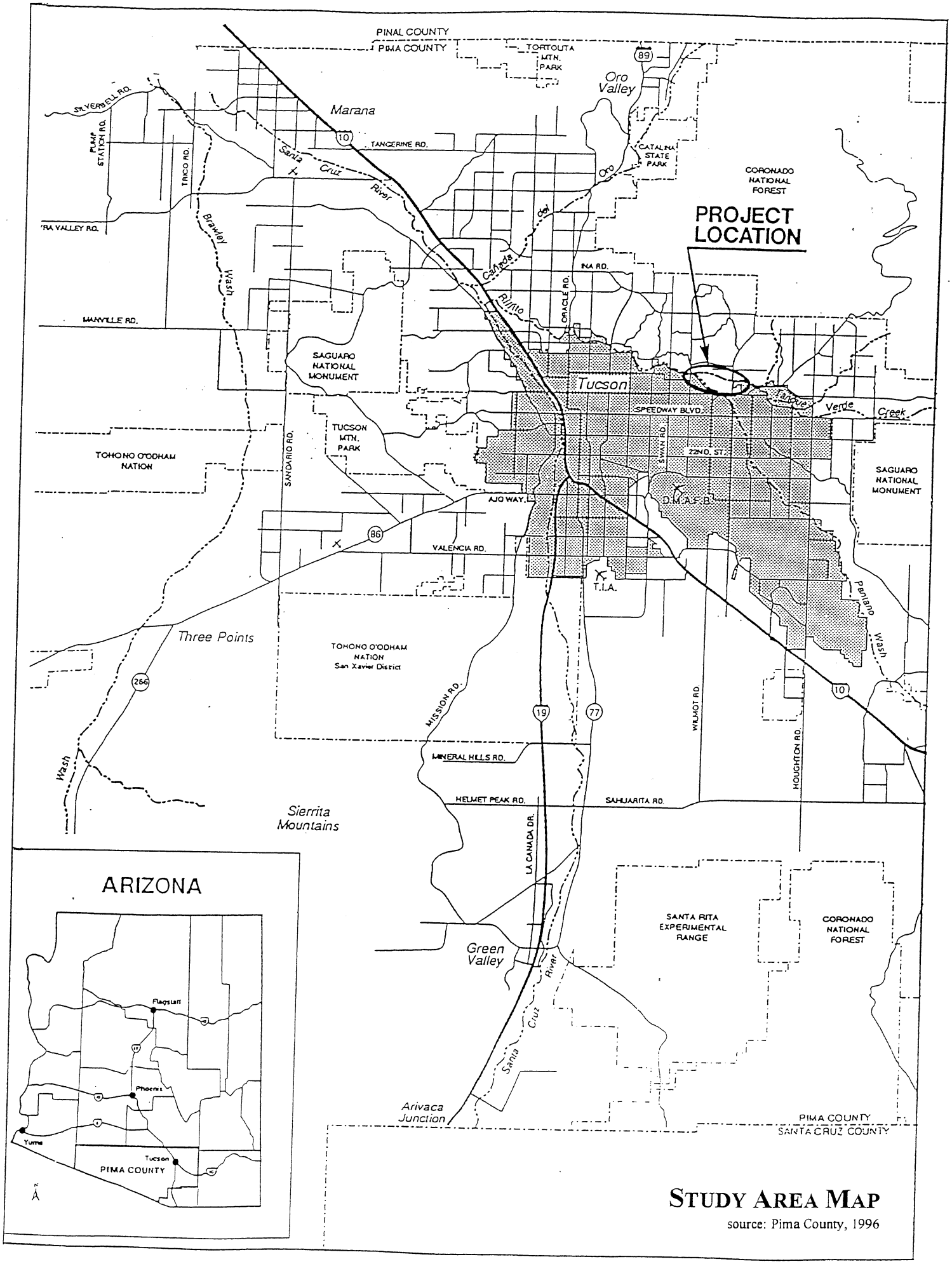
1.0 INTRODUCTION

1.1 Location

Tanque Verde Creek is an ephemeral stream, draining a 219 square mile watershed that extends into the Catalina and Tanque Verde mountains, north and east of the City of Tucson, Arizona. Tanque Verde Creek merges with the Pantano Wash and flows into the Rillito River, which continues west along the northern edge of Tucson. Craycroft Road, a major north-south city/county roadway, crosses directly over the confluence via an 850-foot long multispan bridge. The project area is located between Craycroft Road and Sabino Canyon Road (See Figure.1).

1.2 Project Background

The Corps of Engineers (Corps), initiated general design studies for the Rillito River bank protection project in June 1987 after receiving a letter of assurance, dated 6 May 1987, from the Pima County Department of Transportation and Flood Control District (PCDOT & FCD), the non-Federal sponsor of the project. In the letter, the County expressed their intent to cooperate with the Federal Government in constructing the authorized Rillito River project.



STUDY AREA MAP

source: Pima County, 1996

The authorized project consisted of soil cement, bank stabilization and a comprehensive recreation plan as identified in the May 1986 Rillito River & Associated Streams Survey Report and in the October 1992 General Design Memorandum. Construction of the Rillito River bank protection project has been divided into three increments - Increments I and II for the flood control portion and Increment III for recreation and aesthetic treatment of the entire river reach.

As part of the currently authorized Rillito River and Associated Streams Study (RRAS), the Corps of Engineers completed a Survey Report and Environmental Assessment for the Rillito River and Associated Streams in 1987. This report examined flood related problems on the Rillito River and its major tributaries, including Tanque Verde Creek. At the time of the final report, there were no economically justified flood control measures for Tanque Verde Creek, with the exception of the reach adjacent to the Forty-Niners Country Club Estates (which was later studied by the Corps under Section 205 of the Continuing Authorities Program). Since publication of the final report, however, severe flooding demonstrated that substantial damages could occur to private property, public infrastructure, and existing riparian areas along Tanque Verde Creek, especially along the reach between Craycroft Road and Sabino Canyon Road. The PCDOT & FCD, the proposed non-Federal sponsor, therefore, asked the Corps to prepare a Limited Reevaluation Report (LRR) to investigate the feasibility and justification of adding bank protection, by increments, on Tanque Verde Creek between Craycroft Road and Sabino Canyon Road.

The proposed project is to stabilize unprotected creek banks between Craycroft Road Bridge and Sabino Canyon Road Bridge with soil cement. The non-federal sponsor, PCDOT & FCD, proposes to acquire and set aside as a preserve a 48-acre site along the north bank of the project area that supports mesquite bosque/desert riparian habitat. The mesquite bosque preserve will be used as mitigation for short-term and long-term project impacts. The project reach is approximately two miles long. Currently, approximately 8,800 linear feet of existing bank within the project reach are stabilized with soil cement in four segments (See Figure 2). Bank stabilization for the Recommended Plan (Alternative 4), includes 1,550 feet along the north bank and a total of about 7,050 feet along the south bank, in two segments. In addition, approximately 5,000 feet of modified bank stabilization would be provided along the preserve area on the north bank. All of the proposed bank protection would be follow the alignment of the existing channel banks. The project-related direct loss of habitat is about 9.0 acres for the Recommended Plan, of which 4.88 acres will be temporary losses. The Corps has performed modified Habitat Evaluation Procedures (HEP) and an Incremental Cost Analysis (Appendix B-5) for the Recommended Alternative and other viable Alternatives to identify project-related impacts to biological resources, to determine the number of habitat units lost under each Alternative scenario, and to determine the amount of mitigation required for each Alternative. The Modified HEP calculates habitat units for the construction area as well as for the 48-acre preserve area for existing conditions and for the life of the project for the viable alternatives. Recommended mitigation areas to provide habitat units equal to those that would be lost have been identified. The Corps has performed a Geomorphic/Lateral Migration Analysis for the proposed project including the riparian preserve area (May 1999). The study result shows that banks in the vicinity of the riparian preserve could be eroded on an average of 13 feet per year, or a total of approximately 650 feet over the 50-year period of analysis, which would include almost the entire preserve. The actual rate of erosion may be lower because the existing vegetation provides

limited natural bank stabilization. The majority of lateral erosion is likely to occur in one or a few major storm events, rather than at a steady rate of 13 feet per year. The detailed Lateral Migration Analysis study is located in Appendix A of this Environmental Assessment (EA). Section 3.3 of this EA summarizes the study results.

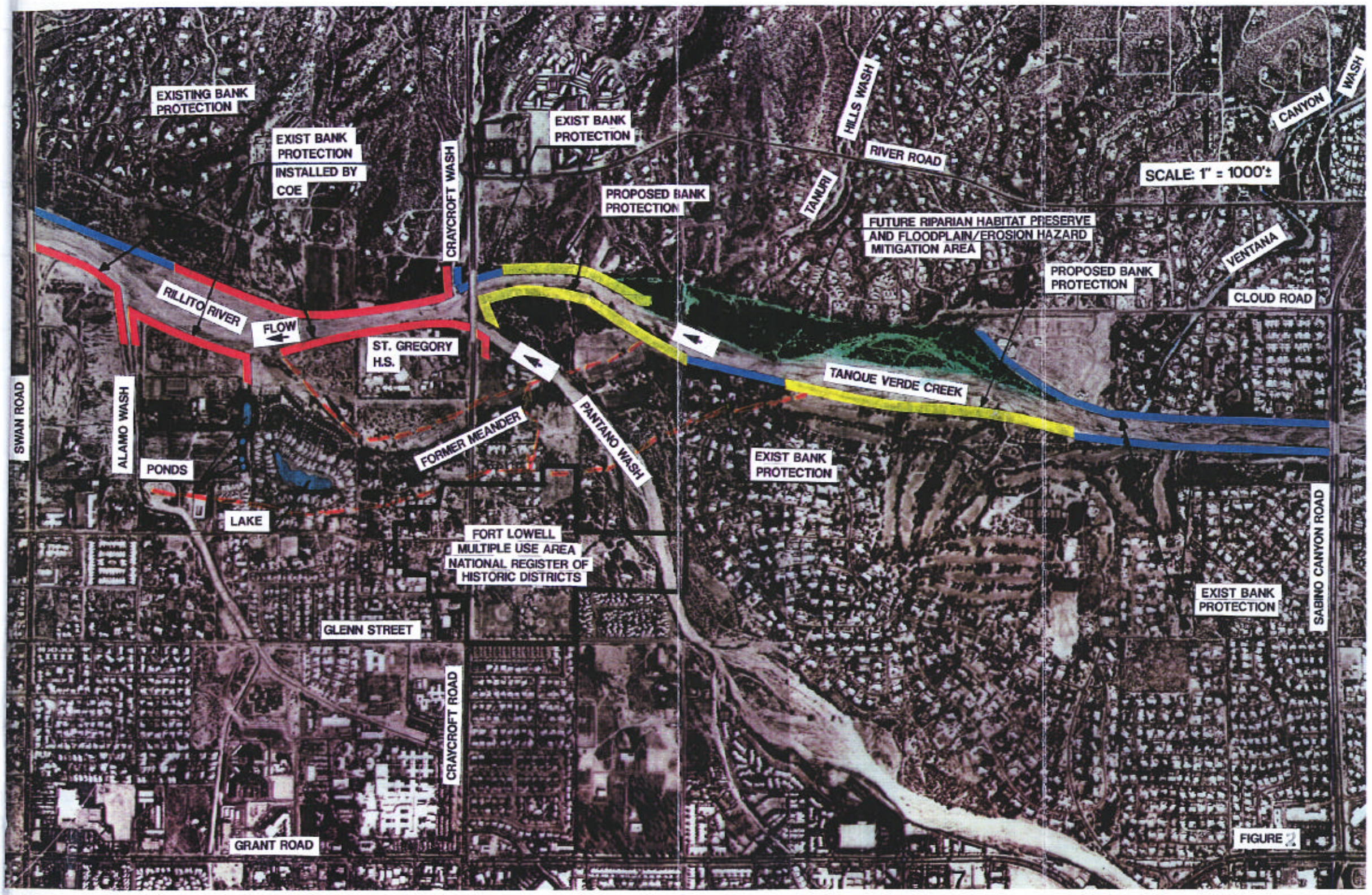

EXISTING BANK PROTECTION
EXIST BANK PROTECTION INSTALLED BY COE
EXIST BANK PROTECTION
PROPOSED BANK PROTECTION
CRAYCROFT WASH
HILLS WASH
TANURI
RIVER ROAD
CANYON WASH
SCALE: 1" = 1000'±
FUTURE RIPARIAN HABITAT PRESERVE AND FLOODPLAIN/EROSION HAZARD MITIGATION AREA
PROPOSED BANK PROTECTION
VENTANA
CLOUD ROAD
RILLITO RIVER
FLOW
ST. GREGORY H.S.
TANQUE VERDE CREEK
SWAN ROAD
ALAMO WASH
FORMER MEANDER
PANTANO WASH
PONDS
LAKE
FORT LOWELL MULTIPLE USE AREA NATIONAL REGISTER OF HISTORIC DISTRICTS
EXIST BANK PROTECTION
SABINO CANYON ROAD
GLENN STREET
CRAYCROFT ROAD
EXIST BANK PROTECTION
GRANT ROAD

FIGURE 2

1.3 Authority

Flood related investigations of Tanque Verde Creek, as part of the currently authorized Rillito River and Associated Streams Study (RRAS) were authorized in Public Law 761, Seventy-fifth Congress, known as Section 6 of the Flood Control Act of 1938, which states:

> *"The Secretary of War (now Secretary of the Army) is hereby authorized and directed to cause preliminary examinations and surveys...at the following localities...Gila River and tributaries, Arizona..."*

Additional authority was given by Section 601(b) of the Water Resources Development Act of 1986 (PL 99-662), which authorized a project for the Rillito River in Tucson, Arizona as follows:

> *"A Rillito River, Tucson, Arizona. Report of the Division Engineer, for the purpose of providing bank protection against the level of flooding that occurred in October 1983, at a total cost of $26,000,000. Section 104 of this act shall apply to the project authorized by this paragraph."*

Specific appropriations further detailing the project area of this EA were included in the *Energy and Water Development Appropriations Bill, 1998*, Report 105-190, which states:

> *"Rillito River, Arizona. --The Corps of Engineers is directed, as part of the Rillito River project, to accomplish a limited reevaluation report of Tanque Creek immediately upstream and including Craycroft Road Bridge to determine the advisability of extending the bank protection and related measures. The analysis will be consistent with that of the Chief of Engineers report for the Rillito Creek project to include full use of location benefits for economic justification purposes. The Committee has provided $5,000,000 for this work and the construction of pedestrian bridges required for safety purposes."*

1.4 Past Studies and Documents:

The summary of previously prepared documents is provided in the following paragraphs. These reports are on file at Corps of Engineers (Corps), Los Angeles District (LAD).

1945-1946 Studies: In November 1945 a report entitled "Interim Report on Survey of Gila River and Tributaries in the Vicinity of Tucson, Arizona" was prepared. In a follow-up report, the Chief of Engineers' Report dated October 31, 1946, construction of a diversion channel and levee system to protect portions of Tucson was recommended.

Late 1960's Studies: In the late 1960's, the Corps studied flood-related problems along the Santa Cruz River and its principal tributaries, extending north from the boundary of the United States and Mexico, to its confluence with the Gila River. This was an interim study conducted under the Gila River and Tributaries, Arizona, and New Mexico study authority. It addressed flood-related problems on the Rillito River and tributaries and Airport Wash (see details in LRR).

Mid-1970's Studies and Reports: In the mid 1970's, two Floodplain Information Reports were prepared by the Los Angeles District at the request of Pima County, under the continuing authority provided by Section 206 of the Land Acquisition Policy Act of 1960 (Public Law 86-645), as amended. The first report addressed the Rillito River and Pantano Wash and was published in June 1973. The second report addressed Tanque Verde Creek and Tributaries and was published in August 1975. The purpose of these reports was to identify those areas subject to possible future flooding. Although these reports did not provide solutions to flood problems, they did furnish a suitable basis for the adoption of land use controls to guide floodplain development, and thereby prevent intensification of future flood-related damages. These reports were utilized by Pima County to regulate floodplain development.

1980-86 Studies and Reports: In October 1983, major flooding occurred along the Rillito River and caused substantial damage. At the request of Pima County, the Los Angeles District initiated a Section 14 (Emergency Streambank Protection) Initial Appraisal, in the vicinity of the Flowing Wells Road Bridge, to examine the feasibility of protecting public property (utilities, bridge, fire station) from imminent damage due to future channel bank erosion. The report, which recommended construction of 700 linear feet of soil cement revetment bank protection, was approved in July 1984. Construction was completed in early 1986.

In May 1985, the Final Tucson Urban Study (TUS) Report was submitted to the South Pacific Division for approval. It recommended no further studies under the TUS authority. Detailed studies were to be continued under the Rillito River and Associated Streams authority. The South Pacific Division and Board of Engineers for Rivers and Harbors concurred with this recommendation in July 1985 and November 1985, respectively (refer to Chapter III of LLR for details).

The authorized plan for stabilization of the Rillito River was developed by the U.S. Army Corps of Engineers in the 1986 Survey Report (revised in February 1987). The project included approximately 10.8 miles of soil cement bank protection and 15 invert stabilizers, similar to that already constructed by local interests along several reaches. At the time of the final report there were no economically justified flood control solutions to the problems on Tanque Verde Creek, with the exception of a reach adjacent to the Forty-Niners Country Club Estates (which was later studied by the Corps under Section 205 of the Continuing Authorities Program).

Final Environmental Assessment (EA) for the Rillito River and Associated Streams Project in Pima County - May 1986: A Final EA was completed and a Finding of No Significant Impact (FONSI) was signed in May 1986, and later revised in February 1987. This Final EA addressed impacts related to stabilization of 13.2 linear miles of banks along the Rillito River with soil cement revetment, and re-establishment of the pre-October 1983 channel alignment and configuration.

1990-1996 Studies and Report: In 1992, the Federal Emergency Management Agency (FEMA) completed a Flood Insurance Study, which designated flood hazard zones within unincorporated areas of Pima County, Arizona. In October 1992, the Corps of Engineers prepared a General Design Memorandum (GDM) for bank protection along the Rillito River.

Construction of the Rillito River bank protection project was divided into three increments. Increments I and II were for flood control, and Increment III was for recreation and aesthetic treatment of the entire river reach. This project included construction of approximately 10.8 miles of soil cement bank protection and 15 invert stabilizers.

The Pima County Flood Control District has prepared a report in 1996 detailing a proposed plan for bank stabilization, and a potential riparian area preserve, along Tanque Verde Creek. The purpose of this report was to develop a plan to provide protection to private property, public infrastructure, and existing riparian areas along Tanque Verde Creek, especially within the reach between Craycroft Road and Sabino Canyon Road.

Final Supplemental Environmental Assessment to April 1986, Final Environmental Assessment Rillito River and Associated streams Project - October 1992: This supplemental EA was prepared to address impacts related to modifications made to the Final EA of 1986. The modifications were: relocation of recreation rest areas and staging areas. The Supplemental EA also included compliance with new Federal and State environmental requirements and policies.

Final Supplemental Environmental Assessment - June 1995: This supplemental EA was prepared to address impacts related to modifications to be made during construction of the second phase of the Corps Rillito River project. During design of the second phase of the project, additional changes were recommended due to changing conditions in the project area and refinement of the project design. These changes included stabilization of about six miles along both banks of the river and construction of nine invert stabilizers between Craycroft Road and the Santa Cruz River.

Supplemental Environmental Assessment - January 1998: This Supplemental EA was prepared to evaluate impacts related to installation of pedestrian bridges (Phase III) in alignment with the recreational trail at intersections of the trail and river channels. Construction of these pedestrian bridges would help preserve the existing bank stabilization measures. They would also eliminate the public safety risk incurred by crossing the tributary and main channels of the Rillito River system in the absence of pedestrian bridges.

1.5 Summary of Impacts

Potential impacts associated with construction of the proposed bank stabilization measures along Tanque Verde Creek are summarized below:

Short Term Impacts: Short-term impacts from stabilization of the banks would result from the excavation of material, use of construction equipment, and transportation of required construction materials.

- Fugitive dust particles and emissions generated by vehicles and equipment would be increased within the project areas during construction. Watering of the excavated site and unpaved road would be employed to control the fugitive dust. Normal conditions would be reestablished after completion of the project.

- Noise levels from the construction equipment would be increased in the vicinity of the project area. This impact would be short term and insignificant.

- Approximately 4.88 acres of desert wash habitat will be excavated for toe-down and access. This habitat is expected to recover within approximately 3-5 years. These temporary impacts have been considered in the mitigation plan.

Long Term Impacts:

- Secondary impacts to the mesquite bosque habitat at the confluence of Tanque Verde Creek with Pantano Wash and the Rillito River may also occur over a long period of time. Mature trees will continue to obtain ground water, but germination and establishment of new seedlings may be inhibited, as the bank protection prevents overflow of floodwaters onto this stand. The proposed mitigation plan takes into consideration these impacts.

- For the Recommended Plan, a total of approximately 4.12 acres of habitat would be permanently removed, including approximately 1.0 acre of high quality mesquite Bosque habitat and 4.22 acres of disturbed desert wash habitat. Bank stabilization utilizing soil cement will not support regrowth of vegetation along the creek banks. Based on the modified HEP, an estimated 2.38 average annual habitat units (AAHUs) would be lost in the construction area over the 50-year period of analysis. Acquisition and maintenance of the preserve area located along north bank of the creek would adequately mitigate for the loss of these AAHUS. Habitat units lost, mitigation requirements, and mitigation costs have also been calculated for the other viable alternatives Appendix B-5.

2.0 PURPOSE AND NEED

The primary purpose of the proposed project is to provide bank protection along Tanque Verde Creek between Craycroft Road and Sabino Canyon Road in order to reduce flood damages to private property, public infrastructure, and existing riparian areas. The Tanque Verde Creek area is subject to periodic inundation from large magnitude floods. Associated flood damages impact residential, commercial, and recreational developments as well as roads, bridges, and utilities. The upper reaches of the creek remain undeveloped and unencroached upon by man. The lower reaches from Wentworth Road to the confluence with the Rillito River are substantially developed.

Historically, flooding has occurred along the Rillito River and its tributaries. The floods of December 1965 (Rillito River, peak discharge of 12,400 cubic feet per second [cfs]) and of December 1967 (peak discharge of 16,000 cfs) caused significant damage in Tucson and in the vicinity. Estimated damage caused by past flooding, per event has ranged from $2,000,000 to $10,000,000. Historically, the highest recorded peak discharge was 28,500 cfs in Pima County. Along Tanque Verde Creek, significant damage occurred due to flooding of 1993. This prompted the renewed investigation into a project to reduce flood damages to private property, public infrastructure, and existing riparian areas. The following problems and opportunities have been identified in the reach of Tanque Verde Creek between Craycroft Road and Sabino Canyon Road. During the flood of 1993, this reach experienced significant lateral erosion. Major damages occurred to an existing 8" sanitary sewer line located along the south bank of Tanque Verde Creek, near the Tucson Country Club Estates, which was exposed due to lateral bank erosion. Lateral bank migration of about 100' also occurred during this flood.

If more flooding occurs in this vicinity, it will damage the sewer line located on the north side of Tanque Verde Creek. This is a 30" sewer line, known as the North Rillito Interceptor, which runs along the base of the river bluff. If a line break occurred, it would be impossible to close down flow without inducing sewer back-flow into residential properties, due to the interceptor's gravity flow design. According to the Pima County Wastewater Management Department, it is likely that a line break during a storm event could produce a 20 million gallon release of wastewater prior to its containment.

On the south side of Tanque Verde Creek, Pima County has already awarded an engineering and design contract for construction of a new 36" Tanque Verde Interceptor Extension sewer line. This interceptor will parallel Tanque Verde Creek from Craycroft Road east to the Tucson Country Club. This project was approved with the 1997 sewer system revenue bond ballot initiative.

Lateral Migration Analysis: The Corps conducted an analysis to investigate erosion along the Tanque Verde Creek banks. This indicated that lateral shifts on the order of 650 feet within the banks of the main channel, of are not unusual over a 50-year time period. This distance correlates very closely to the long-term migration distance (652 feet) computed using building setback formulas in the City of Tucson's drainage standards (City of Tucson, 1989), in conjunction with a bankful discharge of 17,000 cfs. Likewise, over the 50-year period of

analysis, an average annual erosion rate of approximately 13 feet per year appears to be a reasonable estimation of the erosion potential within the area. On a per-event basis, flow events even smaller than a 5-year event could cause bank migration of unprotected banks. The maximum historic migration that has been observed in the study area is 195 feet, although the frequency associated with such an event is unknown.

Under without-project conditions, it is also expected that scour, degradation and erosion along the creek banks will occur. The erosion zone in question includes residential properties, an existing sewer line, a proposed sewer line, and the Tucson Country Club. There are 56 residential structures located within the erosion zone. Equivalent Annual Damages by category are shown in Table 4.2 of Chapter IV of the LRR.

Upstream of the Craycroft Road Bridge, an old meander bend extends south of the existing channel. This meander intersects Craycroft Road approximately 1,000 feet south of the bridge. Flood flows and subsurface flows tend to follow this meander and have already resulted in undermining of the roadway embankment. Periodic repairs to the road surface and to an interceptor sewer line have been required due to these flows. In the event of a severe flood, flows could undermine and break through the roadway embankment, washing out the roadway and the sewer interceptor. Such an event could also cause inundation and erosion damages to houses and other development west of Craycroft Road, the North Rillito Interceptor, and the Tanque Verde Interceptor Extension.

An evaluation of 60 years of photographic records was performed to determine erosion potential along the study area. Photographs used in this analysis were taken in 1936, 1953, 1960, 1967, 1971, 1983, 1993, and 1996. For details see Chapter IV, Problems and Opportunities, of the Limited Reevaluation Report.

The unprotected banks of Tanque Verde Creek would experience rapid erosion during significant flood events. There are two large gaps along the south as well as the north banks. It is necessary to provide bank protection between Craycroft Road and Sabino Canyon Road to halt further channel migration, and to protect existing structures, property, and riparian areas.

Flood flows from Pantano Wash, moreover, have the potential for causing added damage in the confluence area, where floodflows could commingle with flows from Tanque Verde Creek. Such combined flows would potentially cause damage to property within the area between the two conveyances, as well as to the Craycroft Road bridge and embankment.

3.0 ALTERNATIVES DEVELOPMENT PROCEDURE

The Tanque Verde Creek Limited Reevaluation Study was conducted to develop feasible alternatives to provide required bank stabilization to protect properties and infrastructure within the project area and to reduce the flood threat to the residences and businesses located in the vicinity of Tanque Verde Creek. Planning objectives, economic, social and environmental criteria described below have been taken into consideration in the development of the feasible alternatives. Viable alternatives including the No Action Alternative are described in section 3.3.

3.1 Planning Objectives.

The following Planning Objectives have been developed as guidelines for plan evaluation for the Tanque Verde Creek Project:

- Reduce damages resulting from streambed degradation and bank erosion and failure along Tanque Verde Creek.
- Prevent or minimize flood hazards along Tanque Verde Creek.
- Maintain existing open space and natural resources located within the proposed project area to the extent possible.
- Minimize impacts to existing riparian habitat and wildlife resources located within the proposed project area.
- Avoid or minimize impacts to existing historical archaeological resources located within the proposed project boundary.

3.2 Criteria for Plan Evaluation

Bank Protection:

- An alternative should be consistent with Pima County and City of Tucson General Plans, particularly the County's Rillito Corridor study and the authorized Rillito River and Associated Streams Study.
- The Recommended Plan should not cause flood hazards for downstream developments without measures to compensate for the effects resulting from implementation of the selected Alternative.

Economic Criteria:

- The total benefits associated with the implementation of the selected plan must be equal to or exceed the total costs associated with the proposed project.
- Project benefits should be based on analyses of conditions without and with a project, using methodologies described in "Principles and Guidelines" and Corps of Engineers regulations.

- The benefits and costs should be expressed in comparable terms as fully as possible. Plan evaluation should be based on the same price level and the same interest rate for both benefits and costs, and a project life of at least 50 years.

Environmental Criteria:

- An environmental document must be in compliance with the National Environmental Policy Act (NEPA), and applicable Federal, State and Local environmental laws and regulations.
- If possible, avoid impacts to the significant resources located within the project area. Provide mitigation to offset project related impacts fully.
- To the extent practicable, enhance significant resources including wildlife, vegetation, land, air, water, open space, scenic and aesthetics located within the project area.
- Maintain riparian habitat benefits (including mesquite bosque.
- Avoid/preserve historical/archeological resources and perform site testing to identify eligibility of the cultural resources located within the project area.

Socio-economic Criteria:

- Minimize relocation of structures or people from the project area.

- Consideration should be given to safety, health, and social well-being of the people.

3.3 Alternatives

3.3.1 Alternative 1, No Action Alternative

Under the No Action Alternative, no bank stabilization would take place at the reach of Tanque Verde Creek between Craycroft Road and Sabino Canyon Road. The eroded south bank would not receive any stabilizing reinforcement and would be subject to continued erosion by low flows and flood flows on Tanque Verde Creek. About 56 structures, including a sewer line (North Rillito Interceptor), as well as desert riparian vegetation located within and adjacent to the project area are likely to be damaged by future flooding and erosion. If the sewer line is damaged, it could release about 20 million gallons of wastewater in the project area, which would cause significant degradation in water quality of the creek.

Based on the analysis, the south bank of Tanque Verde Creek could be eroded an average of 13 feet per year. A summary of the lateral migration analysis is provided below, details can be found in the LRR and Appendix A of the EA.

Lateral Migration Analysis summary: On July 20-21, 1998, the Corps of Engineers and Pima County staff conducted a site visit with the U.S. Fish & Wildlife Service (USFWS), and the Arizona Game and Fish Department (ADGF). At this meeting the USFWS and ADGF expressed their concerns that the project may result in eroding unprotected riparian vegetation located within the project area. The Corps contracted out the Lateral Migration Analysis Studies to Tetra Tech Inc., Infrastructure Southwest Group (TTISG), to investigate bank erosion, lateral

migration, and channel migration and in particular to assess bank stabilization impacts along the unprotected northern banks of the riparian preserve. The study was performed for the project reach located between Craycroft Road and Sabino Canyon Road along Tanque Verde Creek.

Historical Geomorphic Analysis: Simons Li & Associates (now part of TTISG) performed evaluation of aerial photographs of the study reach of the years 1936, 1953, 1960, 1967, 1971, 1979, 1983, and 1996 in connection with USGS flow records. In addition, changes in land uses and vegetation locations were documented and correlated to movement of the creek banks. This study indicated that in the past, bank erosion has occurred due to shifts in the river course or lateral erosion. About 650 feet of lateral shift occurred during a period of 60 years. Most of the bank erosion occurred due to the major flood event of December 1965 (see details in Appendix A of this EA and in LRR, Lateral Migration Analysis).

Erosion/Meander Potential: The results of the 1998 fluvial geomorphologic analysis revealed that under without-project conditions, lateral shifts or erosion would occur along the creek bank within the project area. It is estimated that under without-project conditions, an average of about 13 feet of bank per year could be eroded. Based on historical data, a flooding event even smaller than a 5-year event could cause lateral migration of unprotected banks, but the majority of lateral migration occurs as the result of one or a few major flood events. Although the maximum historic migration observed in the study area is 195 feet, the frequency associated with this erosion episode is not known.

3.3.2 Alternative 2

Stabilization of unprotected banks between Craycroft Bridge and Sabino Canyon Road (7,050 linear feet along south bank and 1,550-linear feet upstream of Craycroft Road North Bank), acquisition of Mesquite Bosque Preserve along north bank as mitigation

Alternative 2 would stabilize unprotected creek banks between the Craycroft Road Bridge and the Sabino Canyon Road Bridge and would acquire and protect a mesquite bosque/desert riparian preserve from future development as mitigation. This alternative was previously recommended by the U.S. Fish and Wildlife Service as well as the local sponsor; however, due to considerable public and agency concern that the preserve would not endure without erosion protection, Alternative 2 is no longer the recommended plan. The project reach is approximately two miles long and already includes partial bank protection. Approximately 8,800 linear feet of existing bank within this reach have been stabilized with soil cement in four segments (See Figure 2), consisting of about 4,500 feet along the north bank (two segments) and about 4,300 feet along the south bank (two segments).

The actual study reach extends a short distance downstream of Craycroft Road and a short distance upstream of Sabino Canyon Road. On the north bank, existing bank protection begins at Sabino Canyon Road bridge and extends approximately 4,000 feet west (downstream) to Cloud Road. For the remaining distance to Craycroft Road Bridge, the north bank is unprotected, except for about 500 feet of protection immediately upstream of the bridge, and the overbank is heavily vegetated with native mesquite bosque/desert riparian vegetation. On the south bank, existing soil cement bank protection begins at Sabino Canyon Road and extends approximately 2,700 feet west. An additional section of bank protection, constructed after the

1993 flood, begins approximately 4,200 feet further downstream, and continues 1,600 feet west. The Craycroft Road Bridge is roughly 2,400 feet downstream of that point. At the bridge, the banks are protected by soil cement installed either as part of the 1993 flood riprap (north abutment) or as part of the Corps Rillito River Bank Protection Project (south abutment). See the aerial photo at Figure 2 for existing bank protection and proposed bank stabilization features within the project reach.

The project limits for this alternative were established-using an analysis of the 100-year floodplain. A 1993 topographic base map was used for this in conjunction with HEC-2 water-surface profile model. The analysis included a backwater analysis for the confluence region that considered the combined flows from Pantano Wash and Tanque Verde Creek. The entire floodplain model was based on a single discharge, 34,000 cfs, which is the current regulatory 100-year discharge for Tanque Verde Creek. For details, see the LRR, Section IV-B. Acquisition of 48 acres of land along the north bank as a preserve is proposed as mitigation. This privately owned land consists of moderate and high quality mesquite bosque habitat that would otherwise be subject to future degradation. This 48-acre site, when acquired and managed as a preserve, will replace the project-related habitat units lost.

Bank Stabilization: The structural measures for this alternative include stabilization of the unprotected streambed using soil cement along the north and south banks of the creek. In addition, protection features would be constructed along the confluence of Tanque Verde Creek and Pantano Wash to protect property within the area between the confluence of Tanque Verde Creek, Pantano Wash and the Craycroft Road Bridge. Bank stabilization would be constructed to make smooth curves along the existing bank. Where feasible, the ends of the soil-cement banks would match the existing soil cement. On the south bank, at the downstream end, the proposed soil cement would key into the bank just upstream of the confluence with Pantano Wash. On the north bank, at the upstream end, the soil cement would key into the existing bank and be tied back to high ground as shown in Exhibit 11 "Typical Cross Section of Bank Protection" of the LRR.

The soil cement used would match the top of the existing bank, and the toe-down in the streambed would extend about 10 feet below the channel invert. The average height of the soil cement banks would be about 8'. Soil would be obtained from the creek bed and would include soil excavated for the tow-down and slope preparation. Soil cement would be mixed on-site. The soil cement layer would be an 8-foot thick layer of soil and cement that is mixed and placed in 6-inch to 1-foot-thick lifts. The lifts are successively placed until the desired bank protection height is reached. The soil cement banks would have a 2:1 slope.

Construction Materials: About 115,000 cubic yards (C.Y.) total of material would be excavated along the creek banks and toe along the banks to be stabilized. The excavated soil would be mixed with stabilizer material such as Portland cement and pozzolon. About 6,300 tons (3,500 C.Y.) of Portland cement and about 650 tons (360 C.Y.) of pozzolon would be required to mix with the soil. Compacted soil cement of about 43,000 C.Y. would be required to stabilize unprotected banks. Prior to placement of the soil cement, compacted fill material would be placed between the excavated bank and the layer of soil cement, and another 29,000 C.Y. of compacted fill material would be used to smooth the surface of the excavated banks. About

8,250 linear feet of safety hand railing would be installed in selected areas of the project. The stabilization of banks with soil cement, also the non-federal sponsor's preference, would be consistent with the existing stabilized banks along Tanque Verde Creek and along the Rillito River. The materials available on site are close to the ideal materials that can be used for soil cement. They are in the right size range and are relatively well blended and uniformly distributed across that size range. Furthermore, there are no significant amounts of clays present. Soil cement banks would provide the required strength and durability to withstand high velocity flows during larger flooding events and would provide the desired level of flood protection along Tanque Verde Creek.

