

MANAGEMENT OF URBAN RUNOFF  
FOR CONJUNCTIVE RECREATIONAL USE AND FLOODFLOW REDUCTION,  
TUCSON REGION

Proposal Submitted To

Pima Association of Governments  
for Consideration in the EPA 208B Study

From

Water Resources Research Center  
University of Arizona  
Tucson, Arizona 85721

February 1975

MANAGEMENT OF URBAN RUNOFF  
FOR CONJUNCTIVE RECREATIONAL USE AND FLOODFLOW REDUCTION,  
TUCSON REGION

PERIOD OF STUDY: June 1, 1975 through August 31, 1976

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Water Resources Research Center

INTRODUCTION

Continuing expansion and intensification of urban and metropolitan development in semiarid regions is adding new dimensions to the array of problems associated with water supply and management. Increased concentrations of runoff from urbanized areas increase potential loss of life and property by flooding, and possible impairment of ground-water quality becomes imminent when urban runoff waters accrue to ground-water recharge in shallow aquifers along river beds. In semiarid and arid regions, urban runoff comprises a potentially useful water source for domestic, recreational, or other uses, provided that existing hazards to public health and safety associated with water quality and floods are controlled.

Hence, several years of research has been conducted by the Water Resources Research Center and affiliated Departments at The University of Arizona, on the quantity, quality, and possible alternatives for

disposition of storm runoff on urban and suburban watersheds. Studies have been concentrated on five watersheds: (1) Atterbury Experimental Watershed, until recently an undeveloped desert area, used as a control watershed; (2) High School, Arcadia, and Railroad Watersheds, located in the central and eastern parts of Tucson and containing various proportions of residential, commercial, and other types of development; and (3) Anklam Watershed, a diversely developing area on the foothill slopes of the Tucson Mountains on Tucson's west side (see Attachment A).

Research results have been synthesized under a concept of urban runoff management which includes floodpeak reduction, off-channel detention and on-site treatment, and use or recharge of portions of the runoff.

#### OBJECTIVES

It is proposed that this concept be adapted to currently existing conditions on Anklam and Silvercroft Watersheds, and that steps be implemented under the Planning and Management Study, to carry out certain procedures on a pilot scale by:

1. Developing design plans for control and use of storm runoff from Silvercroft and Anklam Washes in or adjacent to the El Rio Park area (see Figure 1), and
2. Constructing a pilot demonstration project for control and use of storm runoff from Silvercroft and Anklam Washes in or adjacent to the El Rio Park area.

#### PROCEDURES

For accomplishing the stated objectives above, the following methods will be used.