Construction Schedule: The proposed bank stabilization along partially unprotected banks along Tanque Verde and at the confluence of Tanque Verde Creek and Pantano Wash would take about six months. About 195 truck trips would be required to transport construction related materials. Transportation of construction related material could be expected to total about 60 days with about 4-truck trips expected daily over this period.

Construction Crew: A selected contractor will construct the project with a construction crew of about 30 members. Most of the construction crew would come from the Tucson, Arizona vicinity, with a maximum travel distance of about 10 miles from the project area.

Construction Equipment: Equipment used for bank stabilization would include: three scrapers, two bulldozers, one compactor, four belly dump trucks for soil cement movement, a cement mixer, and one water truck.

Staging Area: There would be two equipment staging areas and a material-processing site. One staging area would be located in the vicinity of the north bank of Tanque Verde Creek about 50 yards upstream of Craycroft Road. The second staging area could be located along the south bank of the creek in the vicinity of the banks being stabilized. These staging areas will be about 2 acres in size.

Haul/Access Roads: Craycroft Road, Sabino Canyon Road, and Grant Road would be the major haul routes. Material would be excavated using a scraper, and deposited in the area within the creek banks. This activity may require transportation of material for as much as 1/4 mile. Needed cement would be obtained from a local supplier located in Tucson, within about 5 miles of the project site.

Mesquite Bosque Preserve: The study area includes a 48-acre high-value mesquite bosque/desert riparian zone along the north bank, approximately 5,000 feet upstream of Craycroft Road. Currently, this land is privately owned, and could be subject to future development or other disturbance. To restrict future development and disturbance in this area and to preserve this natural riparian vegetation, the Corps and the local sponsor propose to acquire the land and establish a permanent 500-foot-wide riparian vegetation buffer as a preserve along the north bank. Restricting future development within this area would reduce potential degradation or loss of the riparian community and would mitigate for short-term and long-term impacts of the proposed project. The proposed riparian preserve area would continue to experience a similar level of inundation and scour from larger floods as is currently experienced.

With the surrounding banks stabilized, a slight increase in the erosion of the banks along the proposed preserve could be expected as compared to existing conditions. This would allow for some channel movement and occasional inundation of the riparian area. Mesquite bosque ecosystems require occasional inundation by flood flows to stimulate seed germination and provide flushing and cleansing benefits.

3.3.3 Alternative 3

Stabilization of unprotected banks between Craycroft Bridge and Sabino Canyon Road (4,220 linear feet along south bank adjacent to golf course and 1,550-linear feet along north bank upstream of Craycroft Road), acquisition of Mesquite Bosque Preserve along north bank as mitigation

This Alternative is similar to Alternative 2 except that approximately 2,830 feet on the south bank, just upstream of the Craycroft Road Bridge, will not be stabilized with soil cement. The protection on the south bank would tie, instead, into the existing protection upstream of the golf course. It would continue to a point just downstream of the golf course, and beyond the site of the historic meander. The unprotected portion of the south bank would be allowed to erode naturally. The construction schedule could be reduced to about 4.5 to 5 months. Estimated quantities of materials include excavation of about 80,500 C.Y. of excavated material, 2,500 C.Y. Portland cement, 252 C.Y. pozzolon, 20,300 C.Y. compacted fill, and 30,100 C.Y. soil cement. Approximately 140 truck trips would be required to deliver construction materials. Construction methods, equipment, and access would be as described for Alternative 2. Based on the Modified HEP analysis (Appendix B-5) approximately 10 acres of the mesquite bosque preserve would be required to mitigate the impacts of Alternative 3. Alternative 3 is not the Recommended Plan because it would not provide the required level of erosion protection benefits.

3.3.4 Alternative 4 (Recommended Plan)

Stabilization of unprotected banks between Craycroft Bridge and Sabino Canyon Road (7,050 linear feet along south bank and 1,550 linear feet upstream of Craycroft Road north bank), acquisition of Mesquite Bosque preserve along north bank, and modified bank stabilization along preserve.

This Alternative would be similar to Alternative 2 except that modified bank stabilization would be provided for the preserve area to reduce the rate of erosion. Recommended bank stabilization measures include a low soil cement berm adjacent to the bank of the habitat area (approximately 5,000 feet long), with "weep holes" installed through the berm to maintain the hydrologic connection between the creek and the preserve area. The size and spacing of the weep holes will be determined during the Pre-construction, Engineering and Design (PED) phase of this project. The berm would stabilize the slope with a height that would continue to allow overtopping from floods of near the same frequency as under existing conditions, estimated as a 10-15-year frequency flood. The berm will be constructed to the lowest elevation that will effectively control bank erosion. It is estimated that the berm would average approximately 2 feet above ground level and have toe-down depths the same as the upstream and downstream slope protection (approximately 10 feet). Refer to Alternative 2 for details on the construction

schedule, construction equipment, construction crew, construction material, and haul routes. Due to the additional 5,000 feet of soil cement with weep holes, the construction schedule would lengthen and quantities of materials would increase by about 45% assuming a berm 2' above ground surface level and a 10' toe-down. Construction time is estimated at 8-9 months. About 280 truck trips would be required to transport construction materials. Construction material quantities are estimated at 161,000 C.Y. materials excavated, 5,075 C.Y. Portland cement, 522 C.Y. pozzolon, 63,000 C.Y compacted soil cement, 42,000 C.Y. compacted fill material.

3.4 Alternatives Eliminated from further Consideration (Sideslope Stabilization)

In preparation of the "Survey Report & Environmental Assessment, Rillito River & Associated Streams" report, the Corps conducted extensive analyses of the economic and engineering viability of various structural techniques on the Rillito River to which Tanque Verde Creek is a tributary. The Corps determined that gabions and stone revetment were not cost effective in comparison to grouted stone and soil cement revetments and dropped them from further consideration. Current cost data suggest that the cost efficiencies of grouted stone and soil cement revetment still exist. Gabions and stone revetment, therefore, are not considered viable candidates for this report. Although grouted stone is economically viable, current costs and the requirement for additional land sustain its cost ineffectiveness relative to soil cement as in the Survey Report. Web cellular confinement systems were investigated as potential alternatives, but these systems would require the addition of concrete into the cells, as flow velocities exceed 15 cfs. This would defeat their intended environmental functions. Soil cement revetment, in sum remains a viable solution from both engineering and economic perspectives.

3.4.1 Gabion-reinforced Banks

Rather than using soil cement, the south bank of the creek could be reinforced using gabions (rock-filled wire baskets or cages). The gabion toes would be placed at either the elevation of the existing streambed or 2 to 3 feet below the current streambed elevation. Gabion-reinforced banks could provide the needed protection, but would not be consistent with the soil cement banks already established within the project reach. The Corps determined that gabions were cost inefficient in comparison to grouted stone and soil cement revetment and were dropped from further consideration. This option, therefore, has been eliminated from further consideration.

3.4.2 Stabilization of Banks by Riprap

This option consists of stabilizing the creek banks with ungrouted riprap from the toe to the top of the stream bank. Implementation of this option would require transportation of rocks from an existing quarry to the project site. Riprap is also not consistent with the appearance of these stabilized creek banks and rivers in the Tucson area. The Corps also examined this option for the economical analysis. This option is not economically feasible and would not provide the needed level of bank protection and, therefore, not evaluated further in this document.

3.4.3 Grouted Stone Banks

This option would be similar to the riprap bank stabilization, but the riprap placed on the creek banks would be grouted with concrete to fill the spaces between the rocks and to provide

additional armoring for the slope. This option would provide the needed protection to the project area, but would be expensive compared to the preferred alternative. Grouted stone is economically viable; however, current costs and its requirement for additional land maintain its cost ineffectiveness relative to soil cement revetment as analyzed in the Survey Report.

3.4.4 Web Cellular Confinement Systems

The Environmental Resources Branch coordinated the proposed project implementation with the Corps Regulatory Branch, Tucson office. The Regulatory Branch suggested that we examine using Geo-web type of slope protection rather than soil cement. Web-cellular confinement systems were investigated as potential alternatives. These systems would require the addition of concrete into the cells, as flow velocities exceed 15 cfs; thus defeating their intended environmental functions. Based on the creek's hydrology, this alternative is not feasible. In addition, if the cells are filled with concrete, the bank will not support any vegetation.

3.4.5 Concrete-lined Channel Banks

This option would require lining unprotected sections of the Tanque Verde Creek with concrete, although the channel bottom would not need to be lined. Implementation of this alternative would be expensive. The appearance would be that of an obviously man-made structure and would be out of character with the other tributaries and main rivers. It would result in potentially significant effects on native plants and wildlife and the visual character of the creek. For these reasons, this alternative has been eliminated from consideration.

3.4.6 Compacted Fill Banks

This option involves stabilizing the creek bank with compacted fill material. Compacted fill offers very little erosion protection. This option would provide substantially less erosion protection and would be eroded relatively quickly during severe flooding events. Severe flooding and high velocity stream flows are very common along Tanque Verde Creek. The results of a Lateral Migration Analysis (Appendix A) revealed that severe flooding and the high velocity of stream flows caused severe lateral bank erosion in the past. This option would not be consistent with the planning objectives of the project and would require continuous maintenance. It would not provide adequate stream bank protection or flood protection to the property located along the creek banks; therefore, this alternative has been eliminated from consideration.

4.0 EXISTING ENVIRONMENT

4.1 Physical Setting

The City of Tucson is located in a desert valley bounded by the Santa Catalina Mountains on the north, the Rincon Mountains to the east, the Tucson Mountains to the west, and the Santa Rita and Sierrita Mountains to the south. These mountains range in elevation from 4,600 to over 9,000 feet above mean sea level. The city limits extend to an area of 156.04 square miles, and the entire metropolitan area covers nearly 500 square miles.

The study area lies in the southwest physiographic area known as the Basin and Range Province. It is marked by relatively flat alluvial plans located between mountain ranges extending north and south.

4.2 Climate

The climate within the Tucson basin is typified by abundant sunshine, a long hot season, mild winter temperatures, low average annual precipitation, relatively low humidity, and generally light surface winds. Tucson's hot season extends from May through September, when average daily maximum temperatures approach or exceed 90 degrees, and often exceed 100 degrees in the months of June and July. During the remainder of the year, temperatures remain relatively mild. In comparison to most of the United States, Tucson's relative humidity is low. As a result, higher temperatures in the region are more-easily tolerated. Precipitation in the Tucson basin averages 12 inches per year. About 60 percent of the precipitation occurs during the monsoon season, between July and September, when brief torrential downpours cause flash floods.

4.3 Water Quality

The Tucson basin is drained by the north-flowing Santa Cruz River and its three main tributaries: Pantano Wash, Rillito River/Tanque Verde Creek, and Canada del Oro Wash. The Santa Cruz River flowed perennially in the 1800's, but increased pumping and the subsequent lowering of the groundwater table have created an ephemeral river, which flows only during and immediately after significant periods of rainfall.

The quality of surface water in the Tucson area is generally acceptable except for large amounts of suspended sediments. The dissolved solids content is generally less than 400 mg/l. Sources of pollutants originate from treated sewage effluent and urban runoff discharged into the watercourses. Most of the storm water runoff is channeled down the city streets to the major watercourses. The Santa Cruz River and Rillito River, downstream of Tanque Verde Creek, are the primary pollutant sinks of the Tucson area. Based on sampling of wells along the Rillito River and water quality information from the City of Tucson, there is no indication of groundwater contamination from urban runoff. This appears to be the result of dilution from mountain streams and short duration of flows.

Tucson is one of the largest cities in the United States that is totally dependent upon groundwater. The Tucson basin is a 1,000 square mile area in the upper Santa Cruz drainage basin of southeastern Arizona. The major influx of groundwater enters the basin from the south along the Santa Cruz River. The general direction of groundwater movement is north to northwest except for the portion of the basin drained by the Canada del Oro Wash where the water table gradient is to the southwest.

The water supply in Tucson comes from 180 groundwater wells located in and around the Tucson metropolitan area. In urban Tucson, most of the wells, also known as Points of Entry, serve the neighborhood in which they are located with excess supply routed to reservoirs for use elsewhere in the system. Wells located outside the urban core often deliver water to a single "collector" main prior to delivery to customers. The collector main is termed as "combined Point of Entry (POE)" to the drinking water system. The Tucson Water system has four combined POEs: the Southern Avra Valley well field, the Santa Cruz well field, the South Side well field, and the Tucson Airport Area Remediation Project (TARP) well field. In general, the groundwater quality of the Tucson basin remains high. Specific portions of the basin have had wells with high levels of fluoride, sulfate, or nitrate such that the EPA drinking water standards were exceeded. However, water from these wells was mixed with water from wells of higher quality so that standards could be met and the water distributed to the public. In early 1981, trichloroethylene (TCE) in amounts in excess of the EPA recommended reaction level (5 parts per billion) was found in a Santa Cruz well. Subsequent to this finding, additional sampling was conducted. A total of 16 wells, including six operated by the City of Tucson, were found to exceed the EPA standard for TCE.

Potential sources of groundwater contamination include urban runoff, landfill leachate, septic systems, agriculture, and mineral extraction. The Rillito and Santa Cruz Rivers have been identified as pollution sinks from urban runoff. Preliminary analysis has not revealed groundwater contamination from urban runoff. Nine landfills were identified as areas of good possibility for groundwater contamination. Septic systems may be responsible for nitrate contamination of groundwater. Potential groundwater pollutants from agricultural activity consist of pesticides, plant nutrients (nitrogen, phosphorus), dissolved salts, and sediment. There is limited but inconclusive data to support allegations that agricultural areas irrigated with well water are causing groundwater pollution. Sand and gravel mining operations pose a problem when located near watercourses, especially when the abandoned pits are used as dumps.

Several mountain streams feed Tanque Verde Creek, and they probably provide a significant amount of flow to the Creek as opposed to storm water runoff from the urban area. In general, the water quality of the surface flows is acceptable.

The Interior Well Field provides the groundwater for the areas surrounding Tanque Verde Creek. In general, the groundwater for these areas is of good quality.

4.4 Air Quality

Air quality in the Tucson area is under the jurisdiction of the Arizona Department of Environmental Quality (ADEQ), Air Quality Division. The ADEQ maintains a network of air

quality monitoring stations throughout the state of Arizona. These stations monitor the surrounding area for the presence of criteria pollutants for which the state and federal governments have established air quality standards. These pollutants include carbon monoxide (CO), lead, nitrogen dioxide, ozone, particulates of PM_{10} (10 micros or smaller in diameter), and sulfur dioxide.

The study area is within the boundaries of the Tucson Air Planning Area which is a "non-attainment" area (exceeds Federal standards) for carbon monoxide. According to the Environmental Protection Agency, areas are described as "not classified" if they were designated "non-attainment" prior to the enactment of the 1990 Clean Air Act Amendments and if they did not violate the NAAQS for the two-year period 1988 through 1989. A Limited Maintenance Plan for the Tucson Carbon Monoxide (CO) "non-attainment" Area was submitted to the Environmental Protection Agency (EPA), April 1996. The Plan has been deemed complete and is currently undergoing EPA review. Once approved, the area will be redesignated to attainment. From 1987 to 1990, CO concentrations in Tucson gradually declined, and From 1991 to 1996 CO concentrations substantially decreased. These variations were most likely due to changes in meteorological conditions.

According to PDEQ data, ozone concentrations have fluctuated from 1987 to 1996, but remain below the Federal standards of the 1-hour standard, 0.12 ppm. Lead concentrations during the past ten years were well below the quarterly standard, 1.5 ug/m^3, in urban Tucson. This is the result of major reductions in lead emissions from cars from the mid-1970's through the early 1980's. Concentrations of nitrogen dioxide have remained far below the annual standard, 100 ug/m^3 in Tucson. There have been no exceedances of the 1-hour ozone concentration standard monitored in Tucson.

In the Tucson area, according to ADEQ data, PM_{10} concentrations have been lower than in other areas of Arizona. Thus, no exceedances of the annual standard have been monitored in Tucson. For the most part, annual averages have not changed significantly. Further, no exceedances of the 24-hour standard have been monitored in Tucson since 1988.

Overall, the major source of Tucson's air pollution is motor vehicle emissions. Carbon monoxide levels have dropped considerably since the County began monitoring this pollutant in 1973, due mainly to improved Federal tailpipe emission standard for new cars, and the introduction of oxygenated fuels in September of 1995. Air quality in Tucson is also affected by development patterns and industrial activities. As the population continues to grow in the region, CO emissions remain the primary air quality problem.

4.5 Biological Resources

Vegetation: Tanque Verde Creek is located within the Arizona Upland subdivision of the Sonoran Desert Scrub formation. Major plant communities in the region include creosote-bursage on the bajadas, palo verde-saguaro on well-drained upper slopes, saltbush scrub in the bottomlands where flooding and alkali soils occur, and desert riparian along watercourses. The creosote-bursage community is the dominant native association of vegetation in the Tucson region. In addition to the dominant creosote bush (*Larrea tridentata*) and common bursage

(*Ambrosia dumosa*), chain fruit cholla (*Opuntia fulgida*) and cane cholla (*O. spinosior*) are frequently associated with this plant community in the Tucson vicinity. In the immediate project area, the creosote-bursage vegetation has been largely replaced with urban and recreational development.

Desert riparian habitat occurs along watercourses in the region, including portions of Tanque Verde Creek, and is dependent on surface and ground water. In the project area, desert riparian habitat is best represented by the mesquite bosques at the upstream confluence of Pantano Wash and Tanque Verde Creek (approximately 22 acres) and in the proposed preserve area on the north bank of Tanque Verde Creek (approximately 48 acres). Velvet mesquite (*Prosopis velutina*) is the dominant plant species in this community. Other associated species include Fremont cottonwood (*Populus fremontii*), desert willow (*Chilopsis linearis*), burro brush (*Hymenoclea monogyra*), seep willow (*Baccharis salicifolia*), desert broom (*B. sarothroides*), Mexican palo verde (*Parkinsonia aculeata*), and Mexican elderberry (*Sambucus mexicana*). A portion of the proposed mesquite bosque preserve was burned in a fire within the past few years. The area includes some standing dead trees. Some trees that were damaged in the fire have begun to resprout, especially the Mexican elderberry.

In the more disturbed portions of the project area, the desert wash plant community is represented by occasional Fremont cottonwood in the streambed. Scattered mesquite, blue palo verde (*Cercidium floridum*), Mexican elderberry, broom baccharis, and burrobush *are* found on the stream banks. Saltbush (*Atriplex* spp.) scrub is uncommon in the project area. Additional plant species identified on site include:

Cat-claw acacia (*Acacia greggii*)
White acacia (*Acacia constricta*)
Fiddleneck (*Amsinckia intermedia*)
Four-wing saltbush (*Atriplex canescens*)
Desert broom (*Baccharis sarothroides)*
Desert marigold (*Baileya* sp.)
Needle grama (*Bouteloua aristidoides*)
Netleaf hackberry (*Celtis reticulata*)
Jimson weed (*Datura* sp.)
Skeleton weed (*Eriogonum deflexum*)
Eucalyptus (*Eucalyptus* sp.)
Burro-weed (*Isocoma tenuisecta*)
Boxthorn (*Lycium* sp.)
Stick-leaf (*Mentzelia* sp.)
Cholla (*Opuntia whippleei*)
Prickly pear (*Opuntia* sp.)
Tobacco (*Nicotiana* sp.)
Mexican palo verde (*Parkinsonia aculeata*)
Devil's claw (*Proboscidia parviflora*)
Russian thistle (*Salsola iberica*)
Globe mallow (*Sphaeralcia* sp.)
Fluff grass (*Tridens pulchellus*)
Yucca (*Yucca elata*)
Ziziphus (*Ziziphus obtusifolius*)

Fish and Wildlife: A diversity of wildlife occurs in the project area, especially in the mesquite bosques. These desert riparian areas also function as important corridors for wildlife movement and migration.

Mammals characteristic of the project area include kangaroo rats (*Dipodomys* spp.), pocket mice (*Perognathus* spp.), wood rats (*Neotoma* spp.), cottontail rabbits (*Sylvilagus* spp.), blacktailed jackrabbits (*Lepus californicus*), raccoon (*Procyon lotor*), skunks (*Mephitis mephitis, M. macroura,* and *Spilogale putorius*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), and javelina

(*Tayassu tajacu*). Mountain lions (*Felis concolor*) have been reported on site, probably using the area primarily as a migratory corridor.

Numerous bird species are found in the project area, especially in the mesquite bosque areas either as residents or migrants. The following is a list of birds that have been identified in the project area:

Mallard (*Anas platyrhynchos)*
Turkey vulture (*Cathartes aura)*
Cooper's hawk *(Accipiter cooperi)*
Red-tailed hawk *(Buteo jamaicensis)*
Swanson's hawk (*Buteo swainsoni)*
Harris hawk *(Parabuteo unicinctus)*
Gamble's quail *(Calipepla gambelii)*
Great blue heron *(Ardea heradias)*
Rock dove *(Columba livia)*
White-winged dove *(Zenaida asiatica)*
Mourning dove *(Zenaidura macroura)*
Roadrunner *(Ceococcyx californianus)*
Great horned owl *(Bubo virginianus)*
Elf owl (*Micrathene whitneyi)*
Poor-Will *(Phalaenoptilus nuttallii)*
Lesser nighthawk *(Chordeiles minor)*
Anna's hummingbird *(Calypte anna)*
Costa's hummingbird *(Calypte costae)*
Black-chinned hummingbird *(Archilochus alexandri)*
Northern flicker (*Colaptes chrysoides)*
Gila woodpecker *(Centurus uropygialis)*
Vermilion flycatcher (*Pyrocephalis rubinus*)
Ash-throated flycatcher *(Myiarchus cinerascens)*
Says phoebe *(Sayornis saya)*
Cliff swallow *(Petrochelidon pyrrhonota)*
Common raven *(Corvus corax)*
Verdin *(Auriparus flaviceps)*
Cactus wren *(Campylorhynchus brunneicapillus)*
Northern mockingbird *(Mimus polyglottos)*
Curve-billed thrasher *(Toxostoma curvirostre)*
Black-tailed gnatcatcher *(Polioptila melanura)*
Phainopepla *(Phainopepla nitens)*
Starling *(Sturnus vulgaris)*
Lucy's warbler *(Vermivora luciae)*
Wilson's warbler *(Wilsonia pusilla)*
Great-tailed grackle *(Cassidix mexicanus)*
Brown-headed cowbird *(Molothrus ater)*
Cardinal *(Richmondena cardinalis)*
House finch *(Carpodacus mexicanus)*
Lawrence's goldfinch *(Spinus lawrencii)*
Albert's towhee *(Pipilo aberti)*
Lark sparrow *(Chondestes grammacus)*
Black-throated sparrow *(Amphispiza bilineata)*
Chipping sparrow *(Spizella passerina)*
White-crowned sparrow *(Zonotrichia leucophrys)*

Reptiles expected in the project area include Tucson banded gecko (*Coleonyx variegatus bogerti*), western collared lizard (*Crotaphytus collaris baileyi*), horned lizards (*Phrynosoma* spp.), Gila monster (*Heloderma suspectum*), Sonoran gopher snake (*Pituophis melanoleucus affinis*), and western diamondback rattlesnake (*Crotalus atrox*). Few amphibians are expected in the project area due to prolonged periods of drought, but some species adapted to dry conditions, such as Couch's spadefoot toad (*Scaphiopus couchii*) and Great Plains toad (*Bufo cognatus*) may be present. No fish are expected in the project area due to a lack of permanent water (Corps 1986, 1992; USFWS, 1993).

Threatened and Endangered Species: Endangered and Threatened species are protected under the Endangered Species Act of 1973 (as Amended). If the Federal project sponsor determines that an action may affect a listed species, the agency is required to initiate formal consultation

with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Act. The Los Angeles District, U.S. Army Corps of Engineers requested in a letter dated July 16, 1998 that the USFWS provide updated Endangered and Threatened species information pursuant to Section 7 of the Endangered Species Act. The USFWS provided the requested information in a letter dated August 5, 1998. The response includes a total of eighteen (18) listed species one proposed species and five (5) candidate species. The request and response are included in Appendix B-3 of this EA. Subsequent to the preparation of the response, the American Peregrine Falcon (*Falco peregrinus anatum*) was removed from the Federal list of Endangered and Threatened species. The information provided with the response applies to all of Pima County, and is not project specific. The habitat in the project area is unsuitable for the majority of the species. Table 4-5 summarizes the information on the special status species. The following listed Endangered and Threatened species potentially occur in the project area:

Bald Eagle (*Haliaeetus leucocephalus*), Threatened. An estimated 200 to 300 bald eagles winter in Arizona along rivers and reservoirs. A smaller number of resident birds nest in the state. The habitat in the project area is not suitable for nesting, and is probably unsuitable for foraging, as well. Bald eagles would be expected in the project area only as occasional migrants or transients.

Cactus Ferruginous Pygmy Owl (*Glaucidium brasilianum cactorum*), Endangered. The Cactus Ferruginous Pygmy Owl historically occurred throughout much of the Tucson area. Only a few documented sites where this species persists are known. Habitat consists of mature cottonwood/willow riparian woodland, mesquite bosques, and Sonoran desert scrub. The mesquite bosque habitats at the western end of the project area and the proposed preserve area on the north side of the project area appear to be marginally suitable habitat for this owl. Other areas along the project alignment may be marginally suitable, as well. Biologists with Westland Resources, Inc. (1999) surveyed the project area according to proposed USFWS protocol. Westland Resources biologists hold a permit from USFWS to conduct Cactus Ferruginous Pygmy Owl surveys. The surveys were conducted on March 17-19, 1999; April 21, 1999, and May 12-14, 1999, and no Cactus Ferruginous Pygmy Owls were detected. A March 11, 1999 search of the Arizona Game and Fish Department Heritage Data Management System revealed no recent observations within the Township and Ranges that include the project area. In addition, informal coordination with Westland Resources biologists indicated that it would be unlikely that the owl would be found on site in future surveys. The report documenting the findings of the surveys is included in Appendix B-1 of this EA. A previous report on biological resources of the area (Ruffner, et al 1983) does not include the Cactus Ferruginous Pygmy Owl as likely to occur in the project area.

Candidate Species. Candidate species are those species under review for listing as Endangered or Threatened, but for which no formal listing proposal has been published. Federal law does not protect candidate species, but the USFWS recommends that they be considered in the planning process in the event that they become listed or proposed for listing prior to project completion. The proposed project area appears unsuitable for all of the candidate species known from Pima County, Arizona.

Table 4-5 Special Status Species

Known or Potentially Occurring at the Tanque Verde Project Site

SPECIES	STATUS	HABITAT	OCCURRENCE POTENTIAL
Plants			
Huachuca Water Umbel *Lilaeopsis schaffneriana* ssp. *recurva*	Federal Endangered	Cienegas, perennial low gradient streams, wetlands 3,500-6,500'	None - No potential habitat
Kearney's blue star *Amsonia kearneyana*	Federal Endangered	West facing drainages, Baboquiveri Mountains, 3,600-3800'	None - No potential habitat & Outside Range
Nichol's Turk's head cactus *Echinocactus horizonthalonius* var. *nicholii*	Federal Endangered	Sonoran desert scrub on limestone alluvial fans and terraces 2,400-4,100'	None - No potential habitat
Pima pineapple cactus *Coryphantha scheeri robustispina*	Federal Endangered	Sonoran Desert scrub and semi-desert grasslands in alluvial valleys and hillsides 2,300-5,000'	None - No potential habitat
Acuna cactus *Echinomastus erectocentrus acunensis*	Federal Candidate	Well-drained knolls and gravel ridges in Sonoran desert scrub 1,300-2,000'	None - No potential habitat

Table 4-5 Special Status Species

Known or Potentially Occurring at the Tanque Verde Project Site

SPECIES	STATUS	HABITAT	OCCURRENCE POTENTIAL
Invertebrates			
San Xavier talus snail *Sonorella eremita*	Proposed Endangered	Limestone talus, 3,850' to 3820'	None - No potential habitat
Fish			
Desert pupfish *Cyprinodon macularis*	Federal Endangered	Shallow springs, small streams, marshes <5,000'	None - No perennial water
Gila chub *Gila intermedia*	Federal Candidate	Pools, springs, cienegas, and streams 2,000-3,500'	None - No perennial water
Amphibians			
Chiricahua leopard frog *Rana chiricahuensis*	Federal Candidate	Streams, rivers, backwaters, ponds, and stock tanks free from introduced fish and bullfrogs with permanent or nearly permanent water source 3,000-8,300'	None - No perennial water
Reptiles			
Sonoyta mud turtle *Kinosternon sonoriense longifemorale*	Federal Candidate	Ponds and streams, Quitobaquito Springs 1,000'	None - Outside range, No perennial water

Table 4-5 Special Status Species

Known or Potentially Occurring at the Tanque Verde Project Site

SPECIES	STATUS	HABITAT	OCCURRENCE POTENTIAL
Birds			
Cactus ferruginous pygmy owl *Glaucidium brasilianum cactorum*	Federal Endangered	Mature cottonwood/willow, mesquite bosques, Sonoran desert scrub <4,000'	Low to Moderate - potentially suitable habitat (mesquite bosque) on site, but not detected in spring 1999 protocol surveys.
Masked bobwhite *Colinus virginianus ridgewayi*	Federal Endangered	Desert grasslands with diversity of dense native grasses, forbs, and brush, Buenos Aires wildlife Reserve, 1,000-4,000'	None - No suitable habitat, outside present range of species.
Southwestern willow flycatcher *Empidonax trailii extimus*	Federal Endangered	Cottonwood/willow and tamarisk vegetation along rivers and streams	Low - Habitat does not appear suitable, not within critical habitat.
Mexican spotted owl *Strix occidentalis lucida*	Federal Threatened	Canyons, dense forest, sites with cool microclimates, 4,100-9,00'	None - No suitable habitat, elevation too low.
Bald eagle *Haliaeetus leucocephalus*	Federal Threatened	Large trees or cliffs near water, with abundant prey	Low to moderate - Habitat unsuitable for nesting, but may be occasional migrant or visitor

Table 4-5 Special Status Species

Known or Potentially Occurring at the Tanque Verde Project Site

SPECIES	STATUS	HABITAT	OCCURRENCE POTENTIAL
Birds (Continued)			
Mountain plover *Charadrius montanus*	Federal Candidate	Open arid plains, short-grass prairies, and scattered cactus.	None - No suitable habitat.
American Peregrine Falcon *Falco peregrinus anatum*	Delisted 1999 (formerly Federal Endangered)	Cliffs and steep terrain, usually near water or woodlands with abundant prey	Low to moderate - Habitat unsuitable for nesting, but may be occasional migrant or visitor
Mammals			
Lesser long-nosed bat *Leptonycteris curasoae yerbabuenae*	Federal Endangered	Roosts in caves and abandoned tunnels, forages at night on nectar, pollen, and fruit of paniculate agaves and columnar cacti, >6000'	Low - No suitable roosting or foraging habitat, but may fly over area
Mexican gray wolf *Canis lupus baileyi*	Federal Endangered	Chaparral, woodland, and forested areas, may cross desert areas. 4,000-12,000'	Low - Habitat appears unsuitable and elevation too low, extirpated from most of historic range
Ocelot *Felis paradilis*	Federal Endangered	Humid, tropical and sub-tropical forests, savannahs, and semi-arid thorn-scrub, >8000'	Low - Habitat appears unsuitable, no recent confirmed reports in state.

Table 4-5 Special Status Species

Known or Potentially Occurring at the Tanque Verde Project Site

SPECIES	STATUS	HABITAT	OCCURRENCE POTENTIAL
Mammals (continued)			
Jaguarundi *Felis yagouaroundi tolteca*	Federal Endangered	Variety of habitats, 3,500-6,000'	Low - Habitat may be suitable, but no confirmed records from state
Jaguar (U.S. population) *Panthera onca*	Federal Endangered	Formerly ranged from Sonoran desert to conifer forests <8,000'	Low - Population nearly extirpated from Arizona
Sonoran pronghorn *Antilocapra americana sonoriensis*	Federal Endangered	Broad, intermountain alluvial valleys with creosote/bursage & palo verde/mixed cacti associations, 2,000-4,000'	None - No suitable habitat

4.6 Land Use

The City of Tucson is comprised of a variety of land uses that range from residential to industrial, municipal, and commercial development. According to the most recent data, residential acreage in the urbanized Tucson area amounted to 30.70 percent of the total land area. Residential acreage consisted of suburban ranch, single family, multiple family, and mobile homes. Commercial acreage amounted to 5.83 percent of the land area. Commercial structures consisted of general/strip commercial malls, major office buildings and shopping centers. Industrial acreage totaled 4.11 percent of the land area, consisting of industrial structures and non-structures, transportation, communication, utilities, resource extraction and airports. Agriculture acreage is minimal, representing about two percent of the land area. Open space acreage totaled about four percent of the land area, consisting of natural areas and preserves, parks and cemeteries. Overall, a very rural, low-density land use is typical of most of the urban area.

The Tanque Verde Creek study area is predominantly composed of open space and rural residential properties. Residential structures are concentrated on the north side of Tanque Verde Creek along Cloud Road and south of the bank between Sabino Canyon Road and Craycroft Road. To the north of the bank is an existing riparian area consisting of high quality desert habitat. Located alongside the south bank is the Tucson Country Club. The club encompasses approximately 200 acres and includes a clubhouse, tennis courts, swimming pool and golf course.

4.7 Aesthetics

Aesthetics vary considerably throughout Tucson, ranging from the open space and vegetation associated with natural surroundings to the cultural or regional characteristics in the architectural design of homes and commercial buildings. Green trees such as palo verde, mesquite and cottonwood grow in abundance. There are also many varieties of cacti in colorful bloom from April until late May. In the surrounding residential areas of Tanque Verde Creek native desert landscaping and many other types of shrubs and flowers are common.

The aesthetic value of Tanque Verde Creek is associated with the natural surroundings and open spaces. Except for channelization around Sabino Canyon Road, the watercourse remains relatively undisturbed. The confluence of Tanque Verde Creek and Pantano Wash supports an abundance of Cottonwoods.

4.8 Noise

A noise environment consists of a base of steady "background" noise that is the sum of many distant and indistinguishable noise sources. Superimposed on this background noise is the sound from individually recognizable local sources. These sources can vary from an occasional aircraft overflight to virtually continuous noise from traffic on adjacent streets or highways. Within the study area, noise sources include traffic from vehicles, motorcycles, construction vehicles and related equipment, and flight paths associated with Tucson International Airport. However, the predominant noise source in the study area is traffic along Craycroft Road, a major north-south arterial city/county roadway. Noise levels in this area average 70-80 decibels.

4.9 Socioeconomics

As of July 1, 1998, the estimated population for the State of Arizona was 4,764,025, which ranks 24th in the nation. Pima County accounts for 17.2 percent of the State total with an estimated population of 823,900 and is the second most populated county in Arizona. The City of Tucson is the largest city in Pima County with an estimated population of 475,450 as of July 1999, accounting for 56.8 percent of the County total.

According to the U.S. Census figures for Pima County, the median age in 1990 was 32.8, slightly below the national average. The median age is rising primarily because of the aging of the Baby Boom generation, and not because of net migration of senior citizens. A percentage distribution of population by age in 1990 revealed that the greatest percentage of residents in Pima County is within the age category of 20-29 (17 percent). The second largest percentage is in the 30-39 years age group (16.5 percent). Pima County's racial composition is diverse, as reported by the U.S. Census in 1995 as shown in the following table:

White, Nonhispanic	63.7%
Hispanic	26.5%
Black	3.8%
Native American	3.5%
Asian or Pacific Islander	2.47%
Other	0.1%

Source: Future West Greater Economic Council

In the Tucson metropolitan area, residential units authorized by building permits in 1999 totaled about 10,646. Approximately 68 percent were single family, detached homes. Only 4.9 percent were townhouses, while about 10.9 percent were multifamily units and 16.2 percent were mobile homes. Permits in 1999 were up 7.9 percent from 1998.

As of March 1997, the civilian labor force in Pima County totaled approximately 379,300 people, or nearly 50 percent of the projected total population. A much higher percentage of the work force in Pima County is employed in services (31.15 percent), government (22.63 percent), trade (22.05 percent) and a much lower percentage is employed in manufacturing (9 percent), construction (6.54 percent), transportation, communications, public utilities (4.16 percent), finance/insurance/real estate (3.92 percent), and mining (.69 percent). This reflects the influence of tourism, education, and retirement on the local economy. Tourism is an important sector of the Tucson economy generating a total of 36,500 wage and salary jobs, which is more than 12 percent of the wage and salary jobs in Pima County.

Tucson has the second largest university and college enrollment for the State of Arizona. The University of Arizona had an enrollment of 34,000 and Pima County Community College had 65,000, together making up a student population of approximately 100,000.

Arizona's principal crop is cotton. A crop area of 14,570 acres cultivated in Pima County in 1997 was devoted to cotton. Other principal crops grown in Arizona include: lettuce, cantaloupe, broccoli, watermelon, cauliflower, citrus and honeydew. There has been a substantial decrease in agricultural land as a result of the Groundwater Management Act of 1980.

4.10 Transportation

The demographic, economic, and geographic travel trends forecast for the Tucson metropolitan area indicate a substantial increase in travel demand over the next twenty years. In 1990, 72

percent of Pima County residents commuted to work by driving alone, 15 percent carpooled, 10 percent used other means of transportation, and 3 percent worked at home.

The proposed bank stabilization would occur between Craycroft Road and Sabino Canyon Road. Data derived from 48-hour counts that were collected in the spring of 1998 indicate traffic peak times along Craycroft Road are from 7:00am - 8:00am and 5:00pm - 6:00pm. As listed in Table 4-10 below, the subject streets have 4 and 2 lanes. The estimated average daily traffic (ADT), volumes along these streets range from 2,000 ADT along Cloud Road to 36,000 ADT along Sabino Canyon Road.

Table 4-10 Average Daily Traffic

Construction Access Streets	Number of Lanes	Average Daily Traffic (ADT)
Cloud Road	2	2,000
River Road	4	15,300
Craycroft Road	4	26,200
Sabino Canyon Road	4	36,000

Source: Pima Association of Governments, 1999.

4.11 Recreation

The City of Tucson, with its abundant sunshine, allows for a wide range of public recreation. Existing recreation facilities in the Tucson area include city parks, state parks, pools, tennis courts and golf courses. The City of Tucson maintains and operates 119 parks and 24 municipal pools, with facilities include: court games (tennis, basketball), field sports (soccer, baseball, and football), playgrounds, swimming pools, and picnic facilities. Pima County Department of Parks and Recreation service 30 parks in an area covering 2,811.5 acres. Pima County's Recreation Division provides a wide variety of activities for all age groups for all county residents. These activities include: toddler, youth and teen recreation, after school, holiday, and summer day camps, arts and crafts, sports, aquatics, music and cultural events.

Tucson residents also have access to 13 trailheads leading into Coronado National Park, Saguaro National Park, Tucson Mountain Park and the Cienega Creek Natural Preserve.

4.12 Cultural Resources

Cultural Setting. The presence of humankind over the course of time has generally reflected a response to changing environmental conditions. Still in all people find their own methods of maintaining a successful existence in a given environment. The success of a group's methods of

exploiting their environment is found in their ability to reproduce viable offspring, thereby perpetuating group longevity. As environmental conditions varied, the types of resources that are available or that are no longer existent are prime factors that drive change in a culture and its toolkit. As cultures evolve, either in a given area or a specific culture, changes are recorded in the culture's history and chronological sequence.

While studying the culture history of a group of people other elements come into play. Since the early 1960s there has been a movement to study culture change through the processes that precipitated evolution from one stage to another. Another fruitful approach to analyzing cultural changes is the study of the behavioral aspects of culture. In other words, what were these people doing and why were they doing it. Obviously not every decision is based on an environmental situation but also on mental templates that help to characterize a cultural groups identity. These various issues are at the core of developing a culture history of a geographic area and when coupled with modern dating methods we are able to place that history in an accurate temporal framework.

Culture History and Chronology. Culture evolution in the Tucson Basin is primarily grouped into stages of development that are further broken down periods and phases. The oldest Stage is the Archaic, followed by the Formative, then by the unnamed Stage that incorporates the Protohistoric and Historical periods.

PaleoIndian Period. There is an old Paleo-Indian period that is only known in the Tucson Basin from a few isolated Clovis projectile points. Although the older known Paleo-Indian sites are in southeastern Arizona in Cochise County, assuredly there will be Paleo-Indian sites discovered in the alluvial sediments of the Tucson area watercourses. The Clovis Culture dates to around 11,500 years before Present (B.P.).

Archaic Period. The Archaic in the Tucson Basin is divided into three time periods; Early, Middle, and Late. Modifications to the material culture and subsistence patterns are reflected in the transition from one stage to another. The Early Archaic period dates from 8500 to 6000 B.C., the Middle Archaic dates range from 6000 to 1500 B.C., and the Late Archaic begins at 1500 B.C. and extends to A.D. 100. The temporal division between the end of the Late Archaic and the following Formative stage is still poorly defined (Neily, et al. 1999). Little is known of the Early Archaic period in the Tucson Basin. In the absence of reliable dates, a local researcher, Bruce Huckell, has assigned the Pinto Basin projectile point as the diagnostic tool for this period. Otherwise little is known of the Early Archaic beyond speculation.

Exploitation of a very diverse array of microenvironments became emblematic of the Middle Archaic. The diversity included forays into stabilized dune fields, bajadas, and mountain pediment locations. A high degree of mobility is suggested during this period in the Tucson Basin. Sites are small and lack the elements that typify larger, sedentary sites, such as architecture, trash mounds, and storage facilities.

There is general acceptance that the Late Archaic was more of a transitional step to the formative period than a separate cultural stage. As early as 3,000 years ago evidence for maize agriculture was apparent in the floodplains of the Tucson Basin. There was a more pronounced tendency

towards residential stability, corn agriculture, and an advanced material culture. Diagnostic projectile points included points associated with the San Pedro stage, Cochise Culture, and Cienega, and Cortaro styles. The Milagro Site along the Tanque Verde Wash is probably the earliest known agricultural site. Cultural constituents of the Milagro site included bell-shaped pits outside of the main site area, fired ceramic figurines, and small pit structures.

Even with the inroads of agriculture, changing climactic patterns probably required a sustained reliance on seasonal foraging and collecting. In order to address shifting economic patterns, the Late Archaic people were probably organized around a dynamic, composite band that was able to expand and contract as needed.

Hohokam Sequence

Pioneer/Formative Period. The Pioneer/Early Formative period marked the earliest manifestation of the Hohokam culture. The Pioneer was distinguished by increased sedentism and greater reliance on agriculture. In addition to more permanent pitstructures, manufacture of plain ware ceramics was getting underway. These two main features really define the Pioneer period more so than dramatic population or cultural changes. The plainware ceramic horizon was supplanted by a redware ceramic industry. Overall, the early Formative in the Tucson Basin was identified with the aforementioned ceramics, small, well developed pit houses that were loosely arranged, inhumation burials, and large communal houses. Toward the late Pioneer period the Hohokam house became more functionally distinct seen in a combination of both small, informal structures and larger, more formalized structures that were appearing at different sites in the Tucson Basin. The Late Pioneer period is poorly represented in the Tucson Basin; however, it is known that there was a much greater reliance on agriculture by this time.

Colonial Period. Cultural changes of much greater magnitude transpired during the succeeding Colonial period. Substantial increases in population and Hohokam culture area led to increased number of settlements, refinements with ceremonial architecture, new classes of material culture, more advanced mortuary rituals, and redefined settlements patterns and social organization. Following a continuum of minimal data the early Colonial period, the Cañada del Oro phase, is about as poorly defined in the Tucson Basin as the Late Pioneer period's Snaketown phase.

Geomorphic changes in the Santa Cruz River after A.D. 800 led to an increase in the potential for floodwater farming in the Tucson Basin. It is not clear however, if this advanced agricultural conditions were instrumental in the overall cultural changes during the Rillito phase, or if they were restricted to the San Xavier area. Another major cultural feature that arrived full-blown into the Hohokam culture area during the Rillito phase was the Mesoamerican ball court. The interesting feature of the ball courts was that they were public architecture and the ritual activities and exchange practiced in them probably required community participation. The large Rillito phase sites are usually found along the Santa Cruz River testifying to the Hohokam's preference for adapting to a riverine environment.

Hohokam culture reached its climax in the Tucson Basin in the Sedentary period. During this time frame there was unification of the regional system and interregional contacts were at their peak. Perhaps during this period the interregional system was starting to be dismantled leaving

the Tucson Basin as a discrete cultural center. This period is the most prolific for number of well documented sites in the Tucson Basin. As stated in the previous sentence, the Sedentary period sites have been the most intensively investigated. Major Sedentary period sites in the Tucson area include: the Hodges Ruin, Punta de Agua sites, the West Branch site, Valencia, and the Tanque Verde Wash site.

Sedentary Period. Later in the Sedentary period, Rincon phase dry-farming was being practiced outside the floodplain at the West Branch and Valencia sites. The Valencia site, AZ:BB:9:54, bisected by Craycroft Road, is directly northwest of the Tanque Verde Wash project. Possibly due to over utilization of the riverine environments specialized changes in subsistence practices and settlement function were replacing older economic systems. Earlier sites were being abandoned or diminished in size and the ball courts were phased out as well. By the end of the Sedentary period the Hohokam regional system was gone. In the waning days of the Sedentary period, buff wares had been replaced with small numbers of Mimbres Classic Black-on-white ceramics. This indicates a transition in the Tucson Basin Hohokam's external contacts.

Classic Period. Ceramics played a greater role in defining the two phases of the Classic period. The earlier Tanque Verde phase is identified with Tanque Verde Red-on-Brown which perseveres through to the Tucson phase. During the Tucson phase other ceramics coincide with the Tanque Verde phase, Tanque Verde Red-on-Brown. Tucson Polychrome, Roosevelt Red Ware, and a non-local type, White Mountain Redware are associated with the Tucson phase.

Another change in settlement patterns was first identified in the Marana Community in the northern Tucson Basin. Platform mounds were the central focal point for multiple-function settlements that were arranged around it in a specific pattern. In the eastern Tucson Basin settlements were comprised of large multi-compound villages and were constructed in areas that had previously been low population density. New domestic architectural forms appeared in the transitional period between the Sedentary and Classic periods. Styles such as contiguous, rectangular surface rooms, puddled adobe, and enclosed compounds became prevalent. Toward the end of the Classic period there was a regressive tendency to reintroduce pithouse architecture. Platform mounds replaced ball courts as the central feature of the ceremonial system. In spite of structural similarities, there were considerable functional differences between the platform mounds. The number of villages with public facilities such as platform mounds declined from the Sedentary to the Classic period. At one time these changes were considered to part of the expansion of the Salado culture in the Tucson Basin but research has shown that they started during the late Rincon subphase of the Sedentary period.

The Classic period was short lived in the Tucson Basin. There had been a dramatic population decrease by the Tucson phase. The Tucson phase is synonymous with depopulation, reorganization of existing populations, and movement to other areas. Whereas earlier researchers thought these changes were directly attributable to the Salado incursion, they are seen as a cultural response to environmental conditions.

Post Classic Period. The terminal Classic period is synonymous with the collapse of the Hohokam culture. Various scenarios have been advanced to explain the collapse and identify

their predecessors. Currently the four Southern Tribes maintain that they are the descendants of the Hohokam. The Tohono O'odham, formerly known as the Papago, lay claim to a direct link with the Tucson Basin Hohokam. However this has not been archaeologically demonstrated.

Records and Literature Search. A records and literature search was conducted at the Arizona State Museum Archives, and at the office of the Pima County archaeologist before commencing with the fieldwork. Approximately one-half of the APE (Craycroft Road to the project mid-point) had been negatively surveyed. Unfortunately the survey report was missing from the Museum's archives. The survey location on their maps showed it as being negative however. That survey also covered the portion of the APE that included the north bank of the Pantano Wash. A Late Rincon phase Hohokam site, AZ:BB:9:54 (ASM) bisected by Craycroft Road was excavated approximately 200 meters north of the Rillito River/Tanque Verde Wash confluence in 1982. The closest survey to the eastern end of the Tanque Verde Wash was surveyed in 1984 by Allan Dart for Cella Barr Associates. Dart's survey found one site, AZ:BB:9:141 (ASM) that only consisted of two lithic scatters. That site is outside of the APE.

U.S. Army Corps of Engineers Survey. Corps staff archaeologist, Richard Perry, surveyed the area of potential effects (APE) on March 7, 1999, and was accompanied by a cultural resources contractor, Dr. Jeffrey Altschul. Dr. Altschul walked the creek bank during the survey and noted a dark stain associated with some lithics, pot sherds, and faunal material. Heading further east, the stain picked up intensity and thickness. At the time, it appeared that the deposit was a pithouse profile with a midden. More sherds were found as well as lithics, including flakes and a few scrapers. A sample of the sherds were collected and typed at the Statistical Research lab. They were identified as non-diagnostic gray wares. Dr. Altschul; speculated that based on the temper, they were probably indicative of a dual component site--early Formative/Pre-classic occupation and the second component may be early Classic period. Another weaker hypothesis was that it was much older, or dated from the Pioneer period. The site is near the point where a cross channel from the Pantano Wash was hitting the Tanque Verde Banks and eroding away the site. This probably explains the earlier negative survey. The deposit was covered with unconsolidated alluvium that was deposited from high-energy flows on the Tanque Verde. The upper layers of the alluvium contained historic debris. There was no surface evidence of the site. We have no knowledge of how far back into the creek bank the deposit extends.

Mr. Perry returned to the site in June 1999 with Dr. Edgar Huber, of the Statistical Research staff. Dr. Huber had recommended the return visit because the rain water swollen Tanque Verde may have impacted the site. It appeared that as much as two-feet of the creek bank had been sheared off from water flows in the channel. What had originally been identified as a pithouse profile was no longer visible, but the extensive midden stain with artifacts and faunal materials was still intact. The site has been temporarily named COE_TV_99_1. A site record is being prepared to be submitted to the Arizona State Museum for a site number assignment. The rest of the survey was negative.

5.0 ENVIRONMENTAL EFFECTS

This EA addresses impacts related to stabilization of the unprotected banks of Tanque Verde Creek between Craycroft Road Bridge and Sabino Canyon Bridge. The creek banks would be stabilized using soil cement, consistent with existing stabilized creek banks in the vicinity and along the Rillito River. Impacts related to all environmental resources have been analyzed for the viable alternatives, including the No Action Plan and the recommended plan.

5.1 No Action Alternative

If the creek banks are not stabilized, they will continue to erode. A Lateral Migration Analysis (Appendix A) revealed that, on an average, about 13 feet of the creek banks would be eroded annually. However, erosion varies from year to year, and depends on the velocity of the water and duration of the flooding event. The majority of the lateral erosion would most likely occur as the result of one or a few major flood events. The Lateral Migration Analysis to determine the erosion potential within the study area was based on an evaluation of 60 years of photographic records taken between 1936 and 1996. During this time frame, about 650 feet of lateral erosion occurred within the project area. An additional 650 feet of erosion are predicted over the next 50 years. Without implementation of the bank stabilization, there is a flooding potential along the study reach during any 100-year event. In severe flooding events, significant damage could occur to the property located along the creek banks and to development west of Craycroft Road. Flooding could cause damage to the roadway embankment and damage the roadway and the sewer interceptor. Damage to the sewer line would result in adding contaminated sewer water to the creek. The No Action Alternative would not achieve the purpose of the project, to reduce bank erosion and flood damages. For most resources, the No Action Alternative would have no adverse impacts; therefore, no detailed impact analysis is provided in this section. For those resources where No Action would have an adverse impact, the impacts are discussed.

5.2 Physical Setting (Alternatives 2, 3 and 4)

Any project-related impacts on the physical environment are anticipated to be minor. Riparian vegetation located along the north banks would be eroded with or without a project. The average height of the banks is about 10 to 12 feet, but in some areas the height has been lowered to about 4 to 5 feet.

5.3 Climate (Alternatives 2, 3 and 4)

This project will have little to no impact on the climate of the area. Some relatively small amount of dust will be released to the atmosphere during the movement of dirt and sand.

5.4 Water Quality (Alternatives 2, 3 and 4)

Currently, portions of the creek banks have been severely eroded due to past flooding. Bank erosion is prominent within the project area. The proposed action is not expected to increase soil erosion or adversely impact surface water quality. Sewer lines located in the vicinity of the project area would be protected; therefore, accidental discharge of contaminated sewer water into the creek would be prevented. During the field surveys (June 1998 and January 1999) both Tanque Verde Creek and Pantano Wash were dry, and severe erosion was noticed along the gully located along the north bank of the creek. Material required for the project construction will be obtained from the creek bed, primarily from excavation for the toe of the bank protection. No excavation would occur within flowing water to minimize impacts to the water quality. Excavated soil would be mixed with cement in equipment located along the banks or at a staging area. After stabilization of the creek banks, erosion along Tanque Verde Creek and the confluence with Pantano Wash would be reduced. Procedures to minimize erosion during construction would be followed, including: checking weather conditions daily; using clean water and material to stabilize creek banks; ensuring that no polluted silt or other material is placed in the creek or wash; removing debris from the washes; and postponing construction during rainstorms or flood events. Impacts to water quality would be minor. Bank stabilization would reduce future releases of eroded material into Tanque Verde Creek. Thus increased turbidity caused by the flooding events would be minimized with the implementation of the project.

The proposed project would be constructed by the Corps of Engineers; therefore, to comply with Section 404 of the Clean Water Act a Section 404 (b)(1) Evaluation has been prepared The Section 404(b)(1) Evaluation is located in Appendix C-1 of this document. During preparation of the EA, the Environmental Resources Branch staff coordinated the proposed project with the Corps Regulatory Branch, Tucson Office. Regulatory Branch expressed their concerns regarding bank stabilization with soil cement and compliance with the Section 404 (b)(1) guidelines. The agency needs to identify the least environmentally damaging alternative to comply with the Section 404(b)(1) guidelines. They recommended use of riprap or geotech mat for the bank stabilization rather than soil cement. Regulatory Branch will review the Section 404(b)(1) Evaluation for this project. The Environmental Resources Branch (ERB) provided a working copy of a Draft EA and a Section 404 (b)(1) Evaluation to the Regulatory Branch. ERB will continue to coordinate the proposed project with the Regulatory Branch.

On May 11, 2000, informal coordination was conducted with the Arizona Department of Environmental Quality (ADEQ) regarding requirements for Section 401 Water Quality Certification. To meet requirements of the State of Arizona Environmental Quality regulations, a State of Arizona AEQ/WQD Form 404-003 was prepared and is located in Appendix C-2 of this document. A request for the Section 401, State Water Quality Certification will be submitted, including an application form 404-015 to the ADEQ prior to project construction.

A Storm Water Permit will be required for the proposed project if project-related grading exceeds 5 acres. The total area to be graded will be determined during preparation of Plans and Specifications for the project.

5.5 Air Quality (Alternatives 2, 3 and 4)

Bank stabilization activities would have a short-term adverse impact on air quality. Minor adverse impacts would be associated with equipment emissions and fugitive dust particles due to the transportation of materials during construction. Some dust will be released during excavation of the banks and creek bed. Watering trucks will be used as needed to minimize impacts, which are considered short term and minor.

Project-related activities that contribute to emissions include: excavation of the creek banks, stabilizing the creek banks with soil cement, and transportation of the required construction material from the vicinity of the project area. Air quality analysis performed for the construction activities, is located in Appendix D of this EA. The Corps used AP-42 (EPA guideline) and California Environmental Quality Act, Air Quality Handbook, prepared by the South Coat Air Quality Management District, 1993.

About 115,000 C.Y. of material would be excavated from the creek bed and side slopes. About 3,500 C.Y. of the Portland cement and about 360 C.Y. of pozzolon (stabilizer) would be obtained from the vicinity of the project area. About 4 trucks per day would be utilized to transport construction related material from a distance of about 10 miles. Project construction would not result in significant impacts to air quality. Quantities of particulate matter (PM_{10}) generated due to excavation activities and trucks traveling on unpaved roads were calculated (see Appendix D). Per day, about 7 pounds of fugitive dust would be generated by the construction activities after implementation of the mitigation measures.

The construction of the project may take about four months. Project-related emissions would be well below the significance levels of Carbon Monoxide (CO), Reactive Organic Compounds (ROC) and Oxides of Nitrogen (NOX), fugitive dust, and other air pollution.

Mitigation measures to reduce fugitive dust include watering the excavation site and unpaved roads and limiting truck speeds to 15 miles an hour on unpaved roads. Construction related emissions are short term, minimum, and conditions will stabilize after completion of the project.

5.6 Biological Resources

Some loss of habitat and associated wildlife will occur with each of the action alternatives 2,3, and 4. Even with No action, some future decline in habitat values is anticipated due to increased disturbance from the expanding population and development in the surrounding areas and erosion of the unprotected mesquite bosque habitat on the north bank of Tanque Verde Creek. Impacts of any of the action alternatives would be greater than with No Action.

The Watercourse and Riparian Habitat Protection and Mitigation Requirement of the Pima County Floodplain Management Ordinance require a mitigation plan for projects that adversely impact riparian habitat. The Ordinance specifically includes mesquite bosque habitat. Appropriate mitigation measures have been identified for each of the action alternatives.

Modified Habitat Evaluation Procedures (HEP) and an Incremental Cost Analysis were performed to obtain mitigation requirements for the loss of habitat due to implementation of each

of the alternatives, including the No Action Alternative. When mitigation is necessary, Corps regulations (ER1105-2-100:7-35) require an Incremental Cost Analysis of mitigation options for the recommended alternative, other viable alternatives and the No Action Alternative. By performing an Incremental Cost Analysis, comparison and cost for various mitigation options can be identified and the most cost-effective mitigation option or combination of options that best meet the mitigation goals can be implemented for the project. Appropriate/required mitigation measures for each alternative have been developed based on these calculations. The Modified HEP Analysis and Incremental Analysis are provided in Appendix B-5 of this EA. The modified HEP was performed for the recommended alternative, other viable alternatives, and the No Action Alternative.

ALTERNATIVE 1. No Action. Under the No Action Alternative, no construction-related impacts to biological resources would occur, but the overall habitat quality is expected to decline even with no project. The burned area would eventually recover, but other factors such as trespassing, wood-cutting, domestic animals, etc are expected to adversely impact the project area and the preserve area.

Moderate to major erosion to the mesquite bosque is predicted to occur during severe storms, potentially eliminating much of the preserve vegetation. The Lateral Migration Analysis (Appendix A of this EA) predicts a potential for erosion on the north bank of up 650 feet over the period of analysis for this project. Since all but the widest point of the proposed preserve area is 650 feet or less in width, the entire preserve is subject to lateral erosion with the No Action Alternative, as well as Alternatives 2 and 3. Following severe episodes of erosion, desert riparian habitat will be replaced with desert wash habitat, followed by reestablishment of riparian habitat during periods of low to moderate flows. This successional riparian habitat would be considerably different from the existing mesquite bosque habitat, and would most likely consist of faster-growing trees, such as cottonwoods and willows. Invasion by non-native species, especially salt cedar, is also to be expected. As the channel widens, the rate of erosion, channel migration, and habitat loss is expected to decrease. Since the number and intensity of storms over the period of analysis is unpredictable, it will be assumed, for the purposes of this study, that after the first 5 years of the period of analysis, the average condition of the preserve area with no project or with Alternative 2 or 3 will consist of 50% desert riparian habitat and 50% desert wash habitat. Desert riparian habitat is considered a significant resource by federal, state, and county authorities.

ALTERNATIVE 2. The proposed action would affect desert riparian habitat, including mesquite bosque habitat, along Tanque Verde Creek. A total of approximately 9.0 acres of habitat would be directly lost due to project construction, including approximately 1.0 acre of high quality mesquite bosque habitat and 8.0 acres of disturbed desert wash habitat. Impacts to approximately 4.88 acres of the desert wash habitat would be temporary. Impacts to wildlife in the disturbed desert wash area will be minor because relatively few species inhabit these areas, and most are relatively common. Impacts to wildlife found in the mesquite bosque habitats would include temporary and permanent displacement and mortality of some wildlife that is unable to escape. The Lateral Migration Analysis (Appendix A of this EA) indicates that stabilization of the south bank would not significantly accelerate erosion of the mesquite bosque habitat on the north bank, but that the cumulative effects of channelization on Tanque Verde

Creek has a major effect on the erosion of the unprotected areas. The nature of impacts to the preserve area would, therefore, be similar to those described for the No Action alternative.

North Bank Protection, Upstream of Craycroft Road. The addition of approximately 1,550 linear feet of soil cement bank protection on the north bank of Tanque Verde Creek would disturb or eliminate approximately 0.7 acre of desert riparian habitat and associated wildlife. This estimate assumes a width of eight feet for the bank protection, and an additional ten feet of excavation for the toe-down and to provide a smooth slope. Along the downstream and central portions of the reach, approximately 0.8 acres of low to moderate quality desert wash habitat, consisting of scattered mesquite, small shrubs and ground cover, and possibly an occasional cottonwood and palo verde, would be removed. Along the upstream portion of the reach, approximately 0.3 acre of high quality desert riparian (mesquite bosque) habitat and associated wildlife would be eliminated.

South Bank Protection, Pantano Wash to Existing Bank Protection. The addition of approximately 2,830 linear feet of soil cement bank protection on the south bank of Tanque Verde Creek from Pantano Wash to the existing bank protection (including about 300 feet of Pantano Wash at the confluence) would disturb or eliminate approximately 2.4 acres of habitat. Approximately 0.7 acre of mesquite bosque habitat and associated wildlife would be replaced with soil cement along the downstream 1,700 feet of this reach. About 1.0 acre of low to moderate quality desert wash habitat would be replaced with soil cement along the upstream 1,100 feet of this reach. The soil cement revetment on the south bank may indirectly accelerate erosion of the portion of the north bank that would be left in its natural condition under this alternative. At the confluence with Pantano Wash, the soil cement would reduce surface flow to the riparian/mesquite bosque habitat, but ground water and occasional surface flows from Pantano Wash would continue to be available. Some indirect impacts are expected to occur over the long term, due to the altered hydrology, potentially limiting germination and recruitment of new trees. Existing trees would probably not be affected.

South Bank Protection from Existing Bank Protection West of Sabino Canyon Road to Existing Bank Protection Downstream. The addition of approximately 4,220 linear feet of soil cement bank protection on the south bank of Tanque Verde Creek from the existing bank protection west of Sabino Canyon Road to the existing bank protection downstream would disturb or eliminate approximately 3.2 acres of habitat, primarily low to moderate quality desert wash habitat. No mesquite bosque habitat will be lost in this reach.

Mitigation. Based on the HEP Analysis (Appendix B-5), a total of 2.14 Average Annual Habitat Units (AAHUs) will be lost due to implementation of Alternative 2. Project-related impacts include both the direct loss of 9.0 acres (4.22 acres long term and 4.88 acres short term) and indirect effects such as modified hydrology and water availability that lower the quality of habitat that remains. As with the No Action Alternative, all but the widest point of the proposed preserve area is subject to lateral erosion. Following severe episodes of erosion, desert riparian habitat will be replaced with desert wash habitat, followed by reestablishment of riparian habitat during periods of low to moderate flows. This successional riparian habitat would be considerably different from the existing mesquite bosque habitat, and would most likely consist of faster-growing trees, such as cottonwoods and willows. Invasion by non-native species,

especially salt cedar, is also to be expected. As the channel widens, the rate of erosion, channel migration, and habitat loss is expected to decrease. Since the number and intensity of storms over the period of analysis is unpredictable, it will be assumed, for the purposes of this study, that after the first 5 years of the period of analysis, the average condition of the preserve area with no project or with Alternative 2 or 3 will consist of 50% desert riparian habitat and 50% desert wash habitat. Desert riparian habitat is considered a significant resource by federal, state, and county authorities. Based upon the HEP Analysis, acquisition and maintenance of the 48-acre mesquite bosque area along north bank would provide a net increase of only 0.53 AAHUs in mitigation, still 1.61 AAHUs under the requirement Habitat units (HUs) are obtained by multiplying the number of acres by a number between 0.0 and 1.0 called a Habitat Suitability Index (HSI), which rates the habitat relative to optimal habitat for a species or group of species. See Appendix B-5 for more detail.

ALTERNATIVE 3. Impacts of Alternative 3 would be similar to the impacts of Alternative 2, except that less habitat would be disturbed on the South Bank upstream of the confluence with Pantano Wash. Indirect effects on the mesquite bosque habitat at the confluence with Pantano Wash are not anticipated with this alternative. About 1.0 acre of low to moderate quality desert wash habitat would be replaced with soil cement immediately upstream of the golf course to just downstream of the golf course. A total of approximately 2.8 acres of habitat would be lost with this alternative, consisting of approximately 0.3 acre of mesquite bosque habitat and 1.5 acres of disturbed desert wash habitat.

Mitigation. Based on the modified HEP Analysis, approximately 0.61Average Annual Habitat Units would be lost due to implementation of this alternative (Appendix B-5). Based on the modified HEP Analysis, these Habitat units could be replaced with the proposed preserve and minimal restoration following major flood damage. Acquisition of the preserve with no bank protection provides a net increase of only 0.53 AAHUs, still leaving a deficiency of 0.99 AAHUS.

ALTERNATIVE 4. Impacts of Alternative 4 would include the impacts discussed for Alternative 2, as well as impacts of the erosion protection which would be provided on the north bank along the proposed preserve area. Total habitat losses for this alternative are estimated at approximately 9.9 acres, consisting of approximately 1.9 acre of moderate to high quality mesquite bosque habitat and 8.0 acres of disturbed desert wash habitat.

Mesquite Bosque Habitat Erosion Protection. Modified bank protection would be provided along the exposed edge of the mesquite bosque preserve area. Protection would potentially consist of a low soil-cement berm along the existing bank of the mesquite bosque habitat area on the north bank. The berm would be approximately 5,000 feet long and the minimum height that would protect the toe of the preserve area from erosion, probably about 2 feet. "Weep holes" would be embedded through the width of the berm to maintain the hydrologic connection between the creek and the mesquite bosque. The berm would reduce erosion of the mesquite bosque habitat but would be low enough to allow overtopping by flood events of approximately the same frequency that provide overbank flow under existing conditions, approximately a 10-15-year event. Approximately 0.9 acre of moderate to high quality mesquite bosque habitat would be removed or disturbed on the slopes of the preserve area for construction of the erosion

control berm. Approximately 1.1 acre disturbed desert wash habitat would be removed at the base of the slope for the toe-down. This estimate assumes a width of eight feet for the bank protection, for the smooth transition from the erosion protection to the natural bank, and an additional ten feet of excavation for the toe-down. The toe-down of 10 feet would not cut off the ground water to the root zone of the mature mesquite trees but could have detrimental effects on seedlings and saplings that have not yet developed a deep root system especially near the edge of the preserve. The berm would not be of sufficient height to allow development of the parcel. While the soil cement berm may slightly reduce overbank flows from some moderate storms; the majority of overbank flow is from local drainage; therefore, the germination and recruitment of new mesquite seedlings will probably not be inhibited significantly. Slopes of the berm will be graded to minimize the barrier effect on wildlife migration. Although the bank protection for this alternative has been modified to minimize adverse hydrologic effect on the vegetation and barriers to wildlife, the Corps and Pima County will continue to analyze additional options for bank protection of the preserve area during the PED phase of this project.

Mitigation. Based on the modified HEP and Incremental Cost Analysis, the proposed preserve with modified bank protection will provide the appropriate level of mitigation for this project (see Appendix B-5).

Threatened and Endangered Species (Alternatives 2, 3, and 4)

Bald Eagle (Threatened). Although the bald eagle may be an occasional visitor to the area, no impact to this species is anticipated because no nesting or breeding habitat would be affected, and the habitat would be used only occasionally, if ever, for foraging.

Cactus Ferruginous Pygmy Owl (Endangered). The Corps performed a site visit with the resource agencies (USFWS and Arizona Fish and Game) to obtain their view for implementation of the project. The USFWS and Arizona Game and Fish expressed concerns regarding the potential for Federally listed Endangered or threatened species, particularly the cactus ferruginous pygmy owl. WestLand Resources, Inc. Engineering and Environmental Consultants, conducted surveys for the cactus ferruginous pygmy owl under contract to the Corps. WestLand Resources biologists have the required permits to conduct the surveys. Three complete protocol surveys, as proposed (and subsequently adopted) under USFWS protocol were conducted in March, April, and May 1999. Fifteen calling stations provided complete coverage of the project area during each survey session. The area surveyed for this project included all potential habitats from the confluence of Pantano Wash and Tanque Verde Creek to the upstream end of the project area. No evidence of Pygmy Owls or nesting sites was detected during the surveys. The project area includes a preponderance of developed lands, and vegetation in the area appears to lack the structural diversity normally associated with occupied habitats. Based on this assessment, habitat quality along the portion of Tanque Verde Creek surveyed for this report appears low to moderate for the Pygmy Owl. Habitat quality on the nearby lands also appeared low to moderate for Pygmy Owl. Based on protocol surveys conducted in 1999, the Corps has concluded that the proposed action will not affect the Cactus Ferruginous Pygmy Owl because it does not occur in the project area (see report in Appendix B-1). The determination of no effect obviates the requirement to prepare a Biological Assessment and to conduct Section 7 Consultation under the Endangered Species Act. The project has been coordinated with the

USFWS. On June 15, 2000, the USFWS provided a Final Coordination Act Report, in which they indicated that no threatened or endangered species are known to occur in the proposed project area.

5.7 Land Use

No Action Alternative: If the creek banks are not stabilized, adverse impacts to land use are likely to occur, including the possible loss of rural residential structures and land on the north bank and erosion of the Tucson Country Club on the south bank. Loss or damage to the sewer interceptor and roadways could also occur.

Alternative 2. The proposed project would protect existing land uses, including rural residential uses on the north bank and the Tucson Country Club on the south bank. No direct impacts to the desert riparian (mesquite bosque) habitat on the north bank would occur, and this land would be acquired as a preserve. Acquisition of this parcel would prevent urban development and would secure the site as permanent open space. The preserve would continue to be subject to erosional forces: however, the dense vegetation may help to stabilize the slope.

Alternative 3. Effects of Alternative 3 would be similar to Alternative 2, except that an undeveloped reach on the south bank, just upstream of the confluence with Pantano wash would not be protected. Since the area is undeveloped, the effect of leaving it unprotected is minimal.

Alternative 4. Effects of Alternative 4 would be similar to Alternative 2, except that a low soil cement berm with "weep holes" would be constructed along the toe of the slope adjacent to the riparian preserve. The berm would be too low to provide adequate flood protection to the site to allow urban or commercial development.

5.8 Aesthetics (Alternatives 2, 3 and 4)

Short-term adverse aesthetic impacts will occur during the construction period, when construction equipment and the soil-cement processing plant are operating. Long-term aesthetic impacts will not be significant. Nearly all soil cement will be placed over eroded slopes with little or no existing vegetation. The soil cement will be similar in color and texture to existing unvegetated banks.

5.9 Noise: (Alternatives 2, 3 and 4)

Construction activities will increase the noise level in the immediate area of the work. Few people reside in the area to be impacted. Noise will have some adverse impact to users of the Tucson Country Club during construction of the south bank protection. Typical noise levels at 50 feet from most types of construction equipment (i.e. bulldozers, graders, scrapers, loaders) range from about 85 to 89 dBA. Assuming an average construction noise level of 87 dBA, and a 6.0 dBA decrease per doubling of the distance, the noise level will decrease to approximately 70 dBA. This noise level is considered generally acceptable for golf courses and similar recreational facilities within about 400 feet of construction activities.

5.10 Socioeconomics: (Alternatives 2, 3 and 4)

Short-term benefits to local businesses will occur during the construction period, when construction personnel may patronize restaurants and retail shops in the local area. Bank protection will provide long-term economic benefits to local residents and to the Tucson Country Club. Loss of property due to bank erosion would be reduced, and property values may increase due to erosion protection. Designation of the mesquite bosque on the north bank as a preserve would prevent most types of economic development in this area, but the preserve would provide important social benefits associated with shaded open space in a desert urban environment.