1. Available are (a) data on precipitation and storm runoff, both quantity and quality; and (b) hydrologic

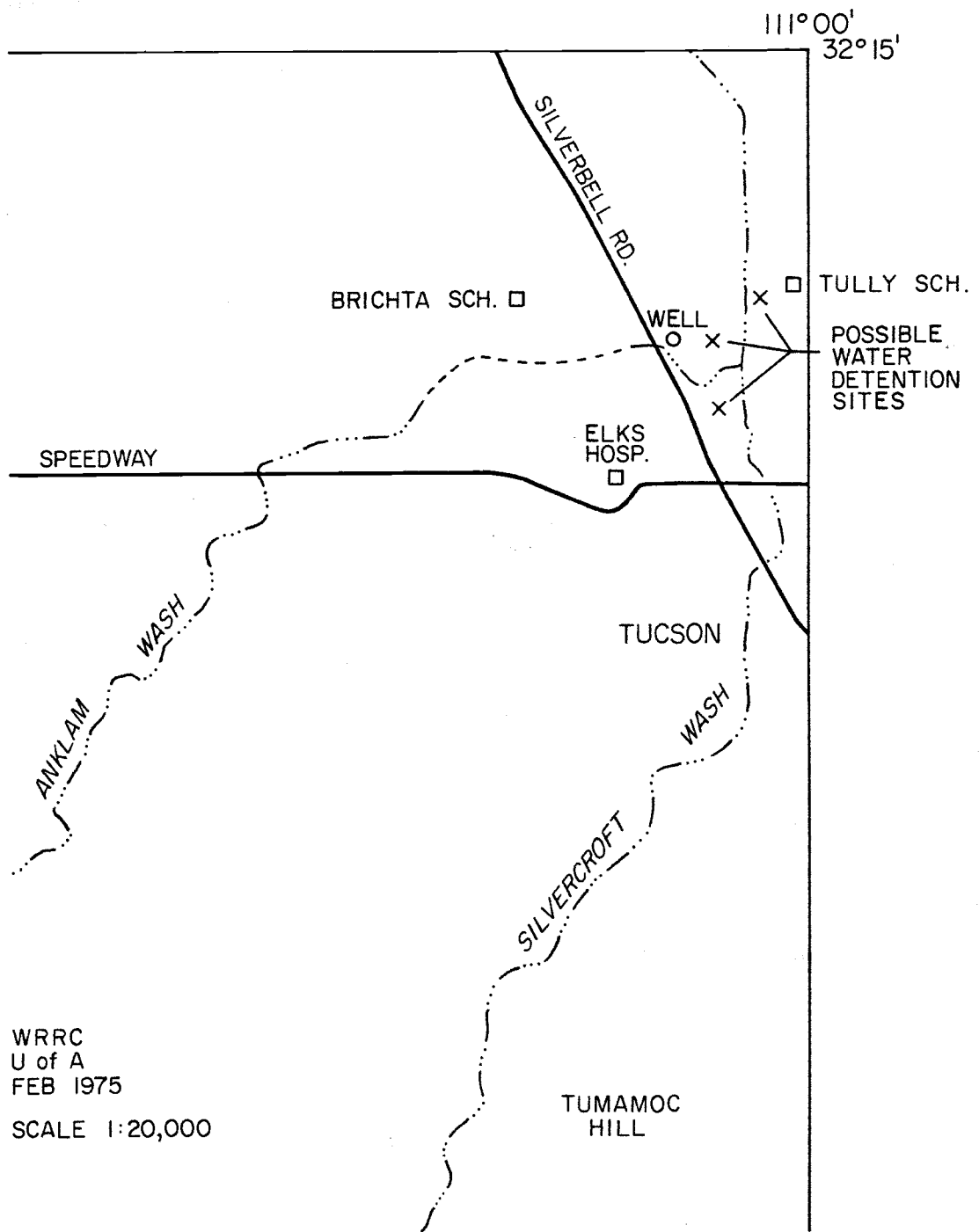


FIGURE I. HYDROLOGIC STUDY AREA

analyses, such as rainfall-runoff relationships, unit hydrographs, mass and duration curves, and runoff recurrence intervals, for the five watersheds in the Tucson area listed above. With these data and analyses, designs of facilities, such as diversion structures, grass and soil filters, plastic-lined lakes, artificial groundwater recharge mechanisms, and flood spillways, for control and use of storm runoff in Anklam and Silvercroft Washes will be made for the El Rio Park area.

The approach used involves reducing flood crests by diverting a portion of the storm runoff into off-channel basins by means of collapsible dams in the channels. Part of the water trapped in these catch basins would be retained for recreational lakes and park irrigation purposes; the remainder would be released slowly back into the stream channel during and after the termination of the storm, thereby aiding in flood control and natural groundwater recharge.

2. Using designs developed under Objective 1, a pilot field facility demonstrating all of the principles involved would be constructed in or adjacent to El Rio Park. The heart of the pilot system would be a plastic-lined one-acre lake, with the cut material being used for landscaping the area adjacent to the lake. Grass on the landscaped area would provide filters for sediment in storm runoff; and the existing park irrigation well can be used for supplemental water in dry periods and also could be used for purposes of artificial groundwater recharge of storm runoff, which

has infiltrated and moved down through the grass-covered soil profile to perforated pipe collectors.

The information obtained through operation of pilot field development would provide adequate definition of the technical and economic feasibility of some of the management alternatives studied.

#### RELATED WORK

Many aspects of the proposed work are based on previous or related research which can be readily extended to implementation of a field demonstration facility.