5.11 Transportation: (Alternatives 2, 3 and 4)

Any of the construction alternatives would have only temporary and minor impacts to traffic. Public roads would be used to transport workers, equipment, and materials to the project site. Since the project does not involve road work, no road closures or lane closures are anticipated. Slow-moving equipment could cause minor traffic delays. No long-term adverse impacts to traffic will occur.

5.12 Recreation: (Alternatives 2, 3 and 4)

Construction would have short-term impacts on recreational use in the project area, especially equestrian use of the creek bed. During the construction period, equestrians will likely be required to temporarily use alternate routes to avoid ongoing construction. Recreational use of the Tucson Country Club will not be precluded during construction; however, the area near the bank of the creek may be temporarily off limits, and some members and guests may choose to avoid areas within about 400 feet of construction due to noise.

5.13 Cultural Resources: (Alternatives 2, 3, and 4)

Applying soil cement or riprap to the exposed cultural surface will impact prehistoric archeology site COE_TV_99_1. At this time, Section 106 consultation has not been coordinated with the State Historic Preservation Officer (SHPO). If, after testing, the site is determined to be eligible for listing in the National Register of Historic Places, the effects will be considered adverse. There is a historic element to the site, but it appears to be only associated with transport from extended high velocity stream flows, not an integral part of the site's composition. Subsurface testing will also indicate if the site is part of AZ:BB:9:54 (ASM). BB:9:54 was a Sedentary period, Late Rincon phase site located approximately 200 meters north.

5.14 Cumulative Impacts: (Alternatives 2, 3 and 4)

Cumulative effects refer to environmental impacts of the project in combination with past, ongoing, and reasonably foreseeable future actions in the project vicinity. The proposed action would fill in gaps in bank protection between existing soil cement bank protection on Tanque Verde Creek downstream of Sabino Canyon Road to the confluence with the Rillito River. The extent of proposed bank protection is relatively minor, as compared with existing bank

protection. No additional bank protection on the Rillito River or tributaries is anticipated in the near future. Although there have been cumulative impacts, due to several federal and non-federal projects on the Rillito River and Tanque Verde Creek, the impacts of the current project will be mitigated. The Rillito River Bank Protection Project did not involve formal mitigation for loss of habitat, but that project included extensive plantings of native vegetation for aesthetic treatment associated with recreational features. In addition, the Corps is currently conducting a feasibility study under authority of Section 1135 of the Water Resources Development Act of 1986, as amended, to restore degraded habitat along the south bank of the Rillito River between Craycroft Road and Alvernon Way. This restoration project, if implemented, would develop approximately 100 acres of wetland, riparian, and native upland habitats. The Corps could potentially become involved in future Section 1135 restoration projects in the Rillito River system as new opportunities are identified.

6.0 COORDINATION

Coordination Summary: Informal coordination has been conducted with the following agencies:

U.S. Fish and Wildlife Service; Corps of Engineers (Regulatory Section, Tucson); Arizona Department of Game and Fish; Arizona Department of Environmental Quality; and Arizona State Historic Preservation Officer.

U.S. Fish and Wildlife Service. The Corps of Engineers requested an updated list of endangered, threatened, and candidate species from the U.S. Fish and Wildlife Service on July 16, 1998. A reply was forwarded to the COE in a letter dated August 5, 1998 (Appendix B-3). Mr. Mike Martinez, with the USFWS, Phoenix office, was contacted in July 1998 by telephone for a site visit. On July 21, 1998, a site visit was conducted with the resource agencies and PCDOT & FCD staff. The USFWS and Arizona Game and Fish participated in this site visit. The USFWS and Arizona Game and Fish expressed their concerns that the cactus Ferruginous Pygmy Owl may be located within the project area. In March, April, and May 1999, WestLand Biological Services, under contract to the Corps, conducted a survey for Cactus Ferruginous Pygmy Owl as per USFWS protocol. No Pygmy Owl was detected during the surveys. Since July 1998, the Corps biologist has continued coordination of the project's progress with the USFWS. The USFWS indicated in their Coordination Act Report a preference for implementation of Alternative No. 2, no structural protection along the riparian vegetation preserve. This view was confirmed in a telephone conversation between the Corps and USFWS on May 3, 2000. The USFWS submitted the Draft Coordination Act Report in January 2000, and the Final Coordination Act Report was provided in June 2000 (Appendix B-2).

Corps of Engineers (Regulatory Branch). During preparation of the Draft EA, project construction was coordinated with Regulatory Branch (Tucson Office) regarding compliance with the Section 404 of the Clean Water Act and preparation of a Section 404 (b)(1) Evaluation. Regulatory Branch expressed their concerns for use of soil cement for the bank stabilization. They prefer use of riprap or geotech mat, which will allow growth of vegetation. To comply with Section 404(b) (1) guidelines, the selected alternative should be the least environmentally damaging. The ERB staff will work with the Regulatory Branch staff for the proposed project.

Arizona Department of Environmental Quality. On May 11, 2000, the Corps coordinated the proposed project with Mr. Andy Travers, ADEQ staff. The Corps provided project related information via telephone. According to Mr. Travers, the project would require State Water Quality Certification. The Corps needed to submit the ADEQ/WQD form 404-003 and form 404-015 application with the Draft EA. He also requested that the Corps provide a map, project description, and design drawing with the Draft EA. The Corps submitted form 404-003 with the Draft LRR and EA as requested (Appendix C-2). The document included the project description and available design drawings. The Corps will submit a request for the State 401 Water Quality Certification with application-404-015 prior to construction.

Arizona Department of Game and Fish. The Corps of Engineers invited the Arizona Game and Fish Department (AGDFG), to participate in the July 21, 1998 field a site visit. At this site visit, Ms. Sherry Ruther of AGDFG expressed concerns that stabilizing the south banks may cause erosion along the riparian vegetation located along north bank of the Tanque Verde Creek. As per AGDFG's recommendation, the Corps performed a lateral migration analysis for the project area (May 1999). This study is located in Appendix A of the EA and details are provided in the LRR. Arizona Game and Fish was also concerned that the cactus Ferruginous Pygmy Owl may be located within the project area. Cactus Ferruginous Pygmy Owl surveys were conducted in the spring of 1999 per USFWS protocol. No Pygmy Owl was detected during the surveys.

Arizona State Historic Preservation Officer. Coordination with the SHPO has been informally initiated. All further consultation towards compliance with Section 106 will be coordinated with SHPO.

7.0 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

7.1 National Environmental Policy Act (NEPA), as amended. National Environmental Policy Act of 1969 (Public Law 91-190) as amended

This EA has been prepared in accordance with the requirements of NEPA of 1969 (42 USC 43221, as amended) for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508) dated 1 July 1988. NEPA requires that agencies of the Federal Government shall implement an environmental impact analysis program in order to evaluate "major federal actions affecting the quality of the human environment." This Environmental Assessment has been prepared in accordance with the requirements of the Act and with the Council of Environmental Quality Regulations for implementing NEPA.

7.2 200-2-2, 33 CFR 230, March 1988

This regulation provides guidance for implementation of the procedural provisions of the National Environmental Policy Act (NEPA) for the Civil Works Program of the USACOE. It supplements Council on Environmental Quality (CEQ) regulations 4-0 CFR 1500-1508, November 29, 1978, in accordance with the CEQ regulations. Wherever the guidance in this regulation is unclear or not specific, the reader is referred to the CEQ regulations. This regulation is applicable to all USACOE responsibility for preparing and processing environmental documents in support of civil works functions.

7.3 ER-1105-2-100 Regulation December 1990

ER-1105-2-100 provides guidance for the conduct of Civil Works planning studies and related programs by the U.S. Army Corps of Engineers. Guidance provided in these regulations has been followed in the preparation of this document.

7.4 Clean Water Act, as amended

The Clean Water Act governs discharge or dredge of materials in the waters of the United States and it governs pollution control and water quality of waterways throughout the U.S. Its intent, in part, is to restore and maintain the biological integrity of the nation's waters. The goals and standards of the Clean Water Act are enforced through permit provisions. Sections 404, 401 and 402 of the Clean Water Act pertain directly to the proposed project. Section 404 outlines the permit program required for dredging or filling the nation's waterways. The COE does not issue itself a permit for civil works projects, therefore, to comply with Section 404 of the act, a 404(b)(1) analysis has been performed (Appendix C-1). Section 230.10(a)(2) of the 404(b)(1) guidelines states that an alternative is practicable if it is available and capable of being done after taking into consideration costs, existing technology and logistics in light of overall project purposes.

The proposed bank stabilization would occur along Tanque Verde Creek and at the confluence of Pantano Wash. State of Arizona water quality form WQMS - 404 003 has been prepared and will be submitted to ADQA in compliance with Arizona Department of Environmental Quality requirements (Appendix C-2). The proposed project has been coordinated with the ADEQ. To meet the requirements of the ADEQ, the Corps will submit required forms. A request for a Section 401 Water Quality Certification with form 404-015 application would be submitted to ADEQ. Prior to the project construction, Section 401 Water Quality Certification would be obtained. Provisions of the Clean Water Act are complied with.

7.5 Clean Air Act, as amended

Section 118 specifies that any Federal activity which may result in discharge of air pollutants must comply with Federal, State, interstate, and local requirements respecting control and abatement of air pollution. Section 176 requires that all Federal projects conform to Environmental Protection Agency-approved or promulgated State Implementation Plans. The proposed construction will not significantly impact the air quality in this area. During construction a watering program will be employed to reduce fugitive dust. The project-related impacts are short term and minor.

7.6 National Historic Preservation Act, as amended

The project is not in compliance with Section 106 of the National Historic Preservation Act (36 CFR 800). Informal consultation has been initiated with the Arizona Office of Historic Preservation by telephone. Currently survey information is insufficient to determine the National Register eligibility of archeology site, COE_TV_99_1. To conform to the requirements of Section 106, a site number needs to be acquired from the Arizona State Museum, a survey report needs to be filed at the Museum and then transmitted to the SHPO, and a subsurface test of the site needs to be completed. If the test indicates the site has the ability to answer significant questions in the prehistory of the Tucson Basin, it will be determined to be eligible for listing in the National Register of Historic Places. Before mitigating adverse effects to the site, a MOA will need to be developed between the Corps of Engineers, the SHPO, interested Native Americans, Pima County, and possibly the Advisory Council on Historic Preservation. The MOA will contain stipulations that will guide mitigation. When the MOA is executed, the project as planned will be in compliance with Section 106 and may proceed. Upon completion of field work for mitigation construction may proceed.

7.7 Endangered Species Act of 1973, as amended (Public Law 93-205)

The Corps requested Endangered Species information from USFWS in a letter dated July 16, 1998. USFWS provided the information as requested in a letter dated August 5, 1998 (see Appendix B-1). Protocol surveys were conducted for the Endangered Cactus Ferruginous Pygmy Owl, as recommended by the USFWS and the Arizona Game and Fish Department. No evidence of Cactus Ferruginous Pygmy Owl was found on site. None of the alternatives would affect listed threatened or endangered species; therefore, the project is in compliance with the Act. WestLand Biological Services, under contract to the Corps, conducted a survey for Cactus

Ferruginous Pygmy Owl as per USFWS protocol in March, April, and May 1999. No Pygmy Owl was detected during the surveys. Based on these surveys, the Corps biologist determined that the project would have no effect on the Pygmy Owl. The Corps also determined that the proposed action would not affect other Threatened or Endangered species potentially occurring in the project area as shown in Table 4-5 of this EA. This determination has been coordinated with the USFWS. USFWS indicated that the determination of no effect needs no further documentation other than that included in the EA; therefore, a Biological Assessment was not prepared and Section 7 Consultation is not required. On October 17, 2001, Mr. Frank Baucom of the USFWS Phoenix office reaffirmed that it was the policy of his office not to comment on another agency's "no effect" determination; therefore, the project is in compliance with the Act. In order to comply with ER 1105-2-100, the Corps will request written concurrence from USFWS that the EA also satisfies ESA Section 7 Consultation/Coordination requirements. This will be accomplished during the Preconstruction, Engineering, and Design (PED) phase of the project. When the Corps receives this concurrence, the project will also be in compliance with ER 1105-2-100.

7.8 Fish and Wildlife Coordination Act (Public Law 85-624)

This project has been coordinated with the USFWS and the Arizona Game and Fish Department. The USFWS, Phoenix Ecological Services Field Office, has prepared a Final Coordination Act Report (CAR) in compliance with the Act. The Final CAR is located in Appendix B-2 of this document. A site visit was conducted with the USFWS staff (Mr. Mike Martinez), Phoenix office, and Arizona Department of Game and Fish (Ms. Sherry Ruther). The USFWS and Arizona Game and Fish expressed their concerns that the cactus Ferruginous Pygmy Owl, a Federally listed Endangered species, may be located within the project area. Their concerns regarding Ferruginous Pygmy Owl and bank erosion along the riparian preserve located along the north bank have been taken into consideration. The Corps conducted a bank erosion study and Westland Biological Services conducted protocol surveys for Pygmy Owl under contract to the Corps. The USFWS indicated in CAR a preference for implementation of Alternative No. 2, no structural protection along the riparian vegetation preserve. This view was confirmed in a telephone conversation between the Corps and USFWS on May 3, 2000.

7.9 Migratory Bird Treaty Act

The proposed project would not involve the taking, killing, harming, or possession of birds protected under the Act. The project is, therefore, in compliance.

7.10 Executive Order 11990, Protection of Wetlands

Wetlands protection includes avoidance to the maximum extent possible of long and short-term adverse impacts associated with the destruction or modification of wetlands and avoidance of support of new construction in wetlands. The proposed project involves no new construction or maintenance in wetlands and is in compliance with the Executive Order.

7.11 Arizona Native Plant Law

This Law provides various levels of protection to many plants native to Arizona. The Law also requires that the Arizona Department of Agriculture be notified prior to removal of protected native plants. The proposed action would not affect any plants designated as a Highly

Safeguarded under the Native Plant Law, but some plants provided a lesser degree of protection, including mesquite, would be removed. The Arizona Department of Agriculture will be notified as required. The law requires contacting the Arizona Department of Agriculture sixty days prior to commencement of a project which may result in the removal of protected species. The project is not required to comply with this State regulation since it is located on Federal land. However, sensitive plants will be avoided or relocated where possible.

7.12 Executive Order 11988, Floodplain Management, May 24, 1977

Under this Order, the USACOE shall take action to avoid development in the base (100-year) floodplain unless it is the only practicable alternative; to reduce hazards and risks associated with floods; to minimize the impact of floods on human safety, health and welfare; and to restore and preserve the natural and beneficial value of the base floodplain.

7.13 Executive Order 12898, Environmental Justice

The alternatives developed for the EA were based on a set of criteria that did not discriminate on the basis of race, color, or national origin. This Executive Order requires that the Federal agency analyze the impacts of federal actions on minority and low-income populations.

7.14 Executive Order 13045, Environmental Health and Safety Risks to Children (62 Fed. Reg. 1988s (1997)

On April 21, 1997, this Executive Order was signed by President Clinton. It is designed to focus Federal attention on actions that affect human health and safety conditions that may disproportionately affect children. Executive Order 13045 requires that federal agencies, to the extent permitted by law, and appropriate and consistent with the agency's mission:

- Shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children.
- Ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

Consistent with Executive Order 13045, the project would not disproportionately impact children in the region of influence.

7.15 Pima County Floodplain and Erosion Hazard Management Ordinance.

Chapter 6.54 Watercourse and Riparian Habitat Protection and Mitigation Requirements

This section of the ordinance describes mitigation requirements for development that adversely affects riparian habitat.

8.0 ENVIRONMENTAL COMMITMENTS

- A watering truck will be utilized during construction to minimize fugitive dust; the water will be obtained from a local water supply and will be free of contaminants.
- Clean material will be used to construct structures; no polluted silts or other material will be placed in the creek water; construction debris and rock will be removed upon completion of the project; and surfaces will be periodically cleaned after storm events.
- No construction would occur during heavy storm events.
- Construction debris as a result of bank stabilization will be removed and will be disposed of properly. Oil and grease potentially generated in the course of construction will be disposed of properly.
- A qualified biologist familiar with the Environmental Assessment, and environmental commitments will be present at critical times during mobilization, construction, and demobilization to monitor the project.
- Biological Mitigation for the Recommended Plan will involve the acquisition and maintenance as a preserve of the 48-acre mesquite bosque habitat area located along the north bank of the creek.
- The mesquite bosque preserve will be provided with modified bank stabilization measures to minimize habitat losses due to bank erosion.
- If bank stabilization for the mesquite bosque preserve consists of a soil cement berm, the berm will be embedded with sufficient "weep holes" to maintain the hydrologic connection between Tanque Verde Creek and the preserve.
- If bank stabilization for the mesquite bosque preserve consists of a soil cement berm, the height of the berm will be the minimum that would protect the bank from lateral erosion, and the slope gradient will be designed to sustain wildlife movement between the preserve and the creek bed.
- During the PED phase of the project, the Corps and Pima County will analyze additional options for bank stabilization along the preserve.
- Mitigation measures will need to be developed if test results from archeology site COE-TV-99-1 (temporary designation) show that it demonstrates the research potential to be determined National Register eligible. Testing will confirm the extent of the site and provide information towards developing a suitable set of research questions. Mitigation will require excavating enough material in the APE to enable answering the research questions. Mitigation measures will be defined in a memorandum of agreement (MOA), in consultation with the State, County, and interested tribes.

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9.0 PUBLIC INVOLVEMENT AND PUBLIC REVIEW

9.1 Public Review. The Draft Environmental Assessment (EA) for this project was sent for 30-day Public Review starting May 24, 2002. Due to problems encountered in distributing and notifying the public of the availability of the document as originally scheduled, the comment period was extended to July 31, 2002. Written comments on the Draft EA and LRR and responses are included in Appendix E of this Final EA.

9.2 Public Meetings. The Corps and the Pima County Department of Transportation and Flood Control District held two public meetings to present the draft LRR and EA to the public and to solicit public comments and concerns on the proposed project. The first of these meetings took place at the Dusenberry/River Public Library on May 28, 2002. Due to problems encountered in notifying interested parties of the first meeting, a second meeting was held on July 9, 2002 at St. Alban's Episcopal Church. Written comments on the EA and LRR, responses, and summaries of the Public Meeting are included in Appendix E of this document.

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10.0 LIST OF PREPARERS AND REVIEWERS

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Ms. Norma Hallisy, Social Science Technician
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Mr. Richard Perry, Archeologist
Mr. Roderic McLean, Archeologist
Mr. Stephen Dibble, Senior Archaeologist, Cultural Resources (Reviewer)
Mr. Alex Watt, Chief, Regional Planning Section (Reviewer)
Dr. Nedenia Kennedy, Chief, Environmental Policy Group (Reviewer)
Mr. Ed Demesa, Civil Engineer (Reviewer)
Mr. Lawrence Smith, Senior Biological Sciences Environmental Manager (Reviewer)
Ms. Megan Wong, Biologist (Reviewer)
Mr. Robert Ngo, Engineer Intern, Technical Assistance
Dr. John Moeur, Senior Terrestrial Ecologist (Reviewer)

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APPENDIX A

TANQUE VERDE CREEK
CRAYCROFT ROAD TO SABINO ROAD
BANK PROTECTION AND
RIPARIAN PRESERVE PROJECT

LATERAL MIGRATION ANALYSIS

Prepared for:

U.S. Army Corps of Engineers
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Prepared by:

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May, 1999

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I. INTRODUCTION

This report presents the results of a lateral migration analysis conducted for four proposed bank-protection alternatives located a study reach of the Tanque Verde Creek which lies between Craycroft Road and Sabino Canyon Road in Pima County, Arizona. This particular reach of Tanque Verde Creek contains approximately 9,500 linear feet of existing bank protection located along four isolated channel segments which lie between the Craycroft Road bridge and the Sabino Canyon Road bridge. Approximately 12,500 linear feet of channel banks are currently unprotected within the study reach. Figure 1, Location Map, shows the study reach and the existing bank protection within the study reach.

Three bank-protection alternatives have been defined to include varying lengths of bank protection within the study reach—all in conjunction with the creation of a Riparian Preserve along a portion of the north bank of the Tanque Verde Creek. All of the proposed bank protection would be located along the alignment of the existing channel banks. The three bank-protection alternatives, along with a "no-action" alternative, have been defined as follows:

Alternative 1: No action.

Alternative 2: Bank protection in the existing gaps along the south bank (5,900 linear feet);

Bank protection upstream of the Craycroft bridge on the north bank (1,600 linear feet); and

Riparian Preserve along the north bank.

Alternative 3: Bank protection along the south bank adjacent, to the golf course (4,200 linear feet);

Bank protection upstream of the Craycroft bridge on the north bank (1,600 linear feet); and

Riparian Preserve along the north bank.

Alternative 4: Bank protection in the existing gaps along the south bank (5,900 linear feet);

Bank protection upstream of the Craycroft bridge on the north bank (1,600 linear feet);

Riparian Preserve along the north bank, and

Bank protection (low flow) along the Riparian Preserve (5,000 linear feet).

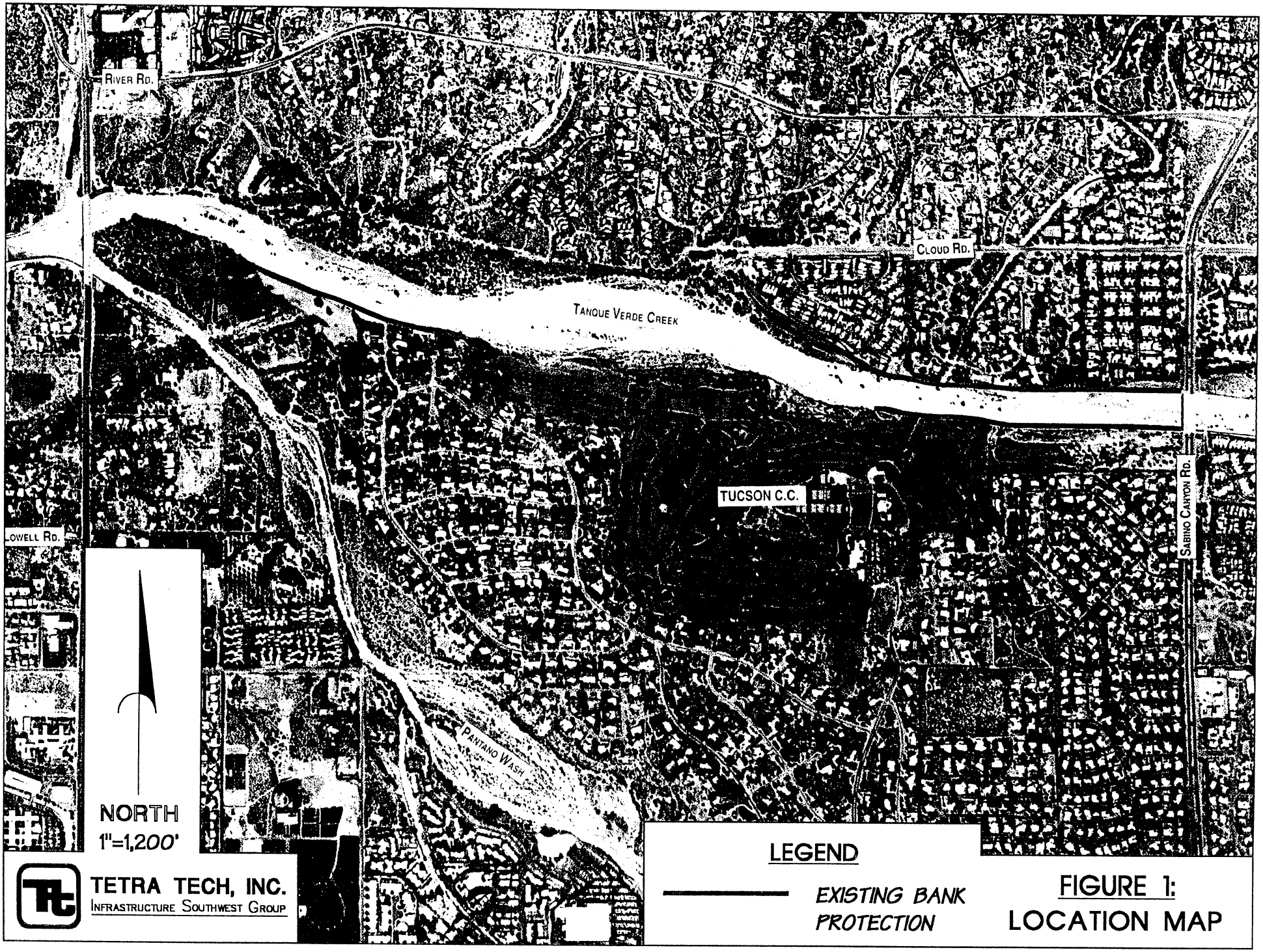

FIGURE 1:
LOCATION MAP

II. PREVIOUS STUDIES

In 1996 the Pima County Flood Control District (District) asked the U.S. Army Corp of Engineers to evaluate flooding and erosion hazards along the study reach of the Tanque Verde Creek. (Pima County, 1996). The District outlined the existing flooding and erosion hazards, and prepared preliminary cost estimates for their proposed solution. The District's 1996 proposal has been included as Alternative 2 in this report.

Subsequently, a hydraulic and geomorphic analysis was completed for the study reach of the Tanque Verde Creek (SLA, 1998) which addressed four major areas of concern. The four areas of concern were (1) the potential for bank erosion, lateral migration, and channel migration along the project reach; (2) the relative stability of the Craycroft Road and Sabino Road bridges; (3) the flooding potential along the study reach during the 100-year event; and (4) the potential threat, if any, that the project might pose on the recently completed Rillito Creek bank stabilization project. For the purpose of the analysis presented within this report, the results of the 1998 SLA analysis regarding the first area of concern—bank erosion, lateral migration, and channel migration—will be examined in further detail and expanded upon in order to assess the impacts that bank stabilization might create along the proposed Riparian Preserve which is to be located along a portion of the north bank of the study reach.

III. QUALITATIVE GEOMORPHIC ANALYSIS

A. Historical Geomorphic Analysis

The 1998 SLA analysis incorporated a fluvial geomorphologic assessment which included an evaluation of aerial photographs of the study reach for the years 1936, 1953, 1960, 1967, 1971, 1979, 1983, 1993, and 1996. Using these historical aerial photographs and USGS flow records, movements of channel banks along the study reach were documented and correlated to flow events over the 60-year time period of the aerial photographs. In addition, changes in land uses and vegetation location and volume were also documented and correlated to the movements of the channel banks. The 1998 analysis presented summaries of the movements of channel banks, land-use changes, and vegetation changes which occurred during the intervening time periods between each successive aerial photograph.

The results of the 1998 fluvial geomorphologic analysis revealed that 650 feet was the maximum lateral movement of the channel banks which occurred during the 60-year time period of 1936 to 1996. A review of historic flow records indicates that a flow event of 12,200 cfs in December of 1965 was responsible for the majority of this severe bank erosion. While the peak flow rate for this event was much less than the adopted 100-year discharge of 34,000 cfs, the extensive bank erosion which occurred during the 1965 event was considered to be primarily due to the prolonged duration of flow (Pearthree and Baker, 1987). Another primary factor was that the flow was directed toward the outside of a appreciable meander bend which existed at the time.

B. Localized Bank Protection along Regional Watercourses

Each of the proposed alternatives would result in varying levels of bank protection along the study reach. The alternatives range from Alternative 1, with no new bank protection, to Alternative 4, with complete bank protection. Alternatives 1, 2, and 3 would all result in localized, or "piecemeal," areas of bank protection within the study reach, with unprotected channel banks located between, and adjacent to, protected channel banks.

The occurrence of increased bank erosion adjacent to localized bank protection has been well documented for regional watercourses within the Tucson basin such as the Tanque Verde Creek, the Rillito Creek, and the Santa Cruz River. During the October, 1983, flow events on these regional watercourses, a systematic pattern of erosion at meander bends was documented that appeared to be *directed or otherwise facilitated by existing localized bank protection* [emphasis added] (Pearthree and Baker, 1987). Localized bank protection, such as is proposed with Alternatives 1, 2, and 3, clearly will concentrate potential bank erosion and focus it upon those unprotected banks which remain within the study reach.

IV. ENGINEERING GEOMORPHIC ANALYSIS

A. Sediment Transport Continuity and Equilibrium Slopes

In order to determine the effect of any proposed channel improvements on channel stability, a quantitative engineering-geomorphic analysis can be conducted to determine both existing and with-project characteristics (ADWR, 1985). That is, an analysis of sediment transport rates and equilibrium slopes can be used to determine the effect of a proposed alternative on the stability of both the channel bed and banks of an alluvial watercourse.

Hydraulic models for both existing and with-project conditions were completed as part of the 1998 SLA analysis. Using hydraulic parameters (i.e., depth, velocity, width) obtained from these hydraulic models for both existing and with-project conditions, sediment transport rates can be calculated and compared to one another in order to identify any changes in sediment transport continuity within the study reach. Such a comparison showed little predicted change, however, since the proposed bank protection for each alternative will generally be located along the existing alignment of channel banks, and therefore existing flow hydraulics and corresponding sediment transport rates will remain essentially unchanged. Consequently, comparison of existing versus with-project sediment transport rates does not predict the occurrence of any substantive change in sediment transport continuity within the study reach.

Any instability in the sediment transport continuity of the study reach can also be identified through an analysis of equilibrium slopes—a procedure which can be used to determine long-term trends toward aggradation or degradation of the streambed. In the 1998 SLA analysis, equilibrium slopes were calculated for the study reach (SLA, 1982) and were compared to existing slopes. Differences in the two slopes were small, between 0.0002 ft./ft. and 0.0003 ft./ft. (i.e., 1.1 ft./mile to 1.6 ft./mile), with a slight trend towards aggradation indicated. Consequently, instability in the sediment transport continuity of the study reach due to either streambed aggradation or degradation is not predicted to occur for either existing or with-project conditions.

B. Shear Stress Analysis at Bendways

The occurrence of lateral migration and bank erosion is not exclusively a function of system sediment imbalances or long-term equilibrium slopes. Localized bank movement along the outside of meander bends will also occur. The extent of this localized bank-erosion process can be predicted by calculating the change in shear stress which occurs on the outside of meander bends during the progression of a flood hydrograph (SLA, 1997). Increased shear stress on the outside of a meander bend is created by the curvature effect induced in the flow as it passes through the bend. Physical model studies have shown that "bend shear stresses" can be more than four times as great as the shear stresses which occur along a straight channel segment.

Single-event bank erosion distance along the outside of an existing meander bend can be predicted by (1) utilizing representative cross sections along the study reach for both a straight approach channel and a meander bend; by (2) adjusting channel hydraulics to represent the outer

portion of flow within the representative cross sections; by (3) computing corresponding sediment transport rates; by (4) considering the geometry of existing meander bends along the study reach; by (5) accounting for the increased shear stress on the outside of the meander bend; and by (6) considering the sediment composition of the eroding bank. Two existing meander bends located along the north bank of the study reach were evaluated for single-event bank erosion using this approach. Results, provided in the appendix to this report, indicate that for current conditions within the study reach, the maximum northward lateral movement of the north bank of the Tanque Verde Creek is predicted to be in the range of 200 feet to 300 feet during the occurrence of a 100-year flow event.

An earlier fluvial geomorphologic assessment (SLA, 1998) of the study reach of the Tanque Verde Creek recommended 650 feet as a reasonable prediction of long-term lateral migration potential. On an average-annual basis, this represents only a few feet of migration per year. However, the amount of lateral migration predicted to occur during a major single event, such as a 100-year flood, accounts for a significant portion of the total lateral migration that is anticipated to occur within the study reach over the long term. Consequently, the ability to passively monitor erosion impacts along the proposed Riparian Preserve—and then take appropriate mitigation measures, as necessary, to preserve the integrity of the Preserve—can be severely compromised since the passage of a major single event can cause several hundred feet of lateral bank movement to occur along the study reach of the Tanque Verde Creek in a matter of only a few hours time.

V. RESULTS

All of the proposed alternatives incorporate installation of varying levels of bank protection for the unprotected channel banks along the study reach. The alternatives range from Alternative 1, with no new bank protection, to Alternative 4, with complete bank protection. Alternatives 1, 2, and 3 would all result in localized, or "piecemeal," areas of bank protection within the study reach, with unprotected channel banks located between, and adjacent to, the protected channel banks. As a result, the potential for erosion along the unprotected segments of channel banks is expected to be high for Alternatives 1, 2, and 3, due to the "piecemeal" nature of the existing and proposed bank protection.

The occurrence of increased bank erosion for unprotected banks located adjacent to localized protected banks has been well documented for regional watercourses within the Tucson basin. Erosion at meander bends has either been caused, or exacerbated by, existing localized bank protection. Localized bank protection, such as is proposed with Alternatives 1, 2, and 3, will clearly concentrate potential bank erosion along those segments of unprotected banks located within the study reach.

Existing fluvial-geomorphic and engineering-geomorphic analyses of the study reach of the Tanque Verde Creek were evaluated for the purpose of determining the effects, if any, of the proposed bank-protection alternatives on lateral migration. Using existing and with-project hydraulic parameters, it was determined that sediment transport rates, and thus overall sediment transport continuity, will not be altered by any of the proposed alternatives. Similarly, a comparison of existing and equilibrium slopes in the study reach indicates that the channel bed profile is approaching long-term equilibrium conditions. These two quantitative methodologies indicate that no substantive change in sediment continuity results from the proposed alternatives.

Using a quantitative methodology which considers the hydraulics and shear stress of flow on the outside of a meander bend, single-event bank erosion estimates were determined along the study reach to range between 200 feet to 300 feet for the two meander bends located within the study reach. Although these estimates are less than historical single-event bank movements that have been recorded, the estimate is considered to be reliable for the geomorphology of the Tanque Verde Creek as it exists today along the study reach (i.e., the existing channel alignment is straighter than in the past, and the ability of the channel to meander has been reduced significantly due to the presence of two bridges and 9,500 linear feet of existing bank protection).

Because the amount of lateral migration predicted to occur during a major single event, such as a 100-year flood, accounts for a significant portion of the total lateral migration that is anticipated to occur within the study reach over the long term, the ability to passively monitor erosion impacts along the proposed Riparian Preserve—and then take appropriate mitigation measures, as necessary, to preserve the integrity of the Preserve—can be severely compromised since the passage of a major single event can cause several hundred feet of lateral bank movement to occur along the study reach of the Tanque Verde Creek in a matter of only a few hours time.

Results of the historical geomorphic analysis indicate that 650 feet represents the maximum long-term lateral movement of the channel banks during the 60-year period of record analyzed (1936 to 1996). As noted in the 1998 SLA analysis of the study reach, this maximum observed lateral migration distance correlates closely to a building setback distance of 652 feet which was calculated using local City of Tucson standards (City of Tucson, 1989). Therefore, while lateral bank movements of this magnitude are less likely today, due to the limiting effect of recent bridge construction and bank protection within the study reach, 650 feet is still considered to be a conservative estimate of worst-case channel movement within the study reach over the long term.

In order to quantify the erosion hazards that are associated with each alternative, unprotected sections of channel bank were tabulated and potential areas of bank erosion were calculated. The results, shown in Table 1 and Figure 2, indicate the relative erosion hazards for each alternative. With the exception of Alternative 4, all of the alternatives are predicted to result in a high risk of erosion along the proposed Riparian Preserve.

TABLE 1: EROSION HAZARDS FOR PROPOSED ALTERNATIVES

Alternative	Proposed Bank Protection (linear feet)	Unprotected Banks (linear feet)	Acreage at Risk (acres)	Structures at Risk
1	0	12,500	187	21 homes, the north and south approaches to the Craycroft bridge, a golf course, and the Riparian Preserve
2	7,500	5,000	75	15 homes, along with the Riparian Preserve
3	5,800	6,700	100	15 homes, the Riparian Preserve, and the south approach to the Craycroft bridge
4	12,500	0	0	None

VI. RECOMMENDATION

Based upon the lateral migration assessment conducted under this study effort, it is recommended that Alternative 4—bank protection in the existing gaps along the south bank (5,900 linear feet); bank protection upstream of the Craycroft bridge on the north bank (1,600 linear feet); Riparian Preserve along the north bank, and Bank protection (low flow) along the Riparian Preserve (5,000 linear feet), be adopted as the preferred alternative for the project.