The data collected from the three small urban watersheds and one rural watershed have been analyzed for the purpose of investigating the effect of urbanization on rainfall-runoff relationships. Using the model developed by U.S. Soil Conservation Service, the effect of urbanization on runoff volume was determined in terms of percentage of impervious area, including paved streets and parking lots, institutions, industrial and commercial areas, and unpaved yet considerably compacted alleys.

The hydrologic and economic effect of urban street pattern on drainage has also been studied. The objective of this study was to investigate tradeoffs between alternative street patterns from the viewpoint of urban drainage. This effort is the subject of a Ph.D. dissertation completed by Kao (1973).

Sampling of runoff for quality analysis was conducted on all study watersheds. Samples received from the watersheds were composited according to flow rate. Complete bacteriological and chemical analyses are available for the samples; solids and chemical oxygen demand (COD) data also were obtained. These quality data were analyzed according to procedures

established by E.F. Mische (1971).

A field-treatment facility in the form of a grass-covered soil filter of native calcareous loam, 200-feet long, 4-feet wide and 5-feet deep, was tested for effectiveness as a water-quality treatment device for Tucson urban storm runoff. Water was pumped from Arcadia Wash and applied to the filter. Inflow and outflow volumes were measured, sampled and analyzed for selected water-quality variables. The general pattern of water-quality changes included a decrease in the average concentration value for each water-quality measure from trial to succeeding trial, and an initially high, or increasing, concentration value of each measure followed by decreasing values in a particular trial. Grass establishment initially increased efficiency of the water-quality improvement process. Further analytical details on this treatment process are found in a thesis by Popkin (1973).

A landscape design model for an 80-acre water-based recreational area on Arcadia Watershed was completed in late summer 1971, and the set of drawings on this have been submitted previously.

Construction of a landscape design model also was completed for an area owned by Tucson Medical Center at the confluence of Arcadia and Alamo Washes. The 38-acre area design would provide two small scenic lakes fed by diversion of peak storm flows in the two washes and desilted by grass filtration on terraced slopes.

A study of a more general planning model, using Anklam Watershed as a reference base for a newly developing area, was carried forward. The study provides procedures for developing a model for planning water-based linear parks along stream channels such as Anklam Wash; the results of the study were presented in an M.S. thesis by Johnson (1973), and the

physical features of the area are shown in Attachment A.

An economic study has been initiated which examines the landscape design models and the projected linear park systems, described earlier, in terms of an alternative flood control solution. This developmental scheme represents one alternative for joint land and water management for the combined purposes of flood control, water supply augmentation, and recreation within the Arcadia Watershed. The study examines various economic aspects of such a scheme to determine its desirability as a public planning alternative.

Legal studies under the project dealt with rights to increased flows generated by urbanization, and with aspects of legal control of development along waterways in the semiarid environment. The full report on the studies is being prepared for publication (Holub, 1973).

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- Holub, H., Some Legal Problems of Urban Runoff, Univ. of Arizona Water Resources Research Center, Typewritten Report, 1973.
- Johnson, R.C., Procedures for Developing a Model for Planning Water-Based Linear Parks Along Stream Channels in Semiarid Urban Regions, Univ. of Arizona M.S. Thesis, 1973.
- Kao, S.E., Effects of Urban Street Pattern on Drainage, Univ. of Arizona Ph.D. Dissertation, 1973.
- Mische, E.F., The Potential of Urban Runoff as a Water Resource, Univ. of Arizona Ph.D. Dissertation, 1971.
- Popkin, B.P., Effects of Mixed-Grass Cover and Native-Soil Filter on Urban Runoff Quality, Univ. of Arizona M.S. Thesis, 1973.



Kenneth J. DeCook  
 Associate Hydrologist  
 Water Resources Research Center  
 University of Arizona

Birthdate  
 June 7, 1925

University of Arizona	B.S. Geology	1951
University of Texas	M.A. Geology	1957
University of Arizona	Ph.D. Water Resources Administration	1970

### Experience

Field Appraiser and Deputy Assessor, Pima County Courthouse, Tucson	1946-1950
Hydrologic Field Assistant and Geologist, U. S. Geological Survey, Arizona and Texas Districts	1950-1958
Assistant Hydrologist and Research Associate, Institute of Water Utilization, University of Arizona	1958-1959
Consulting Geologist and Hydrologist, Tucson and Phoenix Areas	1959-1961 1963-1965
Assistant District Engineer, San Carlos Irrigation and Drainage District, Coolidge, Arizona	1961-1963
Research Associate, Water Resources Research Center, University of Arizona	1965-1970
Associate Hydrologist, Water Resources Research Center, University of Arizona	1970-Date

### Professional and Honorary Affiliations

Member, American Geophysical Union  
 Member, American Institute of Professional Geologists, CPG 1216  
 Member, Geothermal Resources Council  
 Member, Sigma Gamma Epsilon (National Honorary Society for  
 Earth Sciences)  
 Member, Sociedad Geologica Mexicana

### Selected Publications

1. "Reconnaissance of the Ground-Water Resources of the Marathon Area,  
 Brewster County, Texas," Texas Board of Water Engineers Bull. 6111, 1961.
2. "Geology and Ground-Water Resources of Hays County, Texas," U. S.  
 Geological Survey Water-Supply Paper 1612, 1963.
3. "Technical and Institutional Aspects of Sewage Effluent-Irrigation  
 Water Exchange, Tucson Region," Water Resources Bulletin, v. 7,  
 no. 4, p. 726-739, 1971. (With C. B. Cluff, W. G. Matlock).

SoI D. Resnick  
 Professor of Hydrology and Director  
 Water Resources Research Center  
 University of Arizona

Birthdate  
 June 15, 1918

University of Wisconsin	B.S. Agriculture	1941
University of Wisconsin	B.S. Civil Engineering	1942
University of Wisconsin	M.S. Civil Engineering	1949

### Experience

Tennessee Valley Authority, Assistant Hydraulic Engineer	1942-1943
Carson-Newman College, Instructor	1943-1944
United States Army	1944-1948
Colorado State University, Assistant Professor	1949-1952
Agency for International Development, India, Irrigation Specialist	1952-1957
The University of Arizona, Director, Water Resources Research Center, and Professor of Hydrology	1957-Date
Special assignment with SEATO Graduate School of Engineering, Thailand, Sept.-Nov. 1959. Teaching and research in water resources.	
University of Arizona/AID, Brazil, at College of Agriculture, University of Ceara, 1964-1966, Water Resources Specialist.	
Special assignment with International Bank for Reconstruction and Development, Brazil, Oct.-Nov. 1969, Irrigation Engineer.	
Agency for International Development, Philippines, Sept. 1973, Water Resources Specialist	

### Professional and Honorary Affiliations

Member, American Society of Civil Engineers  
 Member, American Society of Agricultural Engineers  
 Member, American Geophysical Union  
 Member, International Commission of Irrigation and Drainage  
 Honorary Societies: CHI EPSILON, PI MU EPSILON, SIGMA XI,  
 ALPHA ZETA, GAMMA SIGMA DELTA, SIGMA TAU