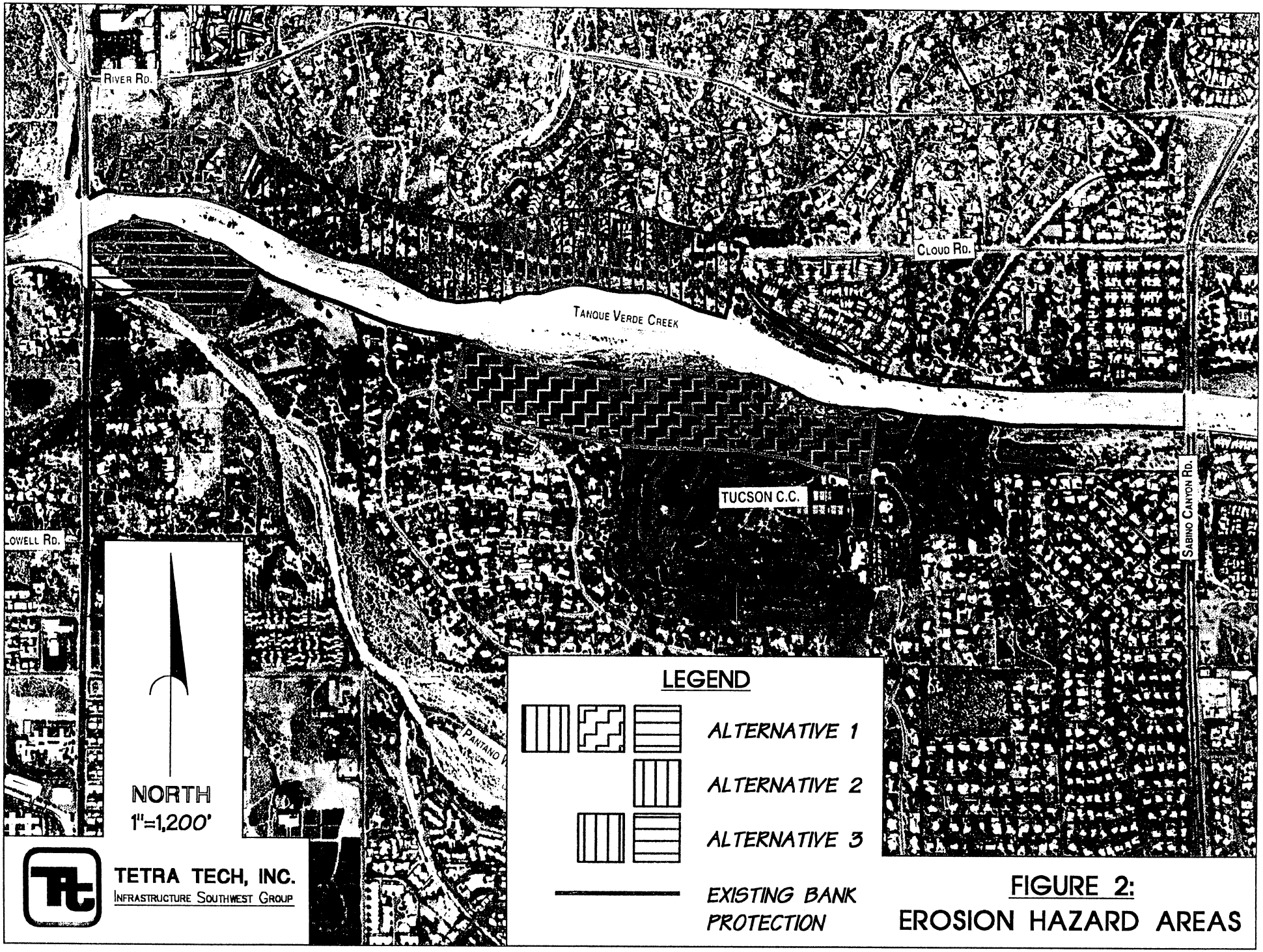

FIGURE 2:
EROSION HAZARD AREAS

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3. *Tanque Verde Creek, Craycroft Road to Sabino Road, Bank Protection and Riparian Preserve Project Limited Reevaluation Report (LRR), Feasibility Level Engineering Analysis*; a report by Simons, Li & Associates, Inc., Tucson, Arizona; May 4, 1998.

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APPENDIX

CALCULATIONS FOR BANK EROSION IN BENDS DUE TO INCREASED SHEAR STRESS

TANQUE VERDE CREEK - CRAYCROFT ROAD TO SABINO ROAD
100-YEAR LATERAL MIGRATION ANALYSIS
WEST MEANDER NEAR CRAYCROFT ROAD

Hydraulics from HEC-2 Design Run (SLA, 98)
Unit Sediment Discharge from Tucson Urban Study (SLA, 82)
qs = (2.75x10^-6) * v^4.29 * y^-0.261

Total Sediment Discharge for Shear Stress Analysis (1/2 section)
Qs = qs * (width/2)

420	Supply channel width
400	Bend channel width
32	Angle of curvature
7	Average height of outer bank
0.7	Fraction of bed material found in bank
0.4	Porosity
5.5	Shape factor

Hydrograph		Supply Reach (XS-5)				Bend Reach (XS-3)					
Time Increment (hr)	Discharge (cfs)	Velocity (ft)	Depth (ft)	Sediment Discharge (cfs)	Sediment Volume (cf) (bulked)	Velocity (ft)	Depth (ft)	Adjusted Velocity (ft)	Adjusted Depth (ft)	Sediment Discharge (cfs)	Sediment Volume (cf) (bulked)
1.5	2200	1.98	3.83	0.0762	686	1.0	6.7	1.13	6.72	0.0056	51
1	8600	5.66	4.83	6.4957	38974	3.6	6.9	4.28	6.97	1.6931	10159
1	15700	7.77	5.98	23.9188	143513	6.2	7.2	7.33	7.54	16.7344	100407
1	26400	9.21	7.52	46.7232	280339	9.1	8.1	10.77	8.73	83.7157	502294
1	33800	9.62	8.51	54.5333	327200	10.3	8.8	12.23	9.67	140.7046	844227
1	27200	9.27	7.63	47.8614	287168	9.2	8.2	10.96	8.82	89.9955	539973
1	20200	8.59	6.64	35.7929	214757	7.6	7.6	8.97	8.00	39.1727	235036
1	17700	8.17	6.28	29.2898	175739	6.8	7.4	8.09	7.73	25.3857	152314
1	13800	7.33	5.69	18.8696	113218	5.5	7.1	6.57	7.36	10.5269	63161
1	10200	6.25	5.1	9.7994	58797	4.2	6.9	5.02	7.08	3.3343	20006
1	7600	5.24	4.66	4.7101	28261	3.2	6.8	3.80	6.91	1.0239	6143
1	5700	4.33	4.34	2.1169	12701	2.4	6.8	2.89	6.83	0.3154	1892
1	4200	3.45	4.09	0.8112	4867	1.8	6.7	2.14	6.77	0.0872	523
1	3300	2.83	3.96	0.3497	2098	1.4	6.7	1.69	6.75	0.0316	189
1	2500	2.22	3.86	0.1243	746	1.1	6.7	1.28	6.73	0.0098	59
2	1700	1.56	3.78	0.0275	330	0.7	6.7	0.87	6.71	0.0018	22
2.5	900	0.84	3.72	0.0019	29	0.4	6.7	0.46	6.70	0.0001	2
Total Sediment Volume (bulked cf)					*1689423*						*2476459*
Sediment Deficit (bulked cf)									*787036*		
Lateral Migration Potential (ft)									*209*		

Tetra Tech, Inc.
Infrastructure Southwest Group

TANQUE VERDE CREEK - CRAYCROFT ROAD TO SABINO ROAD
100-YEAR LATERAL MIGRATION ANALYSIS
EAST MEANDER NEAR SABINO ROAD

Hydraulics from HEC-2 Design Run (SLA, 98)
Unit Sediment Discharge from Tucson Urban Study (SLA, 82)
qs = (2.75x10^-6) * v^4.29 * y^-0.261

Total Sediment Discharge for Shear Stress Analysis (1/2 section)
Qs = qs * (width/2)

360	Supply channel width
705	Bend channel width
35	Angle of curvature
7	Average height of outer bank
0.7	Fraction of bed material found in bank
0.4	Porosity
6.1	Shape factor

Hydrograph		Supply Reach (XS-15)				Bend Reach (XS-12)					
Time Increment (hr)	Discharge (cfs)	Velocity (ft)	Depth (ft)	Sediment Discharge (cfs)	Sediment Volume (cf) (bulked)	Velocity (ft)	Depth (ft)	Adjusted Velocity (ft)	Adjusted Depth (ft)	Sediment Discharge (cfs)	Sediment Volume (cf) (bulked)
1.5	2200	3.66	2.53	1.0156	9140	4.0	1.7	4.90	1.86	7.5432	67889
1	8600	7.06	4.3	14.8130	88878	6.3	3.4	7.67	3.75	42.9264	257558
1	15700	9.27	5.65	44.3703	266222	7.1	4.6	8.73	5.15	68.6535	411921
1	26400	11.6	7.22	108.9060	653436	8.3	6.0	10.21	6.75	125.4274	752564
1	33800	12.8	8.14	161.0138	966083	8.9	6.9	10.94	7.74	163.1262	978757
1	27200	11.74	7.32	114.2468	685481	8.4	6.1	10.29	6.87	129.4549	776729
1	20200	10.36	6.36	69.3101	415860	7.7	5.2	9.44	5.85	92.9302	557581
1	17700	9.78	5.98	55.0098	330059	7.4	4.9	9.06	5.47	79.2813	475688
1	13800	8.74	5.33	34.9956	209974	6.8	4.4	8.36	4.83	58.0495	348297
1	10200	7.62	4.65	20.1366	120820	6.2	3.8	7.55	4.20	38.9012	233407
1	7600	6.66	4.09	11.6856	70113	6.0	3.2	7.29	3.52	35.0940	210564
1	5700	5.82	3.62	6.7655	40593	5.4	2.8	6.56	3.04	23.1090	138654
1	4200	5.04	3.2	3.7687	22612	4.8	2.4	5.89	2.61	15.2435	91461
1	3300	4.51	2.9	2.4007	14404	4.6	2.0	5.65	2.26	13.1905	79143
1	2500	3.97	2.61	1.4278	8567	4.2	1.8	5.12	1.98	8.9696	53817
2	1700	3.33	2.26	0.6974	8369	3.8	1.5	4.61	1.64	5.9860	71832
2.5	900	2.47	1.83	0.2045	3068	2.9	1.2	3.55	1.28	2.0958	31437
Total Sediment Volume (bulked cf)					3913678						5537301
Sediment Deficit (bulked cf)										1623623	
Lateral Migration Potential (ft)										285	

Tetra Tech, Inc.
Infrastructure Southwest Group

APPENDIX B

APPENDIX B-1
CACTUS FERRUGINOUS PYGMY OWL SURVEY

WestLand Resources, Inc.
Engineering and Environmental Consultants

June 21, 1999

U.S. Army Corps of Engineers
Attn: Ms. Lois Goodman, Environmental Research Branch
P.O. Box 532711
Los Angeles, California 90053-2325

RE: CACTUS FERRUGINOUS PYGMY-OWL SURVEY - TANQUE VERDE CREEK PROJECT
CONTRACT NO. DACA09-99-D-0003, DELIVERY ORDER 0003
WESTLAND JOB NO. 408.01

Dear Ms. Goodman:

Under subcontract to Aspen Environmental Group, WestLand Resources, Inc. (WestLand) conducted three surveys for the federally endangered cactus ferruginous pygmy-owl (CFPO) at the Tanque Verde Creek project area. It is our understanding that the project includes two proposed components: 1) soil cement bank stabilization (1,700 feet on the north bank and two segments totaling approximately 6,000 feet on the south bank), and 2) an approximately 180-acre mesquite bosque preserve. The area surveyed includes an approximately 1.5-mile reach of Tanque Verde Creek (from the Craycroft Road bridge/Pantano Wash confluence upstream to the east side of the Tucson Country Club) and approximately 180 acres of adjacent land (T13S, R14E, portion of Section 25 and T13S, R15E portion of Section 30; Figure 1). The survey area is entirely within the City Limits of Tucson on lands administered by Pima County. No CFPO responses were heard and no CFPO were sighted during this survey effort. Survey methods and results are summarized in detail below.

Three complete surveys were conducted along the project area. Two sessions with a single surveyor were required for complete coverage of the area during each survey. The surveys were conducted in the morning hours from approximately one hour before to approximately two hours after sunrise and in the evening from approximately two hours before to approximately one hour after sunset. The first survey session was conducted on March 17th (p.m.) and 19th (a.m.), the second on April 21st (a.m. and p.m.), and the third on May 12th (p.m.) and 14th (p.m.), 1999.

The surveys followed the revised protocol proposed by the U.S. Fish & Wildlife Service (USFWS). Under the revised survey protocol, calling stations are spaced at 400-meter (1,300 feet) intervals, adjacent transects are spaced at up to 800-meter (2,600 feet) intervals, and the time spent at each calling station is 18 to 22 minutes (including travel time between stations). Calling stations were mapped on a 1"=1,200' aerial photograph of the property for use in the field. Surveys were conducted under USFWS Permit No. PRT-834782.

Fifteen calling stations provided complete coverage of the project area during each survey session. Weather conditions during the survey sessions varied – skies were clear to partly cloudy, temperatures were cool to warm (low 40s to low 90s °F), and winds were calm (no wind) to breezy (5 to 10 miles per hour). Background noises associated with vehicular traffic, barking dogs, and other activities on adjacent developed lands were moderate throughout the survey area during each survey session.

There is considerable evidence of past human disturbance within the creek and on adjacent properties (Figure 1). There are existing soil-cement structures on both the north and south banks of the creek upstream and

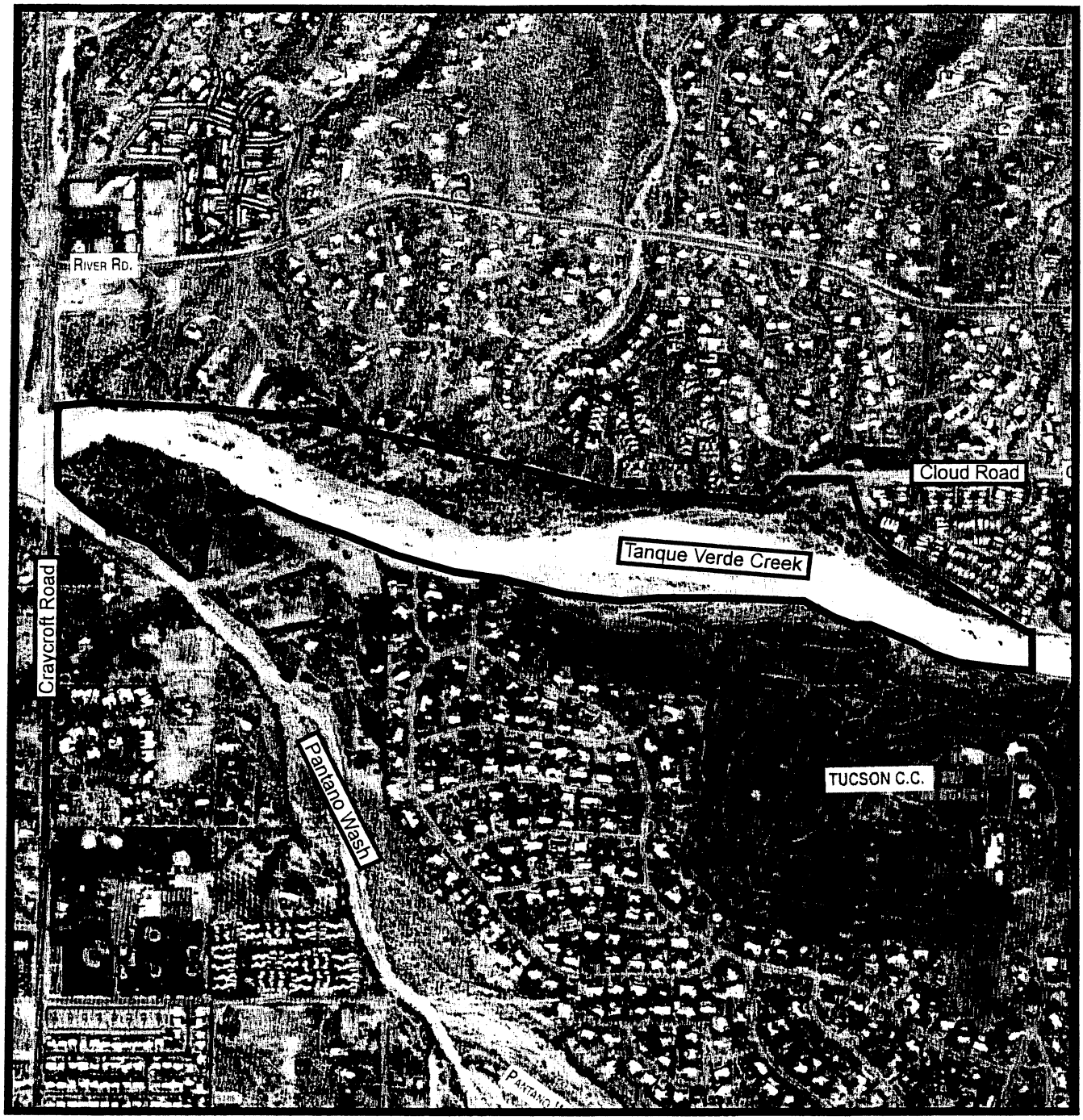
2343 E. Broadway Blvd., Suite 202 ·Tucson, AZ 85719 ·520·206·9585 Fax 520·206·9518

downstream of the project area. In addition, a recent wildfire has impacted portions of lands adjacent to the both banks of the creek, including a portion of the proposed mesquite bosque preserve. Adjoining both sides of the project area are variable-density residential developments. The Tucson Country Club golf course adjoins the south bank of the creek near the east end of the project area.

The area surveyed for this report is located at the confluence of Pantano Wash and Tanque Verde Creek. Elevations along the survey area range from approximately 2,440 to 2,460 feet above sea level. Tanque Verde Creek has a broad, sandy-bottomed channel in which water flows periodically only after moderate to large precipitation events. The sandy wash bottom is largely devoid of vegetation, but there are scattered clumps of vegetation, predominantly along the channel margins. Observed plant species in and along the channel include Fremont cottonwood (*Populus fremontii*), desert willow (*Chilopsis linearis*), burro brush (*Hymenoclea monogyra*), seep willow (*Baccharis salicifolia*), desert broom (*B. sarothroides*), velvet mesquite (*Prosopis velutina*), Mexican palo verde (*Parkinsonia aculeata*), Mexican elder (*Sambucus mexicana*), graythorn (*Ziziphus obtusifolia*), whitethorn acacia (*Acacia constricta*), catclaw acacia (*A. greggii*), four-wing saltbush (*Atriplex canescens*), and canyon ragweed (*Ambrosia ambrosioides*). Adjacent uplands host a similar suite of species. However, these areas have been impacted by a recent wildfire, which has reduced the amount of vegetation at the site as compared to pre-burn conditions. Many trees were consumed by the fire and many others that were killed, but not consumed, remain as standing dead material. Some plants within the burned areas appear to have survived the fire unharmed and, on the north side of the creek, we noted a considerable number of resprouts at the base of burned Mexican elder plants. Grasses and forbs appeared to be more abundant on burned portions of the survey area than on unburned portions. Desert ironwood (*Olneya tesota*) and saguaro (*Carnegiea gigantea*), species commonly associated with occupied CFPO habitats in southern Arizona were not observed within or adjacent to the survey area.

During the surveys, WestLand compared habitats within the survey area to habitats currently and historically occupied by CFPO in Arizona. High vegetation density, species richness, and structural diversity (i.e., relative vegetation densities of overstory, midstory, and understory layers) are commonly associated with habitats known to be occupied by CFPO although, based on new data, USFWS has recently broadened its concept of suitable habitats for the species. Most recent observations of CFPO in Arizona have been in Sonoran desertscrub with dense vegetation dominated by large trees including desert ironwood, blue palo verde (*Cercidium floridum*), and mesquite, and having high numbers of mature saguaros and high structural diversity. Historic records indicate that CFPO were most commonly encountered in dense riparian woodlands dominated by mesquite or in cottonwood-willow forests. The best data available on CFPO habitat suggests that vegetation in this survey area provides suitable nesting habitat for CFPO. The survey area does not contain mature saguaros with cavities that could provide potential nest sites for the species, but there are many trees large enough to have cavities suitable for CFPO nests within its boundaries. Two factors associated with the site that tend to lower its suitability as CFPO breeding habitat are: 1) the preponderance of developed lands in the area, and 2) vegetation in the area appears to lack the structural diversity often associated with occupied habitats. Based on this assessment, habitat quality along the portion of Tanque Verde Creek surveyed for this report appears low to moderate for CFPO. Habitat quality on the nearby lands also appears low to moderate for CFPO.

A search of the Arizona Game & Fish Department (AGFD) Heritage Data Management System dated



LEGEND
Approximate Project Boundary

Work completed under subcontract to Aspen Environmental Group
Contract No. DACA09-99-D-003
Delivery Order 0003

N

Arizona

Feet 0 1200

ASPEN ENVIRONMENTAL GROUP
Tanque Verde Creek Project
Cactus Ferruginous Pygmy-owl Survey

Image Source:
Landiscor Aerial Information
September 21, 1996
T13S, R14E portion of
Section 25 & T13S, R15E portion
of Section 30

WestLand Resources, Inc.
Engineering and Environmental Consultants
2343 E. Broadway Blvd., Suite 202 Tucson, Arizona 85719
520.206.9585 Fax 520.206.9518

Figure 1

Aerial Photograph of Project Area

Digitizer/C:/Cochran/Projects/CFPO/Tanque Verde | Project No.: 0408.01 | Drawn by: JDC | Reviewed by: SJB | Date: April 1999

March 11, 1999 indicated that there are no recorded recent observations of CFPO within T13S, R14E or T13S, R15E. Most recent observations of the species are from northwest of Tucson, 10 to 15 miles northwest of the Tanque Verde Creek survey area. The closest known recent observation of the species is from 10 to 12 miles southeast of the Tanque Verde Creek project area (a 1995 observation from south of Tanque Verde ridge within Saguaro National Park [T15S, R16E]). Records from the early part of this century indicate that the species was commonly encountered in mesquite-dominated riparian woodlands along Tanque Verde Creek and other tributaries of the Santa Cruz River in the Tucson area. However, the extent of these habitats in northeast Tucson is currently much reduced as compared with their late 19th century and early 20th century distribution.

Thank you for the opportunity to complete this survey of the Tanque Verde Creek Bank Stabilization Project Area. If you have any questions or we can be of additional assistance, please contact me at 520-206-9585.

Sincerely,
WestLand Resources, Inc.

Scott Jay Bailey
Senior Biologist

SJB:jc
Attachment: Figure 1

cc: Ms. Natasha Nelson, Aspen Environmental Group

APPENDIX B-2
USFWS FINAL COORDINATION ACT REPORT (CAR)

United States Department of the Interior

U.S. Fish and Wildlife Service
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
Telephone: (602) 640-2720 FAX: (602) 640-2730

In Reply Refer To:
AESO/FA

June 15, 2000

Mr. Robert E. Koplin
Chief, Planning Division
Los Angeles District
U.S. Army Corps of Engineers
Attn: Lois Goodman, CESPL-PD-RQ
P.O. Box 532711
Los Angeles, CA 90053-2352

Dear Mr. Koplin:

This report presents our analysis and recommendations for the Tanque Verde Bank Stabilization Project, Pima County, Arizona. It is provided pursuant to the Fish and Wildlife Coordination Act (FWCA) (48 stat. 401, as amended; 16 U.S.C. 661 et seq.) and constitutes the U.S. Fish and Wildlife Service (Service) report under Section 2(b) of the FWCA. This report is based on field investigations, literature research, file reviews, coordination with the Arizona Game and Fish Department (AGFD), and information provided by the U.S. Army Corps of Engineers (Corps). Literature cited is not a complete bibliography of all literature available on the proposed project, Rillito River and tributaries, nor biological resources within the study area.

PROJECT DESCRIPTION

Under the authorization of the Rillito River and Associated Streams Study (RRAS) and the Water Resources Development Act (WRDA), the Los Angeles District of the Corps is developing, in coordination with the Pima County Department of Transportation and Flood Control District (County), a Limited Reevaluation Report (LRR) and environmental assessment for the Tanque Verde Bank Stabilization Project. The LRR is intended to investigate the feasibility and incremental justification of adding bank protection and a riparian area preserve along Tanque Verde Creek between Craycroft Road and Sabino Canyon Road in Tucson, Pima County, Arizona (area map presented as Exhibit 1 in Corps 1998). The Corps and County are evaluating several alternatives to provide slope protection on the creek. The stated primary purpose of the project is to protect the private property, public infrastructure, and existing riparian vegetation from flood damages between Craycroft Road and Sabino Canyon Road. Properties and structures that would be protected include the North Rillito Interceptor (sewer line), the proposed Tanque Verde Interceptor Extension (sewer line), the Tucson Country Club, and 56 residential structures.

The authorized plan for the stabilization project for the Rillito River was developed by the Corps in 1986 (Corps 1986) and the general design was completed in 1992 (Corps 1992). The Rillito River and tributaries project includes approximately 10.8 miles of soil cement bank protection and 15 invert stabilizers. At the time of the final report there were no economically justified flood control solutions to problems on Tanque Verde Creek. Since that time, the County has requested the LRR to address flood related-problems, including bank erosion, along Tanque Verde Creek.

ALTERNATIVES

Alternative 1

This is the No-Action plan under which slope protection would not be provided. Environmental impacts associated with the proposed project would not occur and flood-related problems along Tanque Verde Creek would be expected to continue.

Alternative 2

This is the locally-preferred alternative and has been adopted by the Corps as the Recommended Plan. Structural features would include soil cement bank protection along approximately 1,600 feet of the north bank upstream of Craycroft Road, and along two segments of 4,000 feet and 2,000 feet in length on the south bank. The alignment of the proposed bank protection would generally follow the smooth curves of the existing bank. Where applicable, the ends would match existing soil cement. At the downstream end on the south bank, the proposed soil cement would key into the bank just upstream of the confluence with Pantano Wash. At the upstream end on the north bank, the soil cement would key into the existing bank and tie back to high ground. The soil cement would match the top of the existing bank, and the toe-down would extend ten feet below the existing thalweg (the deepest point in the channel invert).

The soil cement would consist of an 8-foot-thick layer of soil mixed with Portland cement placed in 6-inch to 1 -foot-high "lifts." Lifts would be successively placed until the desired bank protection height is reached. After compaction, the soil cement would provide a hard and durable surface expected to remain intact throughout the project life of 50 years.

The non-structural component of this alternative would involve acquiring rights-of-way to establish a permanent 500-foot buffer along a portion of the north bank. Public ownership of this land would prevent additional development and associated flood damages, while preserving the existing riparian vegetation. Acquisition of the buffer would be the responsibility of the local sponsor.

Alternative 3

This alternative is similar to Alternative 2, except that no slope protection would be provided for approximately 1,500 feet on the south bank just upstream of the Craycroft Road Bridge. The protection on the south bank would, instead, tie into the existing bank protection upstream of the golf course, and continue downstream of the golf course beyond the site of the historic meander. The unprotected portion of the south bank would be allowed to erode naturally.

Alternative 4

This plan would be similar to Alternative 2, except that a low soil cement berm (approximately 2-4 feet high) would be constructed along the existing bank of the mesquite (*Prosopsis* spp.) bosque on the north bank to provide erosion protection. The berm would stabilize the slope but allow overtopping by 5-10 year floods, allowing flushing flows. The toe-down of the berm would be 10 feet, as with the other slope protection. The bank protection along the riparian habitat would protect the property from bank erosion, but will not provide flood protection at a level that would allow development of the land.

EXISTING BIOLOGICAL RESOURCES

Tanque Verde Creek is an ephemeral stream which drains a 219 square mile watershed that extends into the Catalina and Tanque Verde Mountains north and east of Tucson, respectively. The creek joins Pantano Wash near Craycroft Road to become the Rillito River. The Rillito River continues for approximately 12.2 miles in a northwest direction to its confluence with the Santa Cruz River and includes a total drainage area of 934 square miles. The Tanque Verde Bank Stabilization Project area and adjacent lands have been subjected to considerable human disturbance. Soil cement banks exist on both banks upstream and downstream of the project area. During field investigations the Service noted a recent wildfire has impacted vegetation on both banks of the creek. Adjacent uplands contain residential developments, a golf course, and various other structures.

Tanque Verde Creek has a relatively broad, sandy-bottomed channel. The wash bottom contains little vegetation as these areas are periodically subjected to scouring flood flows. Along the channel margins and banks, vegetation species include Fremont cottonwood *(Populus fremontii)*, desert willow *(Chilopsis linearis)*, burro brush *(Hymenoclea monogyra)*, seep willow *(Baccharis salicifolia)*, desert broom *(B. sarothroides)*, velvet mesquite *(Prosopis velutina)*, Mexican palo verde *(Parkinsonia aculeata)*, Mexican elder *(Sambucus mexicana)*, graythorn *(Ziziphus obtusifolia)*, whitethorn acacia *(Acacia constricta)*, catclaw acacia *(A. greggii)*, four-wing saltbush *(Atriplex canescens)*, and canyon ragweed *(Ambrosia ambrosioides)*. Adjacent uplands contain similar species. These areas have been affected by a recent wildfire which killed many trees, although Westland Resources (1999) noted resprouts as well as grasses and forbs. Ruffner *et al.* (1983) considered the mesquite bosque near the confluence of Tanque Verde Creek and

Pantano Wash to be a unique biological area due to significant vegetation cover, species diversity, and proximity to water.

The project site is located in the Arizona Upland subdivision of the Sonoran desertscrub biotic community as described by Brown (1994). Common wildlife species likely include coyote (*Canis latrans*), javelina (*Tayasu tajacu*), kangaroo rats (*Dipodomys* spp.), black-tailed jackrabbit (*Lepus californicus*), cottontail (*Sylvilagus audubonii*), pocket mice (*Perognathus* spp.), ground squirrels (*Ammospermophilus spp.*), black-chinned sparrow (*Amphispiza bilineta*), roadrunner (*Geococcyx californianus*), Gambel's quail (*Lophortyx californicus*), Harris' hawk (*Parabuteo unicinctus*), thrashers (*Toxostoma spp.*), mourning dove (*Zenaida macroura*), whiptails (*Cnemidophorus* spp.), rattlesnakes (*Crotalus* spp.), horned lizards (*Phrynosoma* spp.), and lizards (*Urosaurus* spp.). The highly urbanized landscape probably limits the diversity of wildlife species that can utilize the project area. Many species requiring relatively large undisturbed home ranges, such as desert mule deer (*Odocoileus hemionus crooki*) and mountain lion (*Felis concolor*) are likely precluded due to their intolerance for high human activity and urban encroachment. No fish are present in the study area due to the lack of perennial water.

No threatened or endangered species are known to occur in the proposed action area. Westland Resources (1999) did not detect the endangered cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*) nor did they observe ironwood (*Olneya tesota*) and saguaro (*Carnegia gigantea*), which are common habitat elements for the pygmy-owl, in the project area during surveys conducted during the spring of 1999.

FUTURE WITHOUT PROJECT SCENARIO

Under the future without project scenario, the Corps would not participate in the proposed Tanque Verde Bank Stabilization Project under the authority of the RRAS and WRDA. However, any localized bank protection would most likely require a Section 404 permit from the Corps Regulatory Branch.

FUTURE WITH PROJECT SCENARIO

Under the future with project scenario, the Corps would participate in the proposed Tanque Verde Bank Stabilization Project under the authority of the RRAS and WRDA. One of the proposed alternatives would be selected to provide bank stabilization and flood protection in the study area. The project's hydraulic analysis indicates the erosion rate on the north bank would likely be accelerated due to deflection of flows from the new soil cement bank protection on the opposite bank. Additionally, information provided by the Corps indicates that Alternative 2 would impact approximately 1 acre of mesquite bosque and 2.5 acres of desert wash, Alternative 3 would impact approximately 0.3 acres of mesquite bosque and 2.5 acres of desert wash, and Alternative 4 would impact approximately 1.9 acres of mesquite bosque and 3.6 acres of desert wash.

DISCUSSION

The Service is concerned about the cumulative effect on regional wildlife communities from the Rillito River and Associated Streams project and the proposed Tanque Verde Bank Stabilization Project. The Corps (1998) states that bank protection upstream of the Tanque Verde Creek study area has contributed to increased erosion along the downstream banks within and below the study area. While soil cement may protect an eroding bank, this protection does not eliminate the erosional force of flood waters. Rather, a soil cement bank deflects and redirects this erosional force to unprotected downstream banks. Localized bank protection will concentrate bank erosion along unprotected banks (Tetra Tech, Inc. 1999), necessitating the need for additional downstream bank protection. The Corps (1998) states that the selected plan should not worsen existing flood hazards for downstream developments without measures to compensate for the effects. These measures would likely consist of additional soil cement bank. We foresee the Rillito River and tributaries entirely lined with soil cement within the near future. We believe the subsequent loss of hydrologic function would result in substantial losses in the physical, chemical, and biological functioning of abiotic and biotic ecosystem components associated with the aquatic and terrestrial environments of the Rillito River and tributaries.

Pearthree and Baker (1987) concluded that the Rillito River system has been irreversibly altered by human intervention, and a return to natural characteristics is impossible due to the following reasons: 1) groundwater overdraft has so lowered the water table that the stabilizing influence of riparian vegetation has been lost, 2) urbanization has reduced the influx of sediments from tributaries into the main channels while increasing the influx of water from individual storms, and 3) channels have been constricted by constricted by bridges, bank fillings, bank stabilization and channelization measures. However, we believe that the Corps and County should not entirely dismiss the possibility of restoring some level of natural function to this system.

The Service encourages non-structural solutions to flood control, such as those described in Alternative 2. We believe rights-of-way and buffers along the banks and within the floodplain and flood prone area would be the best methods by which to prevent additional flood damages while preserving the functional capacity of the existing riparian ecosystems. Restoration and enhancement of riparian vegetation should be seriously considered and evaluated. Opportunities to provide supplemental water to sustain riparian vegetation sufficient to provide natural bank stabilization should be considered. We understand the Corps is pursuing restoration projects along the Rillito River. We look forward to the realization of habitat restoration within the Rillito River system.

We are concerned about the cumulative effects of past and present Corps projects within and around the Rillito River system, including cost-share projects and section 404 permitted projects. In our August 13, 1985, review of the draft survey report and finding of no significant impact (FONSI) for the RRAS project we indicated that we believed the environmental effects were significant enough to make a FONSI inappropriate, especially since no mitigation had been provided. In our subsequent December 16, 1985, FWCA report on the RRAS project we

recommended several measures to mitigate the loss of wildlife habitat, the most significant of which included land acquisition and preserving and restoring native riparian vegetation. We believe those actions remain appropriate and should be a shared federal and local sponsor responsibility. However, we are not aware of the current state of mitigation and are concerned about the further degradation of the Rillito River system, particularly the unique biological area at the confluence of Tanque Verde Creek and Pantano Wash. For these reasons we encourage the preparation of a supplemental environmental assessment to specifically address the cumulative impacts of the RRAS project and other channel modification, bank stabilization, and development along the Rillito River system. The cumulative impact analysis should address the totality of environmental impacts, including direct, indirect, secondary, and cumulative effects.

RECOMMENDATIONS

1) The Corps should continue to place emphasis on the use of non-structural methods to address flood control and flood-related problems. The Corps participation should be contingent upon acquisition and preservation of the buffer described in alternative 2.

2) Investigations should be conducted to evaluate opportunities to enhance and restore the physical, chemical, and biological functions of the Rillito River system; including restoration of natural hydrogeomorphic processes, preservation of existing riparian vegetation, re-planting of native riparian vegetation, and supplemental watering to ensure survival and growth.

3) A supplemental environmental assessment to specifically address the cumulative impacts of the RRAS project and other development on the Rillito River system should be prepared.

We appreciate the opportunity to review and provide recommendations for the Tanque Verde Bank Stabilization Project. If we can be of further assistance or you have questions, please contact Mike Martinez at (602)640-2720, x224.

Sincerely,

David L. Harlow
Field Supervisor

cc: Supervisor, Project Evaluation Program, Arizona Game and Fish Department, Phoenix, AZ

LITERATURE CITED

Brown, D.E. 1994. Biotic Communities: southwestern United States and northwestern Mexico. University of Utah Press.

Pearthree, M.S. and V.R. Baker. 1987. Channel change along the Rillito Creek System of Southeastern Arizona, 1941 through 1983. Implications for flood-plain management. Special Paper 6. Arizona Bureau of Geology and Mineral Technology Geological Survey Branch.

Ruffner, G.A., M.M. Sharp, R. A. Johnson, N.J. Brian. 1983. An assessment of the biological resources of Airport Wash, Rillito River and Associated Streams Project in Pima County.

Tetra Tech Inc., Infrastructure Southwest Group. 1999. Tanque Verde Creek, Craycroft Road to Sabino Road bank protection and riparian preserve project lateral migration analysis. Prepared for U.S. Army Corps of Engineers. May, 1999.

U.S. Army Corps of Engineers. 1998. Tanque Verde Creek, Pima County, Arizona. Limited Reevaluation Report. Los Angeles District, Planning Division, Water Resources Branch. September 1998.

U.S. Army Corps of Engineers. 1992. Design memorandum. Rillito River, Tucson, Arizona, Bank Protection. Los Angeles District. October 1992.

U.S. Army Corps of Engineers. 1986. Survey report and environmental assessment. Rillito River and Associated Streams, Tucson, Arizona. Los Angeles District. May 1986.

Westland Resources, Inc. Memorandum regarding Cactus Ferruginous Pygmy-Owl survey - Tanque Verde Creek Project. August 20, 1999.

APPENDIX B-3
USFWS THREATENED AND ENDANGERED SPECIES LIST

United States Department of the Interior
Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 W. Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
(602) 640-2720 Fax (602) 640-2730

In Reply Refer To:
AESO/SE
2-21-98-I-338
[CCN 980993]

August 5, 1998

Mr. Robert S. Joe
Chief, Planning Division
Corps of Engineers, LA District
P.O. Box 532711
Los Angeles, California 90053-2325

RE: EA for Proposed Bank Protection on Tanque Verde Creek (Craycroft and Sabino Canyon Roads), Tucson, Arizona

Dear Mr. Joe:

This letter responds to your July 16, 1998, request for an inventory of threatened or endangered species, or those that are proposed to be listed as such under the Endangered Species Act of 1973, as amended (Act), which may potentially occur in your project area (Pima County). The enclosed list may include candidate species as well. We hope the enclosed county list of species will be helpful. In future communications regarding this project, please refer to consultation number 2-21-98-I-338.

Please be aware that you may also access limited county species lists for Arizona on our internet web site at the following:

http://ifw2es.fws.gov/endspcs/lists/

The enclosed list of the endangered, threatened, proposed, and candidate species includes all those potentially occurring anywhere in the county, or counties, where your project occurs. Please note that your project area may not necessarily include all or any of these species. The information provided includes general descriptions, habitat requirements, and other information for each species on the list. Also on the enclosed list is the Code of Federal Regulations (CFR) citation for each listed or proposed species. Additional information can be found in the CFR and is available at most public libraries. This information should assist you in determining which species may or may not occur within your project area. Site-specific surveys could also be helpful and may be needed to verify the presence or absence of a species or its habitat as required for the evaluation of proposed project-related impacts.

Endangered and threatened species are protected by Federal law and must be considered prior to project development. If the action agency determines that listed species or critical habitat may be adversely affected by a federally funded, permitted, or authorized activity, the action agency

must request formal consultation with the Service. If the action agency determines that the planned action may jeopardize a proposed species or destroy or adversely modify proposed critical habitat, the action agency must enter into a section 7 conference with the Service. Candidate species are those which are being considered for addition to the list of threatened or endangered species. Candidate species are those for which there is sufficient information to support a proposal for listing. Although candidate species have no legal protection under the Act, we recommend that they be considered in the planning process in the event that they become listed or proposed for listing prior to project completion.

If any proposed action occurs in or near areas with trees and shrubs growing along watercourses, known as riparian habitat, the Service recommends the protection of these areas. Riparian areas are critical to biological community diversity and provide linear corridors important to migratory species. In addition, if the project will result in the deposition of dredged or fill materials into waterways or excavation in waterways, we recommend you contact the Army Corps of Engineers which regulates these activities under Section 404 of the Clean Water Act.

The State of Arizona protects some plant and animal species not protected by Federal law. We recommend you contact the Arizona Game and Fish Department and the Arizona Department of Agriculture for State-listed or sensitive species in your project area.

The Service appreciates your efforts to identify and avoid impacts to listed and sensitive species in your project area. If we may be of further assistance, please contact Tom Gatz.

Sincerely,

Tom Gatz
Acting Field Supervisor

Enclosure

cc: Director, Arizona Game and Fish Department, Phoenix, AZ

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **PIMA**

4/9/98

LISTED TOTAL= 18

NAME: **HUACHUCA WATER UMBEL** *LILAEOPSIS SCHAFFNERIANA ssp RECURVA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 62 FR 665, 01-06-97

DESCRIPTION: HERBACEOUS, SEMI-AQUATIC PERENNIAL IN THE PARSLEY FAMILY (UMBELLIFERAE) WITH SLENDER ERECT, HOLLOW, LEAVES THAT GROW FROM THE NODES OF CREEPING RHIZOMES. FLOWER: 3 TO 10 FLOWERED UMBELS ARISE FROM ROOT NODES.

ELEVATION RANGE: 3500-6500 FT.

COUNTIES: PIMA, SANTA CRUZ, COCHISE

HABITAT: CIENEGAS, PERENNIAL LOW GRADIENT STREAMS, WETLANDS

AND IN ADJACENT SONORA, MEXICO, WEST OF THE CONTINENTAL DIVIDE. POPULATIONS ALSO ON FORT HUACHUCA MILITARY RESERVATION.

NAME: **KEARNEY'S BLUE STAR** *AMSONIA KEARNEYANA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 54 FR 2131, 01-19-1989

DESCRIPTION: A HERBACEOUS PERENNIAL IN THE DOGBANE FAMILY (APOCYNACEAE). THICKENED WOODY ROOT AND MANY PUBESCENT (HAIRY) STEMS THAT RARELY BRANCH. FLOWERS:WHITE TERMINAL INFLORESCENCE IN APRIL & MAY.

ELEVATION RANGE: 3600-3800 FT.

COUNTIES: PIMA

HABITAT: WEST-FACING DRAINAGES IN THE BABOQUIVARI MOUNTAINS.

PLANTS GROW IN STABLE, PARTIALLY SHADED, COARSE ALLUVIUM ALONG A DRY WASH IN THE BABOQUIVARI MOUNTAINS. RANGE IS EXTREMELY LIMITED. PROTECTED BY ARIZONA NATIVE PLANT LAW.

NAME: **NICHOL'S TURK'S HEAD CACTUS** *ECHINOCACTUS HORIZONTHALONIUS VAR NICHOLII*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 44 FR 61927, 10-26-1979

DESCRIPTION: BLUE-GREEN TO YELLOWISH-GREEN, COLUMNAR, 18 INCHES TALL, 8 INCHES IN DIAMETER. SPINE CLUSTERS HAVE 5 RADIAL & 3 CENTRAL SPINES; ONE DOWNWARD SHORT; 2 SPINES UPWARD AND RED OR BASALLY GRAY. FLOWER:PINK FRUIT:WOOLLY WHITE

ELEVATION RANGE: 2400-4100 FT.

COUNTIES: PINAL, PIMA, YUMA

HABITAT: SONORAN DESERTSCRUB

FOUND IN UNSHADED MICROSITES IN SONORAN DESERTSCRUB ON DISSECTED ALLUVIAL FANS AT THE FOOT OF LIMESTONE MOUNTAINS AND ON INCLINED TERRACES AND SADDLES ON LIMESTONE MOUNTAINSIDES.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **PIMA**

4/9/98

NAME: **PIMA PINEAPPLE CACTUS** *CORYPHANTHA SCHEERI ROBUSTISPINA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 57 FR 14374, 04-20-1992

DESCRIPTION: HEMISHPERICAL STEMS 4-7 INCHES TALL 3-4 INCHES DIAMETER. CENTRAL SPINE 1 INCH LONG STRAW COLORED HOOKED SURROUNDED BY 6-15 RADIAL SPINES. FLOWER: YELLOW SALMON OR RARELY WHITE NARROW FLORAL TUBE.

ELEVATION RANGE: 2300-5000 FT.

COUNTIES: PIMA, SANTA CRUZ

HABITAT: SONORAN DESERTSCRUB OR SEMI-DESERT GRASSLAND COMMUNITIES

OCCURS IN ALLUVIAL VALLEYS OR ON HILLSIDES IN ROCKY TO SANDY OR SILTY SOILS. THIS SPECIE CAN BE CONFUSED WITH JUVENILLE BARREL CACTUS (FEROCACTUS). HOWEVER, THE SPINES OF THE LATER ARE FLATTENED, IN CONTRAST WITH THE ROUND CROSS-SECTION OF THE CORYPHANTHA SPINES. ALSO THE AREOLES (SPINE CLUSTERS) OF CORYPHANTHA ARE ON TUBERCULES (BUMPS), WHILE THE AREOLES OF FEROCACTUS ARE ON RIDGES (RIBS).

NAME: **JAGUAR, UNITED STATES POPULATION** *PANTHERA ONCA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 62 FR 39147, 7-22-97

DESCRIPTION: MUSCULAR CAT WITH RELATIVELY SHORT, MASSIVE LIMBS AND A DEEP-CHESTED BODY. CINNAMON-BUFF IN COLOR WITH BLACK SPOTS.

ELEVATION RANGE: <8000 FT.

COUNTIES: COCHISE, PIMA, SANTA CRUZ

HABITAT: IN ARIZONA, RANGED WIDELY THROUGHOUT A VARIETY OF HABITATS FROM SONORAN DESERT TO CONIFER FORESTS

MOST RECORDS ARE FROM THE MADREAN EVERGREEN-WOODLAND, SHRUB-INVADED SEMI-DESERT GRASSLAND, AND ALONG RIVERS. HISTORIC RANGE IS CONSIDERED TO HAVE EXTENDED BEYOND THE COUNTIES LISTED ABOVE. REPORTS OF INDIVIDUALS IN THE SOUTHERN PART OF THE STATE CONTINUE TO BE RECEIVED. THE MOST RECENT RECORDS OF A JAGUAR IN THE U.S. ARE FROM THE NEW MEXICO/ARIZONA BORDER AREA AND IN SOUTHCENTRAL ARIZONA, BOTH IN 1996, AND CONFIRMED THROUGH PHOTOGRAPHS. UNCONFIRMED SIGHTINGS AND TRACKS CONTINUE TO BE REPORTED.

NAME: **JAGUARUNDI** *FELIS YAGOUAROUNDI TOLTECA*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 41 FR 24064; 06-14-76

DESCRIPTION: SMALL CAT WITH SHORT LEGS; SLENDER,ELONGATE BODY; AND LONG TAIL. HEAD SMALL & FLATTENED WITH SHORT ROUNDED EARS. REDDISH-YELLOW OR BLACKISH TO BROWN-GRAY IN COLOR AND WITHOUT SPOTS.

ELEVATION RANGE: 3500-6000 FT.

COUNTIES: SANTA CRUZ, PIMA, COCHISE

HABITAT: CAN BE FOUND IN A VARIETY OF HABITATS (SEE BELOW)

SEMI-ARID THORNY FORESTS, DECIDOUS FORESTS, HUMID PRE-MONTANE FORESTS, UPLAND DRY SAVANNAHS, SWAMPY GRASSLANDS, RIPARIAN AREAS, AND DENSE BRUSH. UNCONFIRMED REPORTS OF INDIVIDUALS IN THE SOUTHERN PART OF THE STATE CONTINUE TO BE RECEIVED. NO SPECIMENS HAVE BEEN COLLECTED IN ARIZONA.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **PIMA**

4/9/98

NAME: **LESSER LONG-NOSED BAT** *LEPTONYCTERIS CURASOAE YERBABUENAE*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 53 FR 38456, 09-30-88

DESCRIPTION: ELONGATED MUZZLE, SMALL LEAF NOSE, AND LONG TONGUE. YELLOWISH BROWN OR GRAY ABOVE AND CINNAMON BROWN BELOW. TAIL MINUTE AND APPEARS TO BE LACKING. EASILY DISTURBED.

ELEVATION RANGE: <6000 FT.

COUNTIES: COCHISE, PIMA, SANTA CRUZ, GRAHAM, PINAL, MARICOPA

HABITAT: DESERT SCRUB HABITAT WITH AGAVE AND COLUNMNAR CACTI PRESENT AS FOOD PLANTS

DAY ROOSTS IN CAVES AND ABANDONED TUNNELS. FORAGES AT NIGHT ON NECTAR, POLLEN, AND FRUIT OF PANICULATE AGAVES AND COLUMNAR CACTI. THIS SPECIES IS MIGRATORY AND IS PRESENT IN ARIZONA , USUALLY FROM APRIL TO SEPTMBER AND SOUTH OF THE BORDER THE REMAINDER OF THE YEAR.

NAME: **MEXICAN GRAY WOLF** *CANIS LUPUS BAILEYI*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-67; 43 FR 1912, 03-09-78

DESCRIPTION: LARGE DOG-LIKE CARNIVORE WITH VARYING COLOR, BUT USUALLY A SHADE OF GRAY. DISTINCT WHITE LIP LINE AROUND MOUTH. WEIGH 60-90 POUNDS.

ELEVATION RANGE: 4,000-12,00IFT.

COUNTIES: APACHE, COCHISE, GREENLEE, PIMA, SANTA CRUZ

HABITAT: CHAPPARAL, WOODLAND, AND FORESTED AREAS. MAY CROSS DESERT AREAS.

HISTORIC RANGE IS CONSIDERED TO BE LARGER THAN THE COUNTIES LISTED ABOVE. UNCONFIRMED REPORTS OF INDIVIDUALS IN THE SOUTHERN PART OF THE STATE (COCHISE, PIMA, SANTA CRUZ) CONTINUE TO BE RECEIVED. INDIVIDUALS MAY STILL PERSIST IN MEXICO. EXPERIMENTAL NONESSENTIAL POPULATION INTRODUCED IN THE BLUE PRIMITIVE AREA OF GREENLEE AND APACHE COUNTIES.

NAME: **OCELOT** *FELIS PARDALIS*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 47 FR 31670; 07-21-82

DESCRIPTION: MEDIUM-SIZED SPOTTED CAT WHOSE TAIL IS ABOUT 1/2 THE LENGTH OF HEAD AND BODY. YELLOWISH WITH BLACK STREAKS AND STRIPES RUNNING FROM FRONT TO BACK. TAIL IS SPOTTED AND FACE IS LESS HEAVILY STREAKED THAN THE BACK AND SIDES.

ELEVATION RANGE: <8000 FT.

COUNTIES: SANTA CRUZ, PIMA, COCHISE

HABITAT: HUMID TROPICAL & SUB-TROPICAL FORESTS, SAVANNAHS, AND SEMI-ARID THORNSCRUB.

MAY PERSIST IN PARTLY-CLEARED FORESTS, SECOND-GROWTH WOODLAND, AND ABANDONED CULTIVATION REVERTED TO BRUSH. UNIVERSAL COMPONENT IS PRESENCE OF DENSE COVER. UNCONFIRMED REPORTS OF INDIVIDUALS IN THE SOUTHERN PART OF THE STATE CONTINUE TO BE RECEIVED.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **PIMA**

4/9/98

NAME: **SONORAN PRONGHORN** *ANTILOCAPRA AMERICANA SONORIENSIS*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-67

DESCRIPTION: BUFF ON BACK AND WHITE BELOW, HOOFED WITH SLIGHTLY CURVED BLACK HORNS HAVING A SINGLE PRONG. SMALLEST AND PALEST OF THE PRONGHORN SUBSPECIES.

ELEVATION RANGE: 2000-4000 FT.

COUNTIES: PIMA, YUMA, MARICOPA

HABITAT: BROAD, INTERMOUNTAIN ALLUVIAL VALLEYS WITH CREOSOTE-BURSAGE & PALO VERDE-MIXED CACTI ASSOCIATIONS

TYPICALLY, BAJADAS ARE USED AS FAWNING AREAS AND SANDY DUNE AREAS PROVIDE FOOD SEASONALLY. HISTORIC RANGE WAS PROBABLY LARGER THAN EXISTS TODAY. THIS SUBSPECIES ALSO OCCURS IN MEXICO.

NAME: **DESERT PUPFISH** *CYPRINODON MACULARIUS*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 51 FR 10842, 03-31-1986

DESCRIPTION: SMALL (2 INCHES) SMOOTHLY ROUNDED BODY SHAPE WITH NARROW VERTICAL BARS ON THE SIDES. BREEDING MALES BLUE ON HEAD AND SIDES WITH YELLOW ON TAIL. FEMALES & JUVENILES TAN TO OLIVE COLORED BACK AND SILVERY SIDES.

ELEVATION RANGE: <5000 FT.

COUNTIES: LA PAZ, PIMA, GRAHAM, MARICOPA, PINAL, YAVAPAI, SANTA CRUZ

HABITAT: SHALLOW SPRINGS, SMALL STREAMS, AND MARSHES. TOLERATES SALINE & WARM WATER

CRITICAL HABITAT INCLUDES QUITOBAQUITO SPRING, PIMA COUNTY, PORTIONS OF SAN FELIPE CREEK, CARRIZO WASH, AND FISH CREEK WASH, IMPERIAL COUNTY, CALIFORNIA. TWO SUBSPECIES ARE RECOGNIZED: DESERT PUPFISH (C. m. macularis) AND QUITOBAQUITO PUPFISH (C. m. eremus).

NAME: **GILA TOPMINNOW** *POECILIOPSIS OCCIDENTALIS OCCIDENTALIS*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: Yes CFR: 32 FR 4001, 03-11-1967

DESCRIPTION: SMALL (2 INCHES), GUPPY-LIKE, LIVE BEARING, LACKS DARK SPOTS ON ITS FINS. BREEDING MALES ARE JET BLACK WITH YELLOW FINS.

ELEVATION RANGE: <4500 FT.

COUNTIES: GILA, PINAL, GRAHAM, YAVAPAI, SANTA CRUZ, PIMA, MARICOPA, LA PAZ

HABITAT: SMALL STREAMS, SPRINGS, AND CIENEGAS VEGETATED SHALLOWS

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **PIMA**

4/9/98

NAME: **AMERICAN PEREGRINE FALCON** *FALCO PEREGRINUS ANATUM*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 35 FR 16047, 10-13-70; 35 FR 8495, 06-02-70

DESCRIPTION: A RECLUSIVE, CROW-SIZED FALCON SLATY BLUE ABOVE WHITISH BELOW WITH FINE DARK BARRING. THE HEAD IS BLACK AND APPEARS TO BE MASKED OR HELMETED. WINGS LONG AND POINTED. LOUD WAILING CALLS ARE GIVEN DURING BREEDING PERIOD.

ELEVATION RANGE: 3500-9000 FT.

COUNTIES: MOHAVE COCONINO NAVAJO APACHE SANTA CRUZ MARICOPA COCHISE YAVAPAI GILA PINAL PIMA GREENLEE GRAHAM

HABITAT: CLIFFS AND STEEP TERRAIN USUALLY NEAR WATER OR WOODLANDS WITH ABUNDANT PREY

THIS IS A WIDE-RANGING MIGRATORY BIRD THAT USES A VARIETY OF HABITATS. BREEDING BIRDS ARE YEAR-ROUND RESIDENTS. OTHER BIRDS WINTER AND MIGRATE THROUGH ARIZONA. SPECIES IS ENDANGERED FROM REPRODUCTIVE FAILURE FROM PESTICIDES.

NAME: **BALD EAGLE** *HALIAEETUS LEUCOCEPHALUS*

STATUS: THREATENED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 60 FR 35999, 07-12-95

DESCRIPTION: LARGE, ADULTS HAVE WHITE HEAD AND TAIL. HEIGHT 28 - 38"; WINGSPAN 66 - 96". 1-4 YRS DARK WITH VARYING DEGREES OF MOTTLED BROWN PLUMAGE. FEET BARE OF FEATHERS.

ELEVATION RANGE: VARIES FT.

COUNTIES: YUMA, LA PAZ, MOHAVE, YAVAPAI, MARICOPA, PINAL, COCONINO, NAVAJO, APACHE, SANTA CRUZ, PIMA, GILA, GRAHAM

HABITAT: LARGE TREES OR CLIFFS NEAR WATER (RESERVOIRS, RIVERS AND STREAMS) WITH ABUNDANT PREY

SOME BIRDS ARE NESTING RESIDENTS WHILE A LARGER NUMBER WINTERS ALONG RIVERS AND RESERVOIRS. AN ESTIMATED 200 TO 300 BIRDS WINTER IN ARIZONA. ONCE ENDANGERED (32 FR 4001, 03-11-1967; 43 FR 6233, 02-14-78) BECAUSE OF REPRODUCTIVE FAILURES FROM PESTICIDE POISONING AND LOSS OF HABITAT, THIS SPECIES WAS DOWN LISTED TO THREATENED ON AUGUST 11, 1995. ILLEGAL SHOOTING, DISTURBANCE, LOSS OF HABITAT CONTINUES TO BE A PROBLEM.

NAME: **CACTUS FERRUGINOUS PYGMY-OWL** *GLAUCIDIUM BRASILIANUM CACTORUM*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 62 FR 10730, 3-10-97

DESCRIPTION: SMALL (APPROX. 7"), DIURNAL OWL REDDISH BROWN OVERALL WITH CREAM-COLORED BELLY STREAKED WITH REDDISH BROWN. SOME INDIVIDUALS ARE GRAYISH BROWN

ELEVATION RANGE: <4000 FT.

COUNTIES: MARICOPA, YUMA, SANTA CRUZ, GRAHAM, GREENLEE, PIMA, PINAL, GILA

HABITAT: MATURE COTTONWOOD/WILLOW, MESQUITE BOSQUES, AND SONORAN DESERTSCRUB

RANGE LIMIT IN ARIZONA IS FROM NEW RIVER (NORTH) TO GILA BOX (EAST) TO CABEZA PRIETA MOUNTAINS (WEST). ONLY A FEW DOCUMENTED SITES WHERE THIS SPECIES PERSISTS ARE KNOWN, ADDITIONAL SURVEYS ARE NEEDED. LISTING EFFECTIVE APRIL 9, 1997.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: PIMA

4/9/98

NAME: **MASKED BOBWHITE** *COLINUS VIRGINIANUS RIDGEWAYI*

STATUS: ENDANGERED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 35 FR 4001, 03-11-1967; 35 FR 8495, 06-02-70

DESCRIPTION: MALES BRICK-RED BREAST AND BLACK HEAD AND THROAT. FEMALES ARE GENERALLY NONDESCRIPT BUT RESEMBLE OTHER RACES SUCH AS THE TEXAS BOBWHITE.

ELEVATION RANGE: 1000-4000 FT.

COUNTIES: PIMA

HABITAT: DESERT GRASSLANDS WITH DIVERSITY OF DENSE NATIVE GRASSES, FORBS AND BRUSH

SPECIES IS CLOSELY ASSOCIATED WITH ACACIA ANGUSTISSIMA. FORMERLY OCCURRED IN ALTAR AND SANTA CRUZ VALLEYS, AS WELL AS SONORA, MEXICO. PRESENTLY ONLY KNOWN FROM REINTRODUCED POPULATION ON BUENOS AIRES.

NAME: **MEXICAN SPOTTED OWL** *STRIX OCCIDENTALIS LUCIDA*

STATUS: THREATENED CRITICAL HAB No RECOVERY PLAN: Yes CFR: 56 FR 14678, 04-11-91

DESCRIPTION: MEDIUM SIZED WITH DARK EYES AND NO EAR TUFTS. BROWNISH AND HEAVILY SPOTTED WITH WHITE OR BEIGE.

ELEVATION RANGE: 4100-9000 FT.

COUNTIES: MOHAVE, COCONINO, NAVAJO, APACHE, YAVAPAI, GRAHAM, GREENLEE, COCHISE, SANTA CRUZ, PIMA, PINAL, GILA, MARICOPA

HABITAT: NESTS IN CANYONS AND DENSE FORESTS WITH MULTI-LAYERED FOLIAGE STRUCTURE

GENERALLY NESTS IN OLDER FORESTS OF MIXED CONIFER OR PONDERSA PINE/GAMBEL OAK TYPE, IN CANYONS, AND USE VARIETY OF HABITATS FOR FORAGING. SITES WITH COOL MICROCLIMATES APPEAR TO BE OF IMPORTANCE OR ARE PREFERED.

NAME: **SOUTHWESTERN WILLOW FLYCATCHER** *EMPIDONAX TRAILLII EXTIMUS*

STATUS: ENDANGERED CRITICAL HAB Yes RECOVERY PLAN: No CFR: 60 FR 10694, 02-27-95

DESCRIPTION: SMALL PASSERINE (ABOUT 6") GRAYISH-GREEN BACK AND WINGS, WHITISH THROAT, LIGHT OLIVE-GRAY BREAST AND PALE YELLOWISH BELLY. TWO WINGBARS VISIBLE. EYE-RING FAINT OR ABSENT.

ELEVATION RANGE: <8500 FT.

COUNTIES: YAVAPAI, GILA, MARICOPA, MOHAVE, COCONINO, NAVAJO, APACHE, PINAL, LA PAZ, GREENLEE, GRAHAM, YUMA, PIMA, COCHISE, SANTA CRUZ

HABITAT: COTTONWOOD/WILLOW & TAMARISK VEGETATION COMMUNITIES ALONG RIVERS & STREAMS

MIGRATORY RIPARIAN OBLIGATE SPECIES THAT OCCUPIES BREEDING HABITAT FROM LATE APRIL TO SEPTEMBER. DISTRIBUTION WITHIN ITS RANGE IS RESTRICTED TO RIPARIAN CORRIDORS. DIFFICULT TO DISTINGUISH FROM OTHER MEMBERS OF THE EMPIDONAX COMPLEX BY SIGHT ALONE. TRAINING SEMINAR REQUIRED FOR THOSE CONDUCTING FLYCATCHER SURVEYS. CRITICAL HABITAT ON PORTIONS OF THE 100-YEAR FLOODPLAIN ON SAN PEDRO AND VERDE RIVERS; WET BEAVER AND WEST CLEAR CREEKS, INCLUDING TAVASCI MARSH AND ISTER FLAT; THE COLORADO RIVER, THE LITTLE COLORADO RIVER, AND THE WEST, EAST, AND SOUTH FORKS OF THE LITTLE COLORADO RIVER, REFERENCE 60 CFR:62 FR 39129, 7/22/97.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: PIMA

4/9/98

PROPOSED TOTAL= 1

NAME: **SAN XAVIER TALUSSNAIL** *SONORELLA EREMITA*

STATUS: PROPOSED ENDANGERED CRITICAL HAB No RECOVERY PLAN: No CFR: 56 FR 13691, 03-23-1994

DESCRIPTION: LESS THAN ONE INCH (AVE 19 MM), LIGHT BROWN, PILL SHAPED, DARK STRIPE ENCIRCLES OUTER PERIMETER

ELEVATION RANGE: 3850 - 3920 FT.

COUNTIES: PIMA

HABITAT: LIMESTONE TALUS ON NORTHSIDE OF A SINGLE HILL.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: PIMA

4/9/98

CANDIDATE TOTAL= 5

NAME: **ACUNA CACTUS** *ECHINOMASTUS ERECTOCENTRUS ACUNENSIS*

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: <12 INCHES HIGH SPINE CLUSTERS BORNE ON TUBERCLES, EACH WITH A GROOVE ON THE UPPER SURFACE. 2-3 CENTRAL SPINES AND 12 RADIAL SPINES. FLOWERS PINK TO PURPLE

ELEVATION RANGE: 1300-2000 FT.

COUNTIES: PINAL, PIMA

HABITAT: WELL DRAINED KNOLLS AND GRAVEL RIDGES IN SONORAN DESERT SCRUB

IMMATURE PLANTS DISTINCTLY DIFFERENT FROM MATURE PLANTS. THEY ARE DISC-SHAPED OR SPHERICAL AND HAVE NO CENTRAL SPINES UNTIL THEY ARE ABOUT 1.5 INCHES . RADIAL SPINES ARE DIRTY WHITE WITH MAROON TIPS.

NAME: **GILA CHUB** *GILA INTERMEDIA*

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: DEEP COMPRESSED BODY, FLAT HEAD. DARK OLIVE-GRAY COLOR ABOVE, SILVER SIDES. ENDEMIC TO GILA RIVER BASIN.

ELEVATION RANGE: 2000 - 3500 FT.

COUNTIES: SANTA CRUZ, GILA, GREENLEE, PIMA, COCHISE, GRAHAM, YAVAPAI

HABITAT: POOLS, SPRINGS, CIENEGAS, AND STREAMS

MULTIPLE PRIVATE LANDOWERS, INCLUDING THE NATURE CONSERVANCY, THE AUDUBON SOCIETY, AND OTHERS. ALSO FT. HUACHUCA. SPECIES ALSO FOUND IN SONORA, MEXICO.

NAME: **SONOYTA MUD TURTLE** *KINOSTERNON SONORIENSE LONGIFEMORALE*

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: PRIMARILY A POND TURTLE, PREFERS MUD OR SANDY BOTTOMS. BODY 3 1/2 TO 6 1/2. HEAD AND NECK MOTTLED WITH CONTRASTING LIGHT AND DARK MARKINGS. FOUND IN QUITOBAQUITO SPRINGS.

ELEVATION RANGE: 1,100 FEET FT.

COUNTIES: PIMA

HABITAT: PONDS AND STREAMS.

SPECIES ALSO FOUND IN RIO SONOYTA, SONORA, MEXICO.

LISTED, PROPOSED, AND CANDIDATE SPECIES FOR THE FOLLOWING COUNTY: **PIMA**

4/9/98

NAME: **MOUNTAIN PLOVER** *CHARADRIUS MONTANUS*

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: WADING BIRD; COMPACTLY BUILT; iIN BREEDING SEASON WITH WHITE FOREHEAD AND LINE OVER THE EYE; CONTRASTING WITH DARK CROWN; NONDESCRIPT IN WINTER. VOICE IS LOW, VARIABLE WHISTLE. ELEVATION RANGE: 0 FT.

COUNTIES: YUMA, SANTA CRUZ, PIMA, COCHISE

HABITAT: OPEN ARID PLAINS, SHORT-GRASS PRAIRIES, AND SCATTERED CACTUS.

NAME: **CHIRICAHUA LEOPARD FROG** *RANA CHIRICAHUENSIS*

STATUS: CANDIDATE CRITICAL HAB No RECOVERY PLAN: No CFR:

DESCRIPTION: CREAM COLORED TUBERCULES (spots) ON A DARK BACKGROUND ON THE REAR OF THE THIGH, DORSOLATERAL FOLDS THAT ARE INTERRUPTED AND DEFLECTED MEDIALLY, AND A CALL GIVEN OUT OF WATER DISTINGUISH THIS SPOTTED FROG FROM OTHER LEOPRD ELEVATION RANGE: 3000-8300 FT.

COUNTIES: SANTA CRUZ, APACHE, GILA, PIMA, COCHISE, GREENLEE, GRAHAM, YAVAPAI, COCONINO, NAVAJO

HABITAT: STREAMS, RIVERS, BACKWATERS, PONDS, AND STOCK TANKS THAT ARE FREE FROM INTRODUCED FISH AND BULLFROGS

REQUIRE PERMANENT OR NEARLY PERMANENT WATER SOURCES. POPULATIONS NORTH OF THE GILA RIVER ARE THOUGHT TO BE CLOSELY-RELATED, BUT DISTINCT, UNDESCRIBED SPECIES.

APPENDIX B-4
ARIZONA DEPARTMENT OF GAME AND FISH COMMENTS ON CAR

United States Department of the Interior
Fish and Wildlife Service
2321 W. Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951
(602) 640-2720 Fax (602) 640-2730

June 7, 2000

FACSIMILE TRANSMISSION

To: Lois Goodman, U.S. Army Corps of Engineers, (213) 452-4204

From: Mike A. Martinez

Re: AGFD comments on draft Tanque Verde report

Pages: 2 (including this page)

Comments:

FYI. These are the comments that the Arizona Game and Fish Department submitted on the draft FWCA report for the Tanque Verde Creek bank stabilization project. We have received the Corps' comments and I should have the report finalized shortly. If you have questions or additional information needs, or if there are problems with copy quality, please contact me at the above phone number or address. Thanks.

THE STATE OF ARIZONA

GAME & FISH DEPARTMENT

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February 18, 2000

Mr. David L. Harlow
Field Supervisor
U.S. Fish and Wildlife Service
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

Re: Draft Fish and Wildlife Coordination Act Report; U.S. Army Corps of Engineers; Tanque Verde Bank Stabilization Project in Pima County

Dear Mr. Harlow:

The Arizona Game and Fish Department (Department) has reviewed the draft Fish and Wildlife Coordination Act (FWCA) Report for the proposed Tanque Verde Bank Stabilization Project. This report was developed by the U.S. Fish and Wildlife Service (Service) pursuant to Section 2(b) of the FWCA, and provides the Service's recommendations for addressing adverse impacts to wildlife habitat as a result of the proposed bank stabilization project.

Overall, the Department agrees with the Service's analysis and recommendations. We would appreciate the opportunity to review the revised documents (e.g., Environmental Assessment, Limited Reevaluation Report) associated with this proposal before they are finalized. Thank you.

Sincerely,

John Kennedy
Project Evaluation Program Supervisor
Habitat Branch

cc: Joan Scott, Habitat Program Manager, Region V, Tucson

APPENDIX B-5: INCREMENTAL COST ANALYSIS AND HABITAT EVALUATION

Tanque Verde Creek
Incremental Cost Analysis and Habitat Evaluation (Modified HEP) for Biological Resources Mitigation Measures

I. INTRODUCTION

The purpose of this analysis is to provide information supporting the recommendations in the Environmental Assessment for biological resources mitigation measures. When mitigation is necessary, Corps regulations (ER 1105-2-100:7-35) require an incremental cost analysis of mitigation options. The purpose of this analysis is to compare mitigation options by cost and the amount of quantifiable units (e.g., Habitat Units, acres) that the mitigation replaces. This allows determination of the most cost-effective mitigation option or combination of options that best meet the mitigation goals.

An incremental cost analysis of a mitigation option's cost-effectiveness requires that resources impacted or lost due to implementation of the proposed action and resources gained from mitigation options be quantitatively estimated. The Corps has utilized a modified HEP analysis for this project to calculate Habitat Units (HUs) for existing conditions and for the Alternatives, including the No Action Alternative. The following analysis uses this modified HEP as a habitat-based method to characterize biological values of fish and wildlife habitat (mesquite bosque/desert riparian and desert wash) in the project area.

The modified HEP process documents the quality and quantity of available habitat for selected wildlife species and/or habitat elements associated with a project and its alternatives. The Habitat based analysis provides the information to compare both the relative values of different habitat areas at one point in time, and the relative values of the same areas at different target years during the life of the project. By combining the two types of comparisons, the impact of proposed or anticipated land and water use changes on wildlife habitat can be quantified.

The modified HEP Analysis that the Corps has adopted for this project emphasizes general habitat conditions rather than habitat requirements of target species to calculate HUs. Focusing on target species is difficult when appropriate habitat suitability models are not available. This modified HEP utilizes an ecosystem approach to calculate habitat values for the different project alternatives and mitigation options. A similar approach has been utilized for Corps projects in Alamo Lake in Arizona (USACE, 1996) and Cucamonga/Deer Creek in California (USACE, 2000), among others. In this case, habitat types (typically defined by dominant vegetation type) are selected and evaluated based on the quality and amount of habitat resources provided to wildlife. The highest attainable value, where the HSI=1.0, is the optimum habitat condition. It should be noted that the HSI may never reach 1.0 during the life of the project.