### Selected Publications

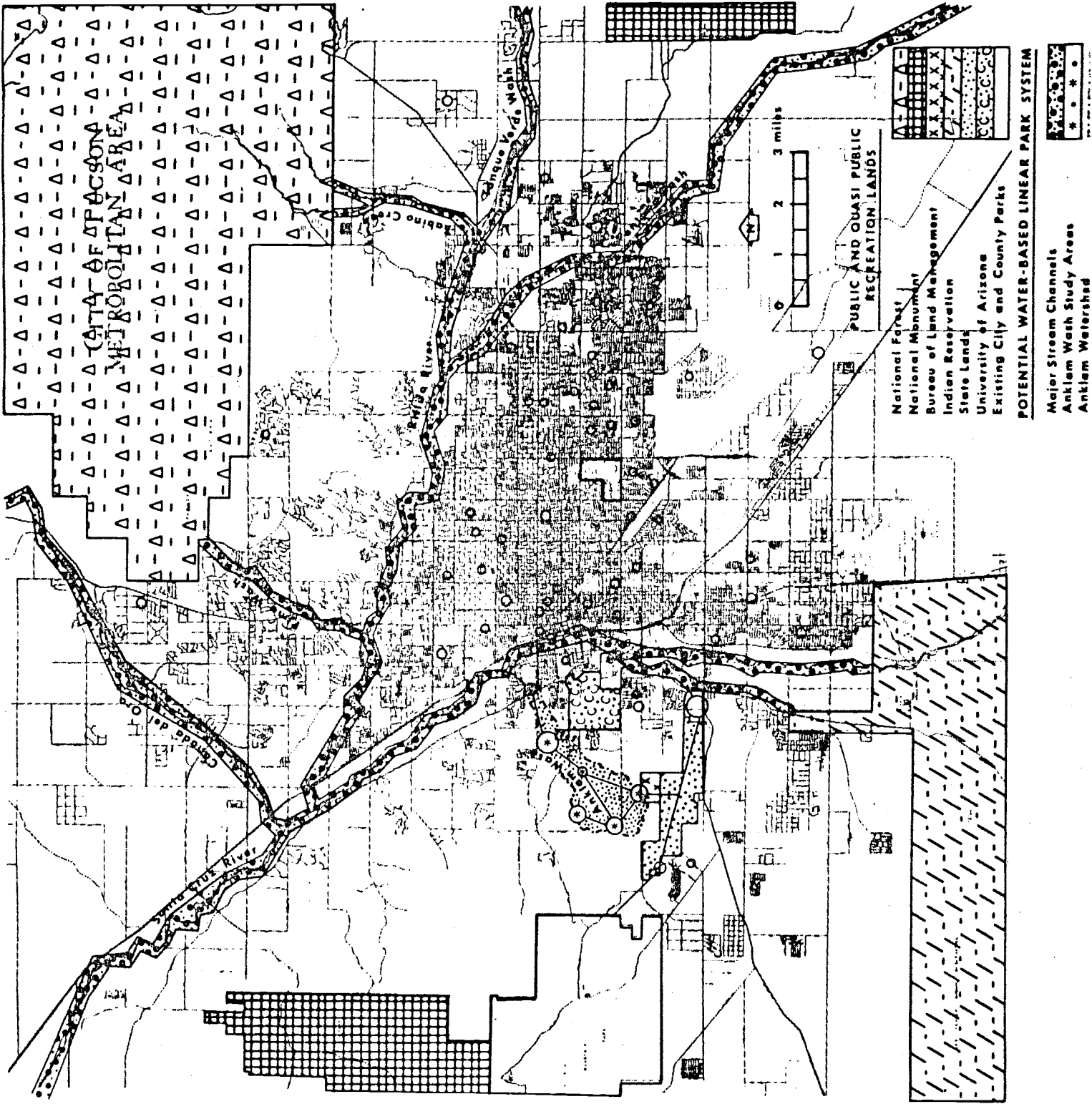
- "Hydraulic Model Tests for Rihand Dam," Colorado Agricultural Experiment Station, with M.L. Albertson, et al., 1950.
- "Calibration of Armco Metergate Model No. 101," Colorado Agricultural Experiment Station, 1951.
- "Analysis of Climatological Data for the Spring Cloud Seeding Period over North Central Colorado," Colorado Agricultural Experiment Station, 1951.
- "Hydrologic Investigations for Planning of Soil Conservation Practices," Journal of Soil and Water Conservation in India, Vol. 5, No. 4, 1957.
- "Development of Water Resources in the Southwest," Arizona Agricultural Experiment Station Technical Paper No. 562, 1959.
- "Artificial Groundwater Recharge," Arizona Watershed Symposium, Proceedings, 5: 24-27, with G. Maddox, 1961.
- "Evaporation Reduction Investigations Relating to Small Reservoirs in Arid Regions," Arizona Agricultural Experiment Station Report 224, with C.B. Cluff, 1964.
- "Dependence of Arizona Agriculture on Water," Arizona Academy, Tenth Arizona Town Hall, Chap. VI, pp 107-130, 1967.
- "Large-Scale Transfers of Water and Alternatives," Arid Lands in Perspective, The American Association for Advancement of Science, The University of Arizona Press, Tucson, Arizona, pp 418-421, 1969.
- "Water Management Team Report for the Bicol River Basin, Luzon Island, Philippines", USAID/Philippines, with W.R. Schmehl and G. Stringham, 1973.