II. MITIGATION FORMULATION PROCESS

A. Mitigation Goals: The following mitigation objectives were developed for the resources that would be affected:

1. Avoidance and minimization of impacts are preferable to other mitigation measures.
2. Where impacts are unavoidable, the overall goal is to mitigate fully (100% mitigation) the expected project-related significant impacts to significant resources.
3. In-kind mitigation for losses of most habitat types.
4. No net loss of habitat value.

B. Habitat-based Evaluation of Impacts and Mitigation: A Modified HEP analysis was used to evaluate the alternatives and to determine mitigation requirements as described below. Calculations of Habitat outputs (habitat units or HUs) in the Modified HEP analysis are shown in Tables 1.1.1 through 1.4.3.

In order to perform the incremental analysis, a habitat-based analysis was used to give a numerical value to biological resources of concern. The procedure used was based roughly on the U.S. Fish and Wildlife Service (FWS) Habitat Evaluation Procedure (HEP). HEP is a formal process whereby tested habitat suitability models for certain species are used which direct the measurement of certain habitat variables for the selected species, (e.g., percent of canopy cover, number of snag trees, stream temperature, percent ground cover, etc.). In the modified HEP used for this evaluation, the selected variables were habitat-based, rather than species-based. For this analysis, all variables are weighted equally. Each variable is assigned a Suitability Index (SI), between 0.0 and 1.0, based on a comparison between field conditions and optimal conditions. The variables are combined, using a formula provided in the model, to obtain a Habitat Suitability Index (HSI). This is then used to obtain a numerical rating of habitat units. Because the number of available, applicable HEP models is limited, and resources to conduct a formal analysis were limited, HSIs and Habitat Units (HUs) for this project were estimated using a simplified model based on collected field data and observations, available literature, selected elements of HEP models, and professional judgment.

A numerical rating or HSI between 0.0 and 1.0 has been assigned to the habitat based on the average value of the variables. The HSI was then multiplied by the area, in acres, of the habitat to obtain the HUs for each habitat type for each alternative. Table 1 summarizes the HSIs, Acres, and HUs for each Alternative for the selected Target Years during the life of the project.

III. ASSESSMENT OF HABITAT IMPACTS/MODIFIED HEP ANALYSIS

A. In the simplified HEP model (see Tables1.1.1 through 1.4.2) for this project, the following variables (V1 through V4) were selected as indicative of overall habitat quality:

V1 = Wildlife Diversity.
V2 = Plant species and Vegetation diversity
V3 = Vegetation Structure and Cover
V4 = Water Availability/Hydrologic Conditions

For the purposes of this analysis, all variables are weighted equally. Refer to the attached tables (1.1.1 through 1.4.2) for the HSIs, and HUs for the different alternatives.

B. The habitats considered in this analysis are:

1. Desert Riparian/Mesquite Bosque. This habitat occurs both in the construction area (approximately 22 acres) and in the proposed preserve (approximately 48 acres).

2. Desert Wash. This habitat occurs in the construction area only. Desert wash is considered to consist of 8.0 acres for all alternatives, and includes those areas that will be excavated for placement of bank protection, covered with bank protection, or disturbed for access and toe-down.

C. HUs/Period of Analysis and Average Annual Habitat Units (AAHUs)

Habitat Units have been estimated at three points in time for each of the alternatives. T = 0 refers to the time immediately preceding construction, T = 5 refers to the time 5 years following construction, and T = 50 refers to the time 50 years following construction or the expected end of the project life. Habitat units were calculated for the period of analysis for each alternative and divided by 51 to obtain AAHUs. A period of 51 years is used to calculate HUs because the period of analysis begins at year 0 rather than year 1. (See HEP Tables 1.1.1 through 1.4.2 for HU calculations and the Habitat Outputs Summary, Table 2 for AAHUs. AAHUs are calculated as follows:

a. To calculate the total HU's over the first six (6) years (years 0-5) of the project, average the HUs at T=0 with HU's at T=5, and multiply X 6.
b. To calculate the total HUs over the remaining 45 years of the project, average the HUs at T=5 with HUs at T=50 and multiply X 45.
c. Add total HUs for the first 6 years with total HUs for the remaining 45 years to obtain HUs over the life of the project.
d. Divide total HUs by 51 to obtain AAHUs.

Alternative 1. No Action

a. Construction Area (Excluding Proposed Preserve Area)

Desert Riparian/Mesquite Bosque Habitat. HUs are expected to decrease slightly under future without project conditions the in construction area with no action. Fluctuations would occur, but the long-term trend will be toward a gradual loss of habitat value, possibly noticeable after about 5 years. The decline in habitat value will be due to unauthorized activities such as trespassing, vandalism, wood-cutting, and invasion by domestic animals. Habitat units are expected to decrease from the 15.13 HUs at T=0 to 12.65 HUs at T=50.

Desert Wash. The habitat values in the desert wash are expected to remain low. Habitat units are expected to fluctuate around 1.90 HUs from T=0 to T=50.

AAHUs. AAHUs in the construction area are calculated as 15.93 for the No Action Alternative (see Table 2).

b. Proposed Preserve Area

The assumption is that if no bank protection project is authorized in the remainder of the project area, the preserve area will remain undeveloped, but various forms of disturbance will occur that will reduce the habitat value over time. Use by domestic animals, limited agriculture, wood-cutting, trespassing, littering, fires, and erosion are some of the factors likely to affect habitat quality. Erosive forces are expected to convert portions of the mesquite bosque habitat to desert wash habitat. HUs are expected to decrease from 33.00 at T=0 to 8.10 at T=50. Most erosion and loss of habitat is likely to occur as a result of one or a few major flood events. For the purpose of this analysis, it assumed that the first major flood event will occur after year 5 and that the extent of lateral erosion will be the full 650 feet over the period of analysis as predicted in the Lateral Migration Analysis. Since all but the widest point of the proposed preserve area is 650 feet or less in width, the entire preserve is subject to lateral erosion. After a riparian area is scoured by erosive forces, it reverts to desert wash habitat. If the scoured area is free of major flood flows for several years, new riparian habitat will develop. The successional riparian habitat will have lower habitat suitability than the original riparian habitat, but higher values than desert wash. The composition of the vegetation will also change because it will be closer to the water table. Cottonwoods, and shrubs such as broom baccharis and burrobush will replace the mesquite and other species as dominants. Other native trees and large shrubs, such as palo verde and Mexican elderberry may become established if several years elapse between major flood events. Invasion by non-native species, especially salt cedar, is also to be expected. Calculations of habitat units between year 5 and year 50 of this analysis in the preserve area are based on the assumption that habitat will fluctuate between desert wash and desert riparian habitat, with an average of 50% of each type present during this period, and with a lower HSI value assigned to the successional riparian habitat than to the mesquite bosque. These assumptions apply to Alternatives 2 and 3, in addition to the No Action Alternative.

AAHUs. AAHUs in the proposed preserve area over the period of analysis are calculated at 24.53 for the No Action Alternative.

c. Combined Construction Area and Proposed Preserve Area. The combined AAHUs for the construction area and Proposed Preserve area = 40.46 for future without project conditions. (15.93 + 24.53 = 40.46). The mitigation goal for the Recommended Plan and other alternatives is to maintain the AAHUs at 40.46 or greater over the life of the project or period of analysis.

Alternative 2.

a. Construction area

Desert Riparian/Mesquite Bosque Habitat. HUs are expected to decrease from 15.13 at T=0 to 10.76 at T=50 as a result of the loss of surface water from Tanque Verde Creek on the north side due to soil cement bank protection, the direct removal of approximately 1 acre of habitat due to construction, and various disturbance-related activities including trespassing, vandalism, wood-cutting, and invasion by domestic animals

Desert Wash. Habitat units are expected to decrease from 1.90 at T=0 to 1.16 at T=50 in the Desert Wash habitat due to the permanent loss of habitat on the protected banks and the temporary loss of habitat in the access and toe-down areas.

AAHUs. AAHUs in the overall construction area (excluding the preserve area) are calculated as 13.80 for Alternative 2, or a net loss of 2.13 AAHUs when compared with the No Action Alternative (see Table 2).

b. Proposed Preserve Area (Acquired as Mitigation). If the preserve is acquired as mitigation with no bank protection, habitat units are expected to decrease from 33.00 at T=0 to 9.30 at T=50.

Acquisition and preservation of this 48-acre site would eliminate or reduce some of the potential sources of disturbance (domestic animals, limited agriculture, wood-cutting, trespassing, littering, and fires), but the potential for erosion remains. Removing the sources of disturbance will allow habitat values to increase between major storm events. As vegetation structure improves, additional wildlife will be attracted to the area. Due to the cumulative effects of channelization projects in the system, considerable loss of habitat due to bank erosion in the preserve area is anticipated over the life of the project as a result of major flood flows. Erosion (lateral migration) of the north bank would be limited to the northern boundary of the geologic flood plain; however, this encompasses almost the entire preserve area. After major floods, in which desert riparian habitat is lost, the habitat will revert back to desert wash, followed by partial recovery of riparian habitat. The new riparian habitat would be different in composition from the mesquite bosque, and would probably be dominated by cottonwoods and shrubs, possibly including the invasive salt cedar. As the channel widens due to erosion, the rate of lateral migration slows. Due to the potentially dynamic nature of the preserve area, for the purposes of this modified HEP analysis, it is estimated that at the end of the period of analysis, the 48-acre site would consist of 50% (24 acres) desert wash and 50% (24 acres) successional riparian habitat

AAHUs. AAHUs in the proposed preserve area are calculated at 25.06 for Alternative 2.

c. Combined Construction area and Proposed Preserve Area (Acquired as Mitigation). The combined AAHUs for the construction area and Proposed Preserve area = 38.86 for Alternative 2 (13.80 + 25.06 = 38.86).

The mitigation goal for the Recommended plan is to maintain a minimum of 40.46 AAHUs. With the preserve, a deficiency of 1.6 AAHUs remains. The 48-acre preserve is, therefore, not adequate mitigation for Alternative 2.

Alternative 3.

a. Construction area

Desert Riparian/Mesquite Bosque Habitat. HUs are expected to decrease from 15.13 at T=0 to 11.12 at T=50 as a result of the loss of surface water from Tanque Verde Creek on the north side due to soil cement bank protection, the direct removal of approximately 1 acre of habitat due to construction, and various disturbance-related activities including trespassing, vandalism, wood-cutting, and invasion by domestic animals

Desert Wash. Habitat units are expected to decrease from 1.90 at T=0 to 1.39 at T=50 in the Desert Wash habitat due to the permanent loss of habitat on the protected banks and the temporary loss of habitat in the access and toe-down areas.

AAHUs. AAHUs in the overall construction area are calculated as 14.41 for Alternative 3 (see Table 2).

b. Proposed Preserve Area (Acquired as Mitigation). If the preserve is acquired as mitigation with no bank protection, habitat units are expected to decrease from 33.00 at T=0 to 9.30 at T=50, the same as for Alternative 2. (See discussion for Alternative 2).

AAHUs. AAHUs in the proposed preserve area are calculated at 25.06, for Alternative 3, the same as for Alternative 2.

c. Combined Construction area and Proposed Preserve Area (Acquired as Mitigation). The combined AAHUs for the construction area and Proposed Preserve area = 39.47 for Alternative 3.

The mitigation goal for Alternative 3 is to maintain a minimum of 40.46 AAHUs. With the preserve, a deficiency of 0.99 AAHU remains. The 48-acre preserve is, therefore, not adequate mitigation for Alternative 3. In addition, Alternative 3 is not the Recommended Plan because it does not provide the required level of bank protection.

Alternative 4.

a. Construction area

Desert Riparian/Mesquite Bosque Habitat. HUs are expected to decrease from 15.13 at T=0 to 10.76 at T=50 as a result of the loss of surface water from Tanque Verde Creek on the north side due to soil cement bank protection, the direct removal of approximately 1 acre due to construction, and various disturbance-related activities including trespassing, vandalism, wood-cutting, and invasion by domestic animals

Desert Wash. Habitat units are expected to decrease from 1.90 at T=0 to 0.90 at T=50 in the Desert Wash habitat due to the permanent loss of habitat on the stabilized banks and the temporary loss of habitat in the access and toe-down areas.

AAHUs. AAHUs in the construction area are calculated as 13.55 for Alternative 4 (see Table 2).

b. Proposed Preserve Area (Acquired as Mitigation, Modified Bank Stabilization Added). If the preserve is acquired as mitigation and modified bank stabilization added, habitat units are still expected to decrease from 33.00 at T=0 to 30.62 at T=50; however, this would be more than double the HUs in the same time-frame as the No Action Alternative. Habitat Unit losses would be due to direct disturbance during construction, minor alteration to hydrologic conditions, and a probable decrease in wildlife diversity in the greater Tucson area. The modified bank protection measures could slightly decrease ground and surface water supply to the mesquite bosque, but severe lateral erosion due to major flood events would be eliminated or greatly reduced. As with Alternatives 2 and 3, acquisition and preservation of this 48-acre site would eliminate or reduce many of the other potential sources of disturbance

AAHUs. AAHUs in the proposed preserve area, if acquired and protected, are calculated at 31.34 for Alternative 4.

c. Combined Construction area and Proposed Preserve Area. The combined AAHUs for the construction area and Proposed Preserve area = 44.89 for Alternative 4.

The mitigation goal for the recommended plan is to maintain a minimum of 40.46 AAHUs. The difference between 44.89 AAHUs and 40.46 AAHUs is +4.43 AAHUs. The 48-acre preserve is, therefore, adequate mitigation for Alternative 4

Table 1. HSI, Acres And Habitat Unit Summary

Alternative	Target Year	Factor	Construction Area			Preserve (Protected In Alts. 2, 3 & 4)	Construction Area + Preserve	
			Mesquite Bosque	Desert Wash	Combined			
1	T=0	HSI	0.69	0.24		0.69		
		Acres	22.00	8.00	30.00	48.00	78.00	
		HU	15.13	1.90	17.03	33.00	50.03	
	T=5	HSI	0.69	0.24		0.69		
		Acres	22.00	8.00	30.00	48.00	78.00	
		HU	15.13	1.90	17.03	33.00	50.03	
	T=50	HSI	0.58	0.24		0.34		
		Acres	22.00	8.00	30.00	24.00	54.00	
		HU	12.65	1.90	14.55	8.10	22.65	
AAHU								40.46
2	T=0	HSI	0.69	0.24		0.69		
		Acres	22.00	8.00	30.00	48.00	78.00	
		HU	15.13	1.90	17.03	33.00	50.03	
	T=5	HSI	0.66	0.24		0.69		
		Acres	21.00	4.88	25.88	48.00	73.88	
		HU	13.91	1.16	15.07	33.00	48.07	
	T=50	HSI	0.51	0.24		0.39		
		Acres	21.00	4.88	25.88	24.00	49.88	
		HU	10.76	1.16	11.92	9.30	21.22	
AAHU								38.86
3	T=0	HSI	0.69	0.24		0.69		
		Acres	22.00	8.00	30.00	48.00	78.00	
		HU	15.13	1.90	17.03	33.00	50.03	
	T=5	HSI	0.66	0.24		0.69		
		Acres	21.70	5.87	27.57	48.00	75.57	
		HU	14.38	1.39	15.77	33.00	48.77	
	T=50	HSI	0.51	0.24		0.39		
		Acres	21.70	5.87	27.57	24.00	51.57	
		HU	11.12	1.39	12.52	9.30	21.82	
AAHU								39.47
4	T=0	HSI	0.69	0.24		0.69		
		Acres	22.00	8.00	30.00	48.00	78.00	
		HU	15.13	1.90	17.03	33.00	50.03	
	T=5	HSI	0.66	0.24		0.68		
		Acres	21.00	3.78	24.78	47.10	71.88	
		HU	13.91	0.90	14.81	31.79	46.60	
	T=50	HSI	0.51	0.24		0.65		
		Acres	21.00	3.78	24.78	47.10	71.88	
		HU	10.76	0.90	11.66	30.62	42.28	
AAHU								44.89

Table 1.1.1 Habitat Evaluation - Alternative 1 - (No Action) - Construction Area					
Habitat Type	**Criteria**	**Habitat Suitability Index (HSI)**			**AAHU**
		T = 0	**T = 5**	**T = 50**	
Desert Riparian/Mesquite Bosque (Confluence Tanque Verde Creek/ Pantano Wash)	wildlife diversity	0.75	0.75	0.60	
	plant species and vegetation diversity	0.75	0.75	0.60	
	vegetation structure and cover	0.75	0.75	0.60	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.69	0.69	0.58	
Acreage		22.00	22.00	22.00	
Habitat Units	(Average HSI X Acreage)	15.13	15.13	12.65	14.03
Desert Wash	wildlife diversity	0.15	0.15	0.15	
	plant species and vegetation diversity	0.15	0.15	0.15	
	vegetation structure and cover	0.15	0.15	0.15	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.24	0.24	0.24	
Acreage		8.00	8.00	8.00	
Habitat Units		1.90	1.90	1.90	1.90
Construction Area Habitat Units		17.03	17.03	14.55	15.93

Table 1.1.2 Habitat Evaluation - Alternative 1 - (No Action) - Preserve Area					
Habitat Type	**Criteria**	**Habitat Suitability Index (HSI)**			**AAHU**
		T= 0	**T= 5**	**T= 50**	
Desert Riparian/Mesquite Bosque	wildlife diversity	0.75	0.75	0.30	
	plant and vegetation diversity	0.75	0.75	0.30	
	vegetation structure and cover	0.75	0.75	0.25	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.69	0.69	0.34	
Acreage		48.00	48.00	24.00	
Habitat Units		33.00	33.00	8.10	22.01
Desert Wash	wildlife diversity	0.15	0.15	0.15	
	plant species and vegetation diversity	0.15	0.15	0.15	
	vegetation structure and cover	0.15	0.15	0.15	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.24	0.24	0.24	
Acreage		0.00	0.00	24.00	
Habitat Units		0.00	0.00	5.70	2.51
Preserve Area Habitat Units		33.00	33.00	13.80	24.53
Combined Habitat Units		50.03	50.03	28.35	40.46

Table 1.2.1 Habitat Evaluation - Alternative 2 - Construction Area					
Habitat Type	**Criteria**	**Habitat Suitability Index (HSI)**			**AAHU**
		T= 0	**T= 5**	**T= 50**	
Desert Riparian/Mesquite Bosque	wildlife diversity	0.75	0.75	0.55	
	plant and vegetation diversity	0.75	0.75	0.55	
	vegetation structure and cover	0.75	0.75	0.55	
	water availability/hydrologic conditions	0.50	0.40	0.40	
Average HSI		0.69	0.66	0.51	
Acreage		22.00	21.00	21.00	
Habitat Units		15.13	13.91	10.76	12.59
Desert Wash	wildlife diversity	0.15	0.15	0.15	
	plant species and vegetation diversity	0.15	0.15	0.15	
	vegetation structure and cover	0.15	0.15	0.15	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.24	0.24	0.24	
Acreage		8.00	4.88	4.88	
Habitat Units		1.90	1.16	1.16	1.20
Construction Area Habitat Units		17.03	15.07	11.92	13.80

Table 1.2.2 Habitat Evaluation - Alternative 2 - Preserve Area (Acquired)					
Habitat Type	**Criteria**	**Habitat Suitability Index (HSI)**			**AAHU**
		T= 0	**T= 5**	**T= 50**	
Desert Riparian/ Mesquite Bosque	wildlife diversity	0.75	0.75	0.40	
	plant and vegetation diversity	0.75	0.75	0.35	
	vegetation structure and cover	0.75	0.75	0.30	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.69	0.69	0.39	
Acreage*		48.00	48.00	24.00	
Habitat Units		33.00	33.00	9.30	22.54
Desert Wash	wildlife diversity	0.15	0.15	0.15	
	plant species and vegetation diversity	0.15	0.15	0.15	
	vegetation structure and cover	0.15	0.15	0.15	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.24	0.24	0.24	
Acreage		0.00	0.00	24.00	
Habitat Units		0.00	0.00	5.70	2.51
Preserve Area Habitat Units		33.00	33.00	15.00	25.06
Combined Habitat Units		50.03	48.07	26.92	38.86

Table 1.3.1 Habitat Evaluation - Alternative 3 - Construction Area					
Habitat Type	**Criteria**	**Habitat Suitability Index (HSI)**			**AAHU**
		T= 0	**T= 5**	**T= 50**	
Desert Riparian/ Mesquire Bosque	wildlife diversity	0.75	0.75	0.55	
	plant and vegetation diversity	0.75	0.75	0.55	
	vegetation structure and cover	0.75	0.75	0.55	
	water availability/hydrologic conditions	0.50	0.40	0.40	
Average HSI		0.69	0.66	0.51	
Acreage*		22.00	21.70	21.70	
Habitat Units		15.13	14.38	11.12	12.98
Desert Wash	wildlife diversity	0.15	0.15	0.15	
	plant species and vegetation diversity	0.15	0.15	0.15	
	vegetation structure and cover	0.15	0.15	0.15	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.24	0.24	0.24	
Acreage		8.00	5.87	5.87	
Habitat Units		1.90	1.39	1.39	1.42
Construction Area Habitat Units		17.03	15.77	12.52	14.41

Table 1.3.2 Habitat Evaluation - Alternative 3 - Preserve Area (Acquired))					
Habitat Type	**Criteria**	**Habitat Suitability Index (HSI)**			**AAHU**
		T= 0	**T= 5**	**T= 50**	
Desert Riparian/ Mesquite Bosque	wildlife diversity	0.75	0.75	0.40	
	plant and vegetation diversity	0.75	0.75	0.35	
	vegetation structure and cover	0.75	0.75	0.30	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.69	0.69	0.39	
Acreage*		48.00	48.00	24.00	
Habitat Units		33.00	33.00	9.30	22.54
Desert Wash	wildlife diversity	0.15	0.15	0.15	
	vegetation structure and cover	0.15	0.15	0.15	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.24	0.24	0.24	
Acreage		0.00	0.00	24.00	
Habitat Units		0.00	0.00	5.70	2.51
Preserve Area Habitat Units		33.00	33.00	15.00	25.06
Combined Habitat Units		50.03	48.77	27.52	39.47

Table 1.4.1 Habitat Evaluation - Alternative 4 - Construction Area					
Habitat Type	**Criteria**	**Habitat Suitability Index (HSI)**			**AAHU**
		T= 0	**T= 5**	**T= 50**	
Desert Riparian/Mesquite Bosque	wildlife diversity	0.75	0.75	0.55	
	plant and vegetation diversity	0.75	0.75	0.55	
	vegetation structure and cover	0.75	0.75	0.55	
	water availability/hydrologic conditions	0.50	0.40	0.40	
Average HSI		0.69	0.66	0.51	
Acreage		22.00	21.00	21.00	
Habitat Units		15.13	13.91	10.76	12.59
Desert Wash	wildlife diversity	0.15	0.15	0.15	
	plant species and vegetation diversity	0.15	0.15	0.15	
	vegetation structure and cover	0.15	0.15	0.15	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.24	0.24	0.24	
Acreage		8.00	3.78	3.78	
Habitat Units		1.90	0.90	0.90	0.96
Construction Area Habitat Units		17.03	14.81	11.66	13.55

Table 4.4.2 Habitat Evaluation - Alternative 4 - Preserve Area (Acquired, Bank Stabilization Added)					
Habitat Type	**Criteria**	**Habitat Suitability Index (HSI)**			**AAHU**
		T= 0	**T= 5**	**T= 50**	
Desert Riparian/ Mesquite Bosque	wildlife diversity	0.75	0.75	0.70	
	plant and vegetation diversity	0.75	0.75	0.75	
	vegetation structure and cover	0.75	0.75	0.70	
	water availability/hydrologic conditions	0.50	0.45	0.45	
Average HSI		0.69	0.68	0.65	
Acreage		48.00	47.10	47.10	
Habitat Units		33.00	31.79	30.62	31.34
Desert Wash	wildlife diversity	0.15	0.15	0.15	
	plant species and vegetation diversity	0.15	0.15	0.15	
	vegetation structure and cover	0.15	0.15	0.15	
	water availability/hydrologic conditions	0.50	0.50	0.50	
Average HSI		0.24	0.24	0.24	
Acreage		0.00	0.00	0.00	
Habitat Units		0.00	0.00	0.00	0.00
Preserve Area Habitat Units		24.00	22.37	20.61	31.34
Combined Habitat Units		41.03	37.18	32.27	44.89

Table 2 - Summary of Habitat Outputs

HABITAT OUTPUTS	ALTERNATIVE			
	Alt.1 (No Action)	Alt.2	Alt.3	Alt. 4 (Recommended Plan)
Total T=50	14.55	11.92	12.52	11.66
a. CONSTRUCTION AREA AVERAGE ANNUAL HABITAT UNITS (AAHUs)	15.93	13.80	14.41	13.55
b. PRESERVE AREA AAHUs	24.53	25.06	25.06	31.34
c. TOTAL AAHUs = (a + b)	40.46	38.86	39.47	44.89
d. MITIGATION REQUIREMENT = Construction Area No Action (Alt. 1) AAHUs - Unmitigated With Project AAHUs		2.14	1.52	2.38
e. MITIGATION PROVIDED = [b - Preserve Area No Action (Alt.1) AAHUs]		0.53	0.53	6.81
f. Net AAHUs Gain (+) or Loss (-) With Mitigation = [c - No Action (Alt. 1) AAHUs Including Preserve Area]		-1.61	-1.00	4.43
g. MEETS MITIGATION REQUIREMENT?		No	No	Yes

Table 3 COMPARATIVE COSTS OF MITIGATION MEASURES

Mitigation Measure	Cost	Net AAHUS	Cost/AAHU
Acquire 48-Acre Mesquite Bosque as County Preserve (No Bank Protection	$780,560.00	0.53	$1,472,754.72
Add Modified Bank Protection to County Preserve	$1,021,214.00	6.28	$162,613.69

APPENDIX C: WATER QUALITY

APPENDIX C-1: 404(b)(1) EVALUATION

Introduction. The following evaluation is provided in accordance with Section 404(b)(1) of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), as amended by the Clean Water Act of 1977 (Public Law 95-217). Its intent is to succinctly state and evaluate information regarding the effects of discharge of dredged or fill material into the waters of the United States. As such, it is not meant to stand alone and relies heavily upon information provided in the Environmental Assessment (EA) to which it is attached. Citations in brackets [] refer to expanded discussion found in the EA, to which the reader should refer for details.

1. PROJECT DESCRIPTION

a. Location. Tanque Verde Creek is a tributary to the Rillito River, and is located along the northern border of the greater Tucson area in eastern Pima County, Arizona [1.1].

b. General Description. The proposed action will include stabilization of approximately 1.4 linear miles (discontinuous) of unprotected banks of Tanque Verde Creek with soil cement between Craycroft Road and Sabino Canyon Road. Approximately 5,900 linear feet of protection will be placed on the south bank, and approximately 1,600-linear feet will be placed on the North Bank. The project also includes acquisition of a 45-acre desert riparian mesquite bosque as a preserve on the north bank [3.3; 3.3.2].

c. Authority and Purpose. Tanque Verde Creek, as part of the currently authorized Rillito River and Associated Streams Study (RRAS) was authorized in Public Law 761, Seventy-fifth Congress, known as Section 6 of the Flood Control Act of 1938 [1.3].

d. General Description of Dredged or Fill Material.

(1) General Characteristics of Material. Fill material consists primarily of clean gravels and sands with occasional silts excavated from the toe and slopes of the existing banks and mixed with cement to provide bank stability [3.3.2].

(2) Source of Material. It is anticipated that all borrow material needed would be obtained from the stream channel adjacent to each area being filled. This borrow material would consist of excess material excavated for the toe-down of the bank protection and material excavated from the banks to provide a uniform slope on which to place the soil cement. Material will not be excavated from the wash for the sole purpose of being used as borrow material. Cement will be obtained from nearby commercial sources [3.3.2]. Outside commercial sources of fill material are not considered practical due to cost considerations for obtaining the material and for disposal of the excavated material.

(3) Quantity of Material. Approximately 40,500 cubic yards (cy) of soil cement and 29,000 cy of compacted fill material would be required for bank stabilization. Approximately 7,900-8,400 tons of cement (stabilizer) would be required to prepare the soil cement [3.3.2].

e. Description of the Proposed Discharge Sites. - the proposed project does not involve the disposal of dredged material, but does involve the placement of fill material. The discharge sites (for placement of fill material) are along both banks of Tanque Verde Creek between Craycroft Road and Sabino Canyon Road. Portions of these areas have been eroded by

past flood events, particularly the October 1983, January 1993, and possibly January 1995 floods. The banks are mostly unvegetated or sparsely vegetated except on the south bank at the confluence with Pantano Wash and the Rillito River where a dense stand of mesquite, with some cottonwoods, is present. A larger stand of desert riparian vegetation (mesquite bosque) occurs on the north bank; however, no soil cement will be placed in that reach [3.3.2].

f. Description of the Disposal Method. - Since construction would be accomplished primarily during the dry season, conventional construction methods would be used. After completion of the excavation and backfill, the stream banks would be protected by the use of soil cement. The soil cement plant would be located within the channel, and all materials, except for the cement, would be obtained from the channel. The cement would be obtained from a commercial source [3.3.2].

2. FACTUAL DETERMINATIONS

a. Physical Substrate Determinations. Construction of the project would result in the replacement of the existing substrate with fill material obtained from the stream channel and with soil cement for bank protection. Soil cement bank protection would prevent erosion of the bank. Since Tanque Verde Creek is an ephemeral watercourse, there is no significant benthic community in the stream [3.3.2; 5.2].

b. Water Circulation, Fluctuation, and Salinity Determinations. The proposed action is expected to have a minor effect on velocities and water surface elevations. Especially in the

vicinity of the Tucson Country Club, flood flows will be more confined between the channelized banks than under existing conditions, resulting in a temporary increase in water surface elevation and increased velocities. No significant effect on circulation is expected. The proposed action will not significantly affect salinity, water chemistry, clarity, color, odor, taste, dissolved gas levels, nutrients, or eutrophication of water in Tanque Verde Creek [5.3].

c. Suspended Particulate/Turbidity Determinations. The project would have a long-term beneficial effect on turbidity. Since construction is to take place primarily during the dry season, there would be no significant construction impacts. Since the creek bank would be protected by soil cement, turbidity over the long term should be decreased [5.3].

d. Contaminant Determinations. No contaminants would be introduced into Tanque Verde Creek as a result of the project. Since the fill material is uncontaminated and from the same area as the disposal site, it is exempt from further chemical or biological testing (40 CFR 230) [5.3].

e. Aquatic Ecosystem and Organism Determinations. Since Tanque Verde Creek is ephemeral and carries water only during and after rainstorms, there is no permanent aquatic community; therefore, the project will not affect any aquatic organisms or aquatic ecosystem [5.3; 5.5].

f. Proposed Disposal Site Determinations. The project would not violate any applicable water quality standard and would not affect human use of the river. The water of Tanque Verde Creek is not used for any municipal or private water supply. Tanque Verde Creek is not suitable for either fishing or other water-oriented recreation. Esthetic impacts of the project could be adverse along portions of Tanque Verde Creek where the soil cement may look unnatural. No National or Historic Monuments, National Seashores, Wilderness Areas, Research Sites, or similar areas are located in the project area.

g. Determination of Cumulative Effects on the Aquatic Ecosystem. The extent of proposed bank protection is relatively minor, as compared with existing bank protection. No additional bank protection on Tanque Verde Creek, the Rillito River or other tributaries is anticipated in the near future. Although there have been cumulative impacts, due to several federal and non-federal projects on the Rillito River and Tanque Verde Creek, additional projects of this type are not foreseen in the immediate future. The Rillito River Bank Protection Project did not involve formal mitigation for loss of habitat, but that project included extensive plantings of native vegetation for aesthetic treatment associated with recreational features [5.13].

h. Determination of Secondary Effects on the Aquatic Ecosystem. - The proposed project will have some effect on the hydraulics of the wash as it confines the flows which were previously unconfined; however, since the Rillito River, downstream of the confluence of Tanque Verde and Pantano Wash, is almost entirely channelized, downstream effects would be minor. The Lateral Migration Study (Appendix A of the EA) indicates that erosion of the proposed preserve area would not increase substantially with the hardening of the opposite bank.

3. FINDING OF COMPLIANCE FOR THE TANQUE VERDE CREEK PROJECT

a. No significant adaptations of the guidelines were made relative to this evaluation.

b. No feasible alternative was available that would have had a lesser impact on the project area. Web cellular confinement systems were investigated as potential alternatives. These systems would require the addition of concrete into the cells, as flow velocities would exceed 15 feet per second, thus defeating their intended environmental functions. The Corps determined that gabions and stone revetment (rip rap) were cost inefficient and would not provide an adequate level of protection against anticipated velocities of major storms. Grouted stone was determined to be cost-effective, but would not have less impact on the environment than soil cement [3.0; 3.3; 3.4].

c. The proposed project would not violate any applicable state water quality standards or the Toxic Effluent Standards of Section 307 of the Clean Water Act.

d. The proposed project would not harm any endangered species or their critical habitat [4.5].

e. The proposed placement of fill material will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life

stages of aquatic life and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, esthetic, and economic values will not occur.

f. On the Basis of the Guidelines, the Proposed Disposal Site(s) for the Discharge of Dredged or Fill Material is specified as complying with the requirements of Section 404(b)(1) of the Clean Water Act with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic and riparian ecosystems [5.14].

Prepared by: Lois Goodman Position: Biological Sciences Environmental Manager

Date: June 20 **APPENDIX - C**, 2000

APPENDIX C-2: ADEQ FORM 404-003

ADEQ/WQD FORM 404-003 Rev 12/29/94

THE ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY POLICY FOR PROTECTING WATER QUALITY DURING FACILITY CONSTRUCTION

Prepared by: Lois Goodman Date: May 2002

For each policy, please describe the procedures, practices and/or facilities that will (a) minimize potential pollution of surface waters and (b) demonstrate compliance with State water quality standards (A.A.C. Title 18, Chapter 11, Articles 1, 2 and 3). Please note that the waters of the State include all watercourses, and perennial or intermittent streams (A.R.S. §49-201.31).

POLICY (1) Provision for temporary pollution control measures such as dikes, basins, ditches, diversions, silt fences and the application of straw and seed, to be functional prior to land disturbing activities.

Clean material will be used to construct the levee, and no construction will occur during heavy storm events. Extensive measures to control water pollution are not anticipated because the stream flows only intermittently. Procedures to minimize erosion during construction would be followed, including: checking weather conditions daily; using clean water and material to stabilize creek banks; ensuring that no polluted silt or other material is placed in the creek or wash; removing debris from the washes; and postponing construction during rainstorms or flood events.

POLICY (2) Erosion control measures including minimizing clearing and grubbing and limiting exposure of erodible surface to 750,000 square feet for each construction phase or location.

The entire area to be disturbed will be considerably under 750,000 square feet.

POLICY (3) Construction of footings in water by sheet pile cofferdam method and pumping water from within the dam to settling ponds before returning it to the watercourse.

Not applicable.

POLICY (4) Isolation of the construction area by dikes and/or berms.

Construction would not occur within the flowing stream; therefore, sand dikes or berms would not be necessary.

POLICY (5) Erection of barriers, covers, shields and other protective devices as necessary to prevent any construction materials, equipment or contaminants/ pollutants from falling or being thrown into a watercourse.

Not applicable.

POLICY (6) Construction of drainage facilities with armoring when necessary to control erosion and sedimentation.

Not applicable

POLICY (7) Provision of an adequate means, such as a bypass channel, to carry a stream free from mud and silt around operations which remove material from beneath a flowing stream.

Diversion dikes or a bypass channel will be constructed, as necessary, to convey flows free from silt and mud around the excavation area.

POLICY (8) A requirement for transportation of materials across live streams to be conducted without muddying the stream. Mechanized equipment should not be operated in stream channels of live streams except as may be necessary to construct crossings or barriers and fill for channel modifications.

A requirement for transportation of materials across a live (flowing) stream is not anticipated.

POLICY (9) A requirement for wash water from aggregate washing or other operations containing mud or silt to be treated by filtration or retention in a settling pond, or ponds, adequate to prevent water from transporting sediment into streams or watercourses.

Environmental protection specifications for the project will include provisions requiring the contractor to prevent sediment-laden wash water from entering the f lowing stream.

POLICY (10) A requirement for oily or greasy substances originating from the contractor's operations not be placed where they will later enter a stream or watercourse.

Environmental protection specifications will stipulate that chemical waste, including oily and greasy substances, will be stored in corrosion-resistant containers, removed from the work area, and disposed in accordance with federal, state, and local regulations. The specifications will also prohibit the contractor from allowing oil or grease to drain onto the ground where they could later be washed into the watercourse.

POLICY (11) Provisions for Portland cement or fresh Portland cement concrete not be allowed to enter flowing water of streams.

Construction would not occur during major storms or periods of high water, thus, there would be little risk of Portland cement (a component of soil cement). Additional precautions will be taken when mixing the soil cement

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POLICY (12) A requirement to return the flow of streams as nearly as possible to a meandering thread without creating a possible future bank erosion problem when operations are completed.

Construction and excavation will occur along and adjacent to the banks. Little or no effect to the low-flow channel is anticipated.

POLICY (13) A requirement that material derived from roadway work should not be deposited in a live stream channel where it could be washed away by stream flows.

Not applicable. The project will not involve roadway work.

POLICY (OTHER POLLUTANTS) A requirement that plans and procedures be prepared for facilities and activities within a watercourse to protect water from pollution with fuels, oil, bitumens, calcium chloride and other harmful materials.

The contractor will be required to prepare an Environmental Protection Plan, subject to Corps approval, prior to commencing work. The plan will include measures to protect water from pollution with fuels, oil, bitumens, calcium chloride and other harmful materials.

POLICY (MONITORING) The person responsible for the activity should monitor for turbidity every day in which there is a disturbance of the bed of the waterway. Monitoring should be performed not greater than 300 feet downstream from the construction or related operations and 100 feet upstream, and may be required at different frequencies and for other parameters to demonstrate compliance with water quality standards. Reports of turbidity levels should be reported to the Arizona Department of Environmental Quality, Surface Water Quality Section.

The majority of construction will occur "in the dry." In the event that some construction will occur during periods of stream flow, monitoring of water areas affected by construction activities will be included in the construction specifications as follows: The contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters. Monitoring of water areas affected by construction activities shall be the responsibility of the contractor. Water shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.

ADDITIONAL INFORMATION

Not applicable.

APPENDIX D

TABLE 1
TANQUE VERDE CREEK BANK STABILIZATION PROJECT
Excavated and Construction Material

Total Material to be Escavated(cy)	115,000 (uncompacted soils)
Total Amount of Pozzolon (Stabilizer) (cy)	360
Total Amount of Portland Cement (cy)	3,500

TABLE 2
TANQUE VERDE CREEK BANK STABILIZATION PROJECT
Construction Equipment

Scrappers	3
Bulldozers	2
Compactor	1
Water Truck	1
Bully Dump Truck	4

TABLE 3
TANQUE VERDE CREEK BANK STABILIZATION PROJECT
On & Off-Road Truck Emissions

Project Related Material to be Transported and Number of Truck Trips to be utilized per day

Volume of Material (cy)	4,610	Total # of Trips Required	195
Truck Hauling Capacity (cy)	20		
Truck Weight (lbs)	>6K	# of Trips Required/Day	4.0
# Trucks Used	4	Vehicle Miles Traveled/Day	
Project Time (Months)	3	On Road	80
Project Time (Work Days)	63	Off Road	2
Travel Distance (Miles/Trip)			
On Road (roundtrip)	20		
Off Road (roundtrip)	0.5		
Speed (On Road mph)	55		
Speed (Off Road mph)	35		
Cold Starts	100%		
Hot Starts	0%		

On Road Emission Factors (gram/mile)

Activity	PM-10	CO	ROC	Nox	Sox	Pb
					Not Available	Not Available
Exhaust+Evaporative	0.24	7.15	0.56	5.5	"	"
Tire Wear	0.19				"	"
Cold Start		31.31	2.14	2.02	"	"
Hot Start		3.46	0.56	0.97	"	"
Hot Soak			0.46		"	"
Diurnal			1.96		"	"

On-Road Emission Factors (lb/day)

Activity	PM-10	CO	ROC	Nox	Sox	Pb
					Not Available	Not Available
Travel Emissions	0.076	1.260	0.099	0.969	"	"
Cold Start		0.276	0.019	0.018	"	"
Hot Start		-	-	-	"	"
Hot Soak			0.004		"	"
Diurnal			0.017		"	"
Totals	0.076	1.536	0.139	0.987	"	"

Off Road Emission Factors (gram/mile)

Activity	PM-10	CO	ROC	Nox	Sox	Pb
					Not Available	Not Available
Exhaust+Evaporative	0.24	7.82	0.81	4.21	"	"
Tire Wear	0.19				"	"
Cold Start		31.31	2.14	2.02	"	"
Hot Start		3.46	0.56	0.97	"	"
Hot Soak			0.46		"	"
Diurnal			1.96		"	"

Off-Road Emission Factors (lb/day)

Activity	PM-10	CO	ROC	Nox	Sox	Pb
					Not Available	Not Available
Travel Emissions	0.002	0.034	0.004	0.024	"	"
Cold Start		0.276	0.019	0.018	"	"
Hot Start		-	-	-	"	"
Hot Soak			0.004		"	"
Diurnal			0.017		"	"
Totals	0.002	0.310	0.044	0.042	"	"

FUGITIVE DUST GENERATED BY THE CONSTRUCTION ACTIVITIES.

Extraction-PM10 emissions-26.4 lbs/43,560 cu. ft.
(Soil Excavated cu. ft. x 26.4 lbs)/43,560 cu.ft = lbs/day
Note: 1 cy = 27 cu. ft.

Emission for 115,000 cy of material removed:

115,000 x 27 = 3,105,000 x 26.4/43560 = 1,181.82 for the project duration (without mitigation or watering)

34% control efficiency used for PM10 mitigation measures - watering project site twice a day (Table A11-9-A, SCAQMD, CEQA Air Quality Handbook, April 1993)

After application of mitigation - (watering the unpaved road = 639.82 lbs for the project duration.

639.82/180 = 3.5 lbs per day.

Vehicle miles travel per day (VMT)
Distance traveled by a vehicle x Number of Vehicle = Total VMT per day.

Fugitive dust generated by truck traffic on unpaved road=
2.1 x (G/12) x (H/30) x $\{[(I/3)^{0.7} \times (J/4)^{0.5}]\}$ x [(365-K)/365) in pounds per miles traveled Where,
G = Surface silt loading in percent (Table A9-9-D-1)
H = Mean vehicle speed in miles per hour (Table A9-9-D-2)
I = Mean vehicle weight in tons (Table A9-9-D-3)
J = Mean Number of wheels on vehicles (Table A9-9-D-3)
K = Mean number of days per year with at least 0.01 inches of precipitation (Table A9-9-D-4)

Fugitive dust generated by truck traffic on unpaved road=
2.1 x (G/12) x (H/30) x $\{[(I/3)^{0.7} \times (J/4)^{0.5}]\}$ x [(365-K)/365); where G = 28; H = 15 miles/hr; I = 10,000 lbs/2000 = 5 tons; J = 6; K = precipitation condition in days = 34.

F = 2.1 x 2.33 x 0.5 x 1.43 x 1.22 x 0.91 = 3.88 lbs/miles

Therefore, E = 2 miles/day total traveled distance on unpaved road = 2 x 3.88 = 7.76 lbs for trucks traveling on unpaved orad.

45% apply water three times daily is used for truck traveled on unpaved road and 40% traffic speed on all unpaved road is 15 mph or less (15 miles of speed is used for calculating fugitive dust emission.)

After application of mitigation of 45% = 7.76 x 45/100 = 3.49 lbs per day for trucks traveling on unpaved road.

Fugitive dust generated per day by the project would be = 3.5 + 3.49 = 7.00 lbs per day.

APPENDIX E: PUBLIC INVOLVEMENT AND PUBLIC REVIEW

PUBLIC MEETING SUMMARIES

Public Meeting Summary

First Public Meeting

Date: May 28, 2002

Location: Dusenberry/River Public Library

Corps and Pima County representatives presented and summarized the project and documents.

The project is authorized under the Flood Control Act of 1938 and WRDA 1996. Bank protection on the Tanque Verde was reevaluated due to flood damage in1993.

Several participants noted that they had just received notice of the meeting that day, or had not been officially notified of the meeting and heard about it by accident.

Mr. Joseph Cesare, a property owner who owns part of the proposed preserve area requested introduction of attendees. The following attendees introduced themselves:

Lori Woods- RECON
Sherry Ruther - (Arizona) Game and Fish Department
Julia Fonseca- Pima County
Larry Cesare- Property owner.

A few other attendees declined to introduce themselves.

The question was asked, What if property owners don't want to sell?

Pima County FCD & DOT responded that it is their responsibility to obtain the land.

Mr. J. Cesare spoke in favor of a linear park. He would like to see it be included in the plan. He also inquired about revegetating the burned areas. He also asked if the soil cement protection be amended.

The proposed alignment is based on Pima County's post 1993 request.

Sherry Ruther asked if the proposed alignment is "Set in stone?" We are dealing with banks as they currently exist, not reclamation of riparian habitat area. Earlier soil cement caused the stream to migrate to the north.

John Drake (Corps, Project Manager) suggested looking at other types of protection for the riparian preserve such as: Kelner jacks or soil cement with pipes to allow flow to reach mesquite bosque.

Ira Artz (Tetra Tech) said the smooth bank on the south, would reduce erosion on north bank.

Joseph Cesare has been revegetating the burned area.

Ruth Villalobos (Corps, Chief of Planning Division). The Corps did not have authority to look at Habitat Restoration before the mid 1990's. This project has no recreation trails.

Suzanne Shields (Pima County)- We can't have trails on south side by Tucson County Club Estates.

24 June is comment deadline for inclusion in final report. (The deadline was subsequently extended).

Second Public Meeting

Date: July 9, 2002

Location: St. Alban's Episcopal Church

The Corps and Pima County representatives summarized the project.

The Public comment period was has been extended to July 31 due to late notification of the availability of the document.

Suzanne Shields, Pima County Deputy Director for Flood Control, discussed some other projects in Pima County, including other natural treatments for riparian areas. She will have field meetings in the fall. The goal is to maximize riparian habitat preservation.

Bobby Ulich spoke in behalf of the Tanuri Ridge Homeowners Association (TRHA). TRHA owns 18 acres of the (proposed) preserve. They are already legally prevented from developing it. Would the land then be available for County to develop recreation?

Ms. Shields Responded that right of way purchase is the County's Responsibility. No recreation features would be there.

Members of the public asked about a walkway along the North Bank (along the preserve).

The county responded that there would be some tie-in with the trail system on Tanque Verde.

Sonja Macys, representing Tucson Audubon Society favors on-site mitigation, but questions the purchase of acreage that is already preserved.

John Drake, Army corps of Engineers replied that are aware of the covenants. We do not have a real estate appraisal yet. We will need to determine how binding the covenants are before determining if purchase or some other means to secure the preserve is appropriate.

Lois and Rick Eisenstein. –(TRHA President) also asked about recreation. Plans show accessibility, and a connected path would increase access. They are also concerned with scour of the riparian area in major floods.

Mike Zeller - Tetra Tech – (worked for Pima County before 1981). Regarding north bank erosion, water would be deflected from the south, which would also reduce reflective meander, but this does not completely prevent erosion.

David Berg brought up the need for access across Tanque Verde Creek for native wildlife including javelina, mountain lion, bobcat, jackrabbits and other species.

Robert Fee – Chief, Tucson County Club Fire Department said that after the 1965 flood there was a lake. Land was offered in exchange for bank protection. South side water mains were damaged. He suggests some area for recreation use, but not clear where.

Barbara Brody, TRHA member also expressed concern about the proposed development on the SE corner of Craycroft Road and River Road. This would be adjacent to the proposed project.

Pima County is reviewing the plan. They will need mitigation. The Flood plain ordinance requires dedication.

Suzanne Shields - Other properties have been acquired by Pima County FCD and management plans developed.

Rick McNeely, TRHA, indicated that some of the Mitigation area does not have riparian vegetation. He does not want a river walk close to the residences. Could property be acquired under eminent domain?

As indicated earlier, the County is responsible for obtaining ownership or rights-of-way.

Some attendees say the (LRR/EA) report is too difficult to understand.

Suzanne Shields will prepare a summary of the Limited Reevaluation Report (LRR).

PUBLIC REVIEW COMMENTS AND RESPONSES

June 6, 2002

Mr. Ed Demesa, Chief, Planning Section A
Plan Formulation Branch
US Corps of Engineers
PO Box 532711
Los Angeles, CA 90053-2325

Dear Mr. Demesa;

Thank you for the announcement of the public meeting here in Tucson, AZ concerning the Tanque Verde Creek, scheduled for May 28, 2002 which I received today by First Class mail. I would also like to point out that our zip code was changed at least four years ago, if not longer.

My wife and I would have liked to attend the meeting since the matter to be reviewed is of interest to us; we live very close to the area in question and the meeting place is walking distance.

I would hope that future notices will be more timely and with more up to date addressing.

Very truly yours,

Donald E Williams

Cc: Mr Kurt Weinrich, Director
Pima County Dept of Transportation and Flood Control District

Response: We apologize for the late mailing of the notice for the May 28, 2002 public meeting for this project. Due to problems in notifying interested parties for the initial meeting, another meeting was scheduled, with notification reaching the public in a timely manner. We hope you were able to attend and participate in the second public meeting on July 9, 2002 at St Alban's Episcopal Church. Thank you for your updated address information.

June 8, '02

To Mr Ed Demesa
Re Tanque Verde Creek bank project
Public meeting May 25th 2002? But we
got this letter June 7th!

There is no mention of walking path along
the top of a new embankment but I
assume it is part of the plan so as to
link up with paths west and east of
that segment.

Also - we need a footbridge over
Ventana Wash where it empties into
Tanque Verde Creek. For years the pipe
railings lay on the ground nearby as
though it was planned. The cement
embankments are there. Perhaps a builder
went under + didn't finish.

How can I find out if these
items are included?

Johanna Von Mayr, M.D.

Response: See previous response regarding the late notification and the second public meeting. The proposed plan does not include recreational features such as walking paths or trails along the top of the new embankment to connect with other trails to the east and west. Such features would be the responsibility of the County. A footbridge over Ventana Wash is not within the scope of this project. Pima County Department of Parks and Recreation is likely to have additional information regarding the status of the bridge that appears to have been started but never completed.

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
2221 West Greenway Road, Phoenix, AZ 85023-4399
(602) 942-3000 • www.azgfd.com

Governor
Jane Dee Hull
Commissioners
Chairman, Michael M. Golightly, Flagstaff
Joe Carter, Safford
Susan E. Chilton, Tucson
M. Jean Hay, Phoenix
Joe Melton, Yuma
Director
Duane L. Shroufe
Deputy Director
Steven K. Ferrell

Tucson Office, 555 N. Greasewood Rd., Tucson, AZ 85745

June 18, 2002

Ms. Ruth Villalobos
U.S. Army Coups of Engineers
Planning Division
P.O. Box 532711
Los Angeles, California 90053-2325

ATTN: Tanque Verde LRR

Dear Ms. Villalobos:

At the conclusion of the May 28, 2002, public meeting in Tucson, Arizona, several members of your staff, representatives of the local sponsor (Pima County Flood Control District), and I discussed some of the concerns that the Arizona Game & Fish Department (Department) has with the currently proposed Tanque Verde Bank Stabilization Project Between Craycroft Road and Sabino Springs Road. The Department's primary concerns relate to project design and the appropriateness of the proposed mitigation site.

Briefly, the Department believes that the gap in the alignment of the stabilization on the north bank proposed in order to accommodate preservation of the mesquite community actually compromises the long-term viability of this area via the erosive forces of lateral channel migration. Hard surfacing this exposed bank is also expected to negatively affect this mesquite community by eliminating/significantly reducing overbank storage. There was additional discussion that mitigation, in this case, would be more effective if sites upstream of the proposed project where the riparian community is more in tact were utilized to off-set project-related impacts. (This point has even more merit as recent findings show that Pima County already has measures in place {restrictions on development and easements} that protect a significant portion of the 48-acre proposed mitigation site.)

Subsequent to these discussions, it was mutually agreed to arrange a meeting in the near future to further explore these issues and to modify the proposed project if warranted. I look forward to working with your staff, representatives of the local sponsor, and the U.S. Fish and Wildlife Service in this endeavor. Please contact me at gruther@gf.state.az.us or 520/628-5982 ext. 550 to coordinate the Department's participation.

1. The Department's primary concerns relate to project design and the appropriateness of the proposed mitigation site.

Response: The combined responses to the more specific concerns that follow will address this more general comment.

2. The Department believes the gap in stabilization along the exposed edge of the mesquite community on the north bank compromises the long-term viability of the area due to exposure to erosive forces. Hard surfacing the exposed bank (as proposed in Alternative 4) is also expected to negatively affect the community by eliminating of significantly reducing overbank storage.

Response: Although the "Lateral Migration Analysis" for this project indicates little if any increased erosion of the preserve due to placement of soil cement upstream, downstream, and on the opposite bank, the Corps concurs that significant erosion of the preserve could occur with or without the project. Due to concerns of the Department and several other individuals and groups, the Corps is reevaluating providing bank protection for the preserve. The alternative that provided soil cement bank protection for the preserve (Alternative 4) was, initially, not selected, primarily for the reasons stated in the Department's letter. A soil cement berm has the potential to reduce overbank storage and to prevent overflows from the smaller floods that are most beneficial to the riparian community while allowing the larger, more destructive floods to reach the habitat. In order to protect the preserve from erosion, while maximizing the

Sincerely,

Sherry A. Ruther
Habitat Specialist

SAR:sr

cc: Bob Broscheid, Project Evaluation Program Supervisor, Habitat Branch, PHX (AGFD Log No.5-24-02/01)
Bob Lemmon, District Wildlife Manager, Region V
Mike Martinez, USFWS, Az Ecol. Services State Ofc, PHX
Larry Robison, Pima Co. Flood Control District

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hydrologic connection, the Corps proposes to construct a berm to the minimum height that would protect the toe from erosion and to install pipes to conduct water through the soil cement. With these modifications, the Corps believes that the negative effects of the low soil cement berm, such as loss of overbank storage, would be minimized, and the erosion protection benefits would be maximized. The Corps and Pima County will also look in more detail at other options for bank stabilization of the preserve area during the Pre-construction, Engineering, and Design (PED) phase of this project.

3. The Department suggests using riparian habitat upstream of the site as mitigation.

Response: The cost of off-site mitigation would be beyond the budget for this project.

4. Pima County already has measures in place that protect a significant portion of the 48-acre proposed mitigation site.

Response: The Corps concurs that some restrictions and easements exist on portions of the proposed preserve area, but deed restrictions can often be reversed. Real Estate division will determine what needs to be done to secure the land as a permanent preserve. The final action may involve a combination of land acquisition and easements that ensure protection from future development.

5. The Department requests a meeting with the Corps, the local sponsor, and U.S. Fish and Wildlife Service to explore the issues discussed in the letter and at the May 28, 2002 public meeting on this project.

Response: The requested meeting took place on June 20, 2002, at the Pima County offices.

CITY OF TUCSON
DEPARTMENT OF TRANSPORTATION

June 18, 2002

Mr. Ed Demesa
Study Manager
Plan Formulation Branch
U. S. Army Corps of Engineers
P.O. Box 532711
Los Angeles, California 90053-2325

SUBJECT: TANQUE VERDE CREEK BANK STABILIZATION PROJECT. CRAYCROFT ROAD TO SABINO CANYON ROAD. LIMITED REVALUATION REPORT (LRR) AND DRAFT ENVIRONMENTAL ASSESSMENT (EA).

Dear Mr. Demesa:

Thank you very much for giving us an opportunity to comment on the subject LRR. We acknowledge the proposed construction limits are all outside the incorporated City of Tucson limits, however, the City has interest in the success of this project because it will result in major benefits to residents living in the area. We trust that the public meeting held on May 28, 2002 at 6:00pm was productive.

We have reviewed the subject report and are pleased to see that the analysis performed to evaluate the need for bank stabilization was addressed in great detail. The proposed design to construct 1550 feet of bank protection (north bank) and 2,830 feet of bank protection (south bank) upstream from the Craycroft Road bridge is needed to protect the bridge and the roadway.

The plan to construct the 4,220 feet of bank protection along the golf course (south bank) will also result in valuable benefit to the area and stop the recurring lateral migration of the south bank during rare flooding events.

We would like to request that preservation of the riparian habitat area along the north bank be studied further. The thalweg of the creek skirts the toe of the north bank along the riparian area and we believe this may have the effect of eroding the north bank during significant flow events. We would suggest that the low flow bank protection be limited to one or two feet, not four feet as studied in the report.

DIRECTOR'S OFFICE
P.O. BOX 27210 • TUCSON, AZ 85726-7210
(520) 791-4371 • FAX (520) 791-5902
www.cityoftucson.org

The project area is outside the Tucson city limits, but the Department of Transportation is interested in the success of the project due to the benefits it would provide in the area. The proposed bank protection would provide valuable benefits on both the north and south banks. The thalweg of the creek skirts the north bank along the riparian area and may cause erosion. The Department favors erosion protection but suggests limiting the height of the soil cement berm to 1 to 2 feet (primarily for esthetic reasons).

Response: The Corps is currently reevaluating protective measures for the riparian habitat preserve. Four feet was considered a maximum height for the berm in Alternative 4. The Corps concurs that if a soil cement berm is constructed to protect the preserve, it should be at the lowest height that would protect the bank from undercutting. A berm 1 to 2 feet in height would cost less than a higher berm and may be superior in terms of biological benefits as well as esthetics.

Based on the high benefit/cost ratio as evaluated in the recommended plan, as presented in the LRR Report, we are hopeful that the next phase of the project, including design and construction, will be undertaken soon.

Again, thank you for the opportunity to provide comments and we look forward to future involvement in this project.

Sincerely,

James W. Glock, P.E.
Deputy Director of Transportation

DOT No.: 02-109

JWG:YDD:sb

c: Benny Young, Assistant City Manager
Andy Dinauer, Engineering Administrator
Dena Wakefield, Engineering
Larry Robison, P.E.

6/30/02

Mr. Ed Demesa, Chief
Planning Section A
Plan Formulation Branch,
U.S. Army Corps of Engineers
P.O. Box 532711
Los Angeles, CA 90053-2325

Dear Sir:

In response to your notice of a meeting to be held July 9, 2002 and request for views and comments we submit the following statements:

As residents in the Tanuri Ridge Homeowners Association we oppose any plan to use the 48 acres being taken for this flood control project (the draft LRR, the draft EA, and the proposed Recommended Plan including future maintenance) for any other purpose than stabilization of the unprotected banks of Tanque Verde Creek.

Specifically we oppose the development or any recreation uses within the 48 acres which is proposed to be taken.Using any part of that area for walking, cycling etc. would disrupt the tranquillitry of the area, and the quiet enjoyment of our property would be taken from us.

We use the 48 acres now for bird watching and nature walks. Any development of any sort would devalue the properties of the individual property owners within the Tanuri Ridge Association.

Very Truly Yours

Frank T. Murray
Suzanne M. Murray

cc: Rick Esenstein, Pres.
Tanuri Ridge Homeowners Assoc.
cc: Melinda Carrell

The Murrays oppose any plan for the 48 acre mesquite bosque) site other than for stabilization of unprotected banks. They specifically oppose development of recreational uses for walking, cycling, etc. that would disrupt the tranquility of the area.

Response: The current plan does not include any recreational uses or development for the 48- acre mitigation site. The Draft EA does refer to possible future passive recreational development by Pima County; however, the County has subsequently indicated that no recreational features will be developed in the preserve. References to potential recreational features in the preserve area have been eliminated in the Final EA. See last paragraph, section 3.3.2 of Final EA.

July 1, 2001

Mr. Ed Demesa, Chief Planning Section A
Plan Formulation Branch
U.S. Army Corps of Engineering
P.O. Box 532711
Los Angeles, California 90053-2325

Re: Tanque Verde LRR and Draft EA

Our home is immediately north of the Tanque Verde Creek so we are pleased to hear of the proposed bank stabilization.

When we built our home in 1986 it was our understanding and that of our Homeowners Association that the land north of Tanque Verde Creek would never be used for commercial or public recreational use. This is desert land consisting of many types of native trees, shrubs and cacti and is a safe habitat for several desert creatures such as coyotes, bobcats, javelina and many bird species including quail, hawks and owls. It is our sincere hope this area can remain pristine and not be opened for public access and/or recreational purposes.

We will be out of state for the July 9th meeting so we are sending this letter to express our thoughts.

Art Nehring

Rose Nehring

The Nehrings favor bank stabilization but oppose public access to and recreational development of the land north of Tanque Verde Creek (the proposed preserve area). Their understanding was that the site would never be used for commercial or public recreational use. The letter lists some of the wildlife species found in the habitat. The Nehrings were unavailable to attend the July 9 public meeting.

Response: The purpose of acquiring the mesquite bosque is to preserve it in an undisturbed condition and to allow natural recovery from previous disturbance. See also the response to the letter from Frank and Suzanne Murray. The Corps also appreciates the information provided pertaining to additional species inhabiting the site. This information has been incorporated into the Final EA, Section 4.5.

July 7, 2002

Mr. Ed Demesa,

We are writing you this letter in regard to the purchase of the mesquite grove in our neighborhood. We live in Tucson, Arizona, along the Rillito River, between Sabino Canyon and Craycroft Roads.

We are OPPOSED to the purchase of the Mesquite Grove, as this is our private neighborhood property. We are not opposed to the soil erosion program, to reinforce the banks of the River, nor the walking path. The path could be constructed in the same manner as on the West Side of Craycroft. It is not necessary to purchase the mesquite grove in addition.

Thank you for your consideration in this manner.

Sincerely,

Steven G. Eggen Susan Eggen

Mr. and Mrs. Stephen G. Eggen

Mr. And Mrs. Eggan are opposed to the purchase of the mesquite habitat, which is private neighborhood property. They are not opposed to the soil erosion (protection) program or the walking path.

Response: A portion (approximately 18 acres) of the proposed 48-acre mesquite bosque preserve is dedicated open space for the Tenari Ridge residential area. Deed restrictions on development within the mesquite habitat area are in place. Our Real Estate branch will need to carefully review the language of the deed restrictions to determine if existing restrictions are adequate to preserve the area. The Corps and the County will then determine the most appropriate action to assure that the property remains undeveloped.

July 8, 2002

Mr. Ed Demesa, Chief, Planning Section A,
Plan Formulation Branch,
US Army Corps of Engineers,
PO Box 532711, Los Angeles, CA 90053-2325

Dear Mr. Demesa,

Tomorrow evening we are attending courses at work that are required for our jobs. For that reason we are unable to attend the Public Review and Public Meeting concerning stabilizing the unprotected banks of Tanque Verde Creek between Craycroft Road and Sabino Canyon Road.

Thank you for carefully considering all of the impact on the area. We are not as concerned about stabilizing the unprotected banks of the creek as we are about the idea of creating a preserve of 48 acres. Included in that 48 acres is 17 acres of Common area for exclusive use by members of our neighborhood that would be taken away from our neighborhood.

Our family recently moved to E Country Club Vista Drive in August 2001. We moved here because the area is private and safe, while not requiring as long a commute to work as some other areas of Tucson. We consider the washes on each side of our home to be a protection from strangers since our home is out of the way and not easily visible. We abhor the idea that a public park has been considered near our home, since we are at work during the day and our home would be placed at greater risk for burglaries. Currently it is at low risk; no burglaries have occurred in our neighborhood in years.

We appreciate the common area owned by the Tanuri Home Owners Association. It is controlled and carefully landscaped. This helps to maintain the quality of our neighborhood and the property value of our home. More importantly, this area is used by local wildlife, such as mountain lions, bobcats, javelina and coyotes, for travel between the washes.

Thank you for your consideration of our concerns.

Sincerely,
Robert and June Foltz

Robert D. Foltz
June W. Foltz

Robert and June Foltz are concerned about creating the 48-acre preserve, which includes 17 acres of the Tanuri Ridge Home Owners common area. A public park near their home would reduce protection from intrusion by strangers and increase the risk of burglary in their currently safe neighborhood. The common area helps maintain the quality of the neighborhood and property values. More importantly, the area serves as a wildlife corridor. This letter cites mountain lions in addition to other species previously mentioned.

Response: See responses to previous letters from Tanuri Ridge Homeowners Association members. We appreciate the additional information about the mesquite habitat use as a wildlife corridor and especially the reference to its use by mountain lions. Several participants at the July 8, 2002 public meeting also confirmed mountain lion sightings. This information has been incorporated into the Final EA, Section 4.5.

Mr. Ed Demesa
Chief, Planning Section A
Plan Formation Branch
U.S. Army Corps of Engineers
P. O. Box 532711
Los Angeles, CA 90053-2325

Re: Tanque Verde Creek

Dear Mr. Demesa:

We are writing in regards to the proposal by the Army Corps of Engineers and the Pima County Flood Control District to stabilize the unprotected banks of the Tanque Verde Creek between Craycroft Road and Sabino Canyon Road. The Tanuri Ridge Homeowners Association owns approximately 18 acres of property, which is a part of your proposed plan of action. Our home and personal property adjoin this common area.

We appreciate your rescheduling the public meeting and extending the deadline for comment when the original notices were not delivered prior to the original meeting.

We would like to make you aware of two major concerns we have with the plan as proposed. The selected plan provides for stabilizing the south bank of the creek on the south side of the Tanque Verde but does not provide for similar protection on the north bank. During the 1983 flood we stood on our lot and watched the trees on the south bank fall into the river. Subsequent to that flood, the river was stabilized upstream – west of the Sabino Bridge. Due to that bank stabilization, the course of the river changed drastically and during the 1993 flood a large portion of land on the north bank was lost.

We believe that it is critically important that protection be provided for the north bank of the river. While we understand that the Fish and Wildlife Service is opposed to soil cementing the north bank because of concern for wildlife (which we share), we would like to have spelled out in advance the means by which the Corps intends to protect the north bank.

Our second major concern is the proposal by Pima County to purchase 48 acres on the north bank for the purpose of providing a future pedestrian/bicycle path through it. We are adamantly opposed to any pedestrian or bicycle path on the north side of the river. The approximately 18 acres, which are a part of the Tanuri Ridge Subdivision, are

1. The Tanuri Ridge Homeowners Association owns approximately 18 acres of property within the proposed project area.

Response: Comment noted. Several members of the Homeowners Association have provided this information.

2. They appreciate the rescheduling the public meeting and extending the comment deadline.

Response: Comment noted. The public's views are important to the study process.

3. Due to bank stabilization upstream, west of Sabino Canyon Road, following the 1983 floods, the course of the river changed, and during the 1993 flood, land on the north bank was lost. They believe protection for the north bank of the river is critically important, but share the concern for wildlife with the U.S. Fish and Wildlife Service opposing soil cement on the north bank (along the preserve area). They would like to know in advance the means proposed to protect the north bank.

Response: There has been a general consensus that some type of bank protection is needed for the north bank of the river (mesquite bosque preserve area). Note that all of the action alternatives (1-3) include 1,550 linear feet of bank protection on the north bank immediately upstream of Craycroft Road. Due to considerable public input on this issue, the Corps is reevaluating the need for erosion protection for the proposed preserve area. The current proposal is a modification of Alternative 4. The plan still includes a soil cement toe wall, but the height would be the minimum that would prevent undercutting and low enough to allow overflow from the

already protected as common area. Wildlife such as javalina, bobcats, coyotes, skunks, raccoons and mountain lions live in the riparian area and/or use it as a corridor via the Tanuri Wash to the Tanque Verde Creek. Elf and great horned owls, Harris hawks, hummingbirds, and other birds are found there. Reptiles include a variety of snakes, horned lizards and gila monsters. There are too few riparian areas left in the Tucson area as it is. Purchasing the land for use as a county park/ pedestrian pathway will certainly destroy its value as a wildlife corridor and habitat.

We would appreciate your consideration of these points as you go forward with your planning process.

Thank you.

Sincerely,

William D. Carrell, Jr.

Melinda T. Carrell

Cc: The Honorable Jim Kolbe
The Honorable Ray Carroll
The Honorable Ann Day

smaller, beneficial floods. PVC pipes would be placed through the wall to maintain the hydrologic connection between the creek and the habitat.

4. They oppose the proposal to purchase and provide a future pedestrian/bicycle path through the 48-acre site. The 18 acres in their subdivision are already protected. Wildlife (examples provided) live in and use the area as a corridor. Too few riparian areas remain in the Tucson area. Purchasing the land as a county park/pedestrian pathway will destroy its value as a wildlife corridor and habitat.

Response: The County has no plans to construct recreational trails through the preserve area. The Corps and the County concur that too little riparian habitat remains in the Tucson area. That was the main rationale for the proposal to acquire the 48-acre mesquite bosque site as a preserve to mitigate for impacts of the bank protection project. Any land use of this area that would destroy its value as a wildlife corridor and habitat would be contrary to the purpose of its acquisition. See also responses to earlier letters from other members of the Homeowners Association. We appreciate the additional information regarding wildlife identified on the site. Species not previously noted have been incorporated into the final EA (Section 4.5).

August 3, 2002

Mr. Ed Demesa, Chief, Planning Section A
Plan Formulation Branch
US Corps of Engineers
PO Box 532711
Los Angeles, CA 90053-2325

Dear Mr. Demesa;

Unfortunately, my wife and I were unable to attend the two meetings held in Tucson recently concerning the Tanque Verde Creek and the proposal to stabilize the remaining unprotected banks from erosion.

I am enclosing the write up in the Tucson morning newspaper which may be of interest to you if you haven't already seen it. For us, it provided more details about the erosion plan that we were not aware of. The area between Craycroft Road and Sabino Canyon Road bordering Tanque Verde Creek continues to be blessed with considerable and diverse small animal wildlife. Sometimes we feel we live within a small animal zoo, especially in the Spring.

We agree that erosion needs to be controlled for the protection of property. The provision of the 48 acre preserve is a noteworthy step towards preserving the diverse animal life we enjoy. We would hope that the soil cementing of the river banks can be done with a provision towards the preservation of animal corridors across the river and up and down the embankments. The actual process of cementing the river banks is going to be stressful enough for the animals but hopefully not too disastrous for them.

Very truly yours,

Donald E Williams

Donald E Williams

Response:
We appreciate the article from the Arizona Daily Star. It provides a good summary of our second public meeting. The concerns expressed in this letter were shared by several of the participants at the meetings and in some of the other written comments. Preservation of wildlife corridors across the river is a priority, and this will be taken into consideration in the final design of any bank protection for the preserve area. (See Section 8 of the Final EA, Environmental Commitments).

S.H.P.O.- 2002 - 1095 (11164)

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P. O. Box 532711
LOS ANGELES, CALIFORNIA 90053-2325

May 21, 2002

RECEIVED
MAY 23 2002

REPLY TO ATTENTION OF

Office of the Chief
Planning Division

TO INTERESTED PARTIES:

Enclosed for your review and comment is a copy of the Draft Limited Reevaluation Report (LRR) and Draft Environmental Assessment (EA) for the Tanque Verde Creek, Pima County, Arizona bank stabilization project between Craycroft Road to Sabino Canyon Road.

The review period for the draft LRR and draft EA is 30 days. Comments on this document received prior to the close of the review period will be incorporated into the Final LRR and EA. Please address written comments to:

U.S. Army Corps of Engineers
Planning Division
P.O. Box 532711
Los Angeles, California 90053-2325
ATTN: Tanque Verde LRR

If you have any questions regarding the draft LRR and draft EA, please contact Mr. Ed Demesa, Chief, Planning Section A at (213) 452-3792 or Ms. Lois Goodman, Environmental Coordinator, Regional Planning Section, at (213) 452-3869.

Sincerely,

Ruth Bajza Villalobos
Chief, Planning Division

Thank you for the information about the undertaking. The SHPO looks forward to consulting according to 36 CFR 800.

for SHPO June 26, 2002

Enclosure

RECEIVED
JUL - 3 2002
PLANNING DIVISION

Response: This letter acknowledges receipt of the draft EA by the Arizona SHPO. The Corps will complete the consultation requirements according to 36CFR 800 in the next phase of the project as indicated.