### Current Research

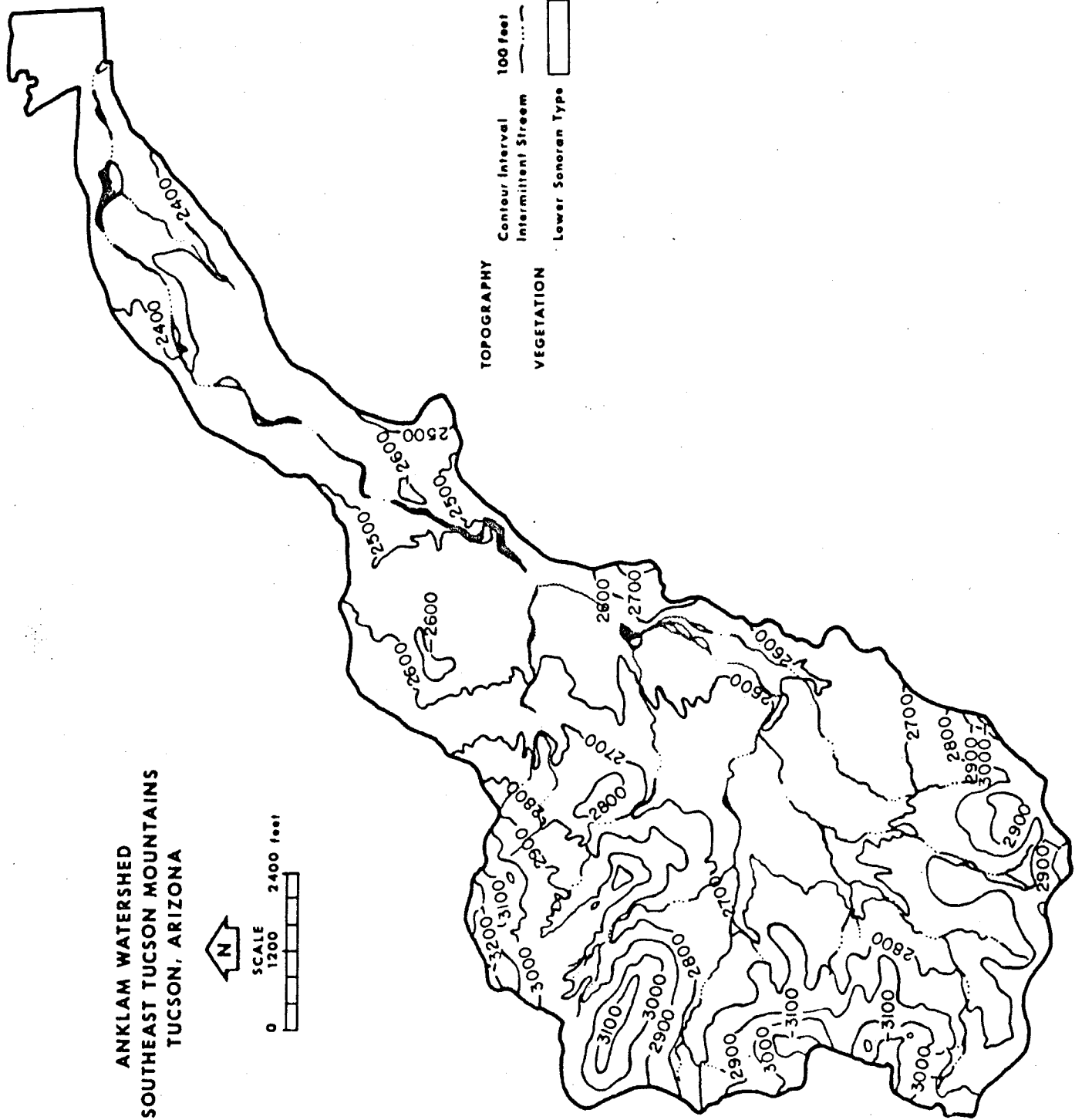
- Reuse of salvageable water resources and urban hydrology.



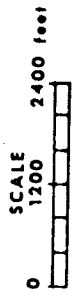
Attachment A



**ANKLAM WATERSHED  
SOUTHEAST TUCSON MOUNTAINS  
TUCSON, ARIZONA**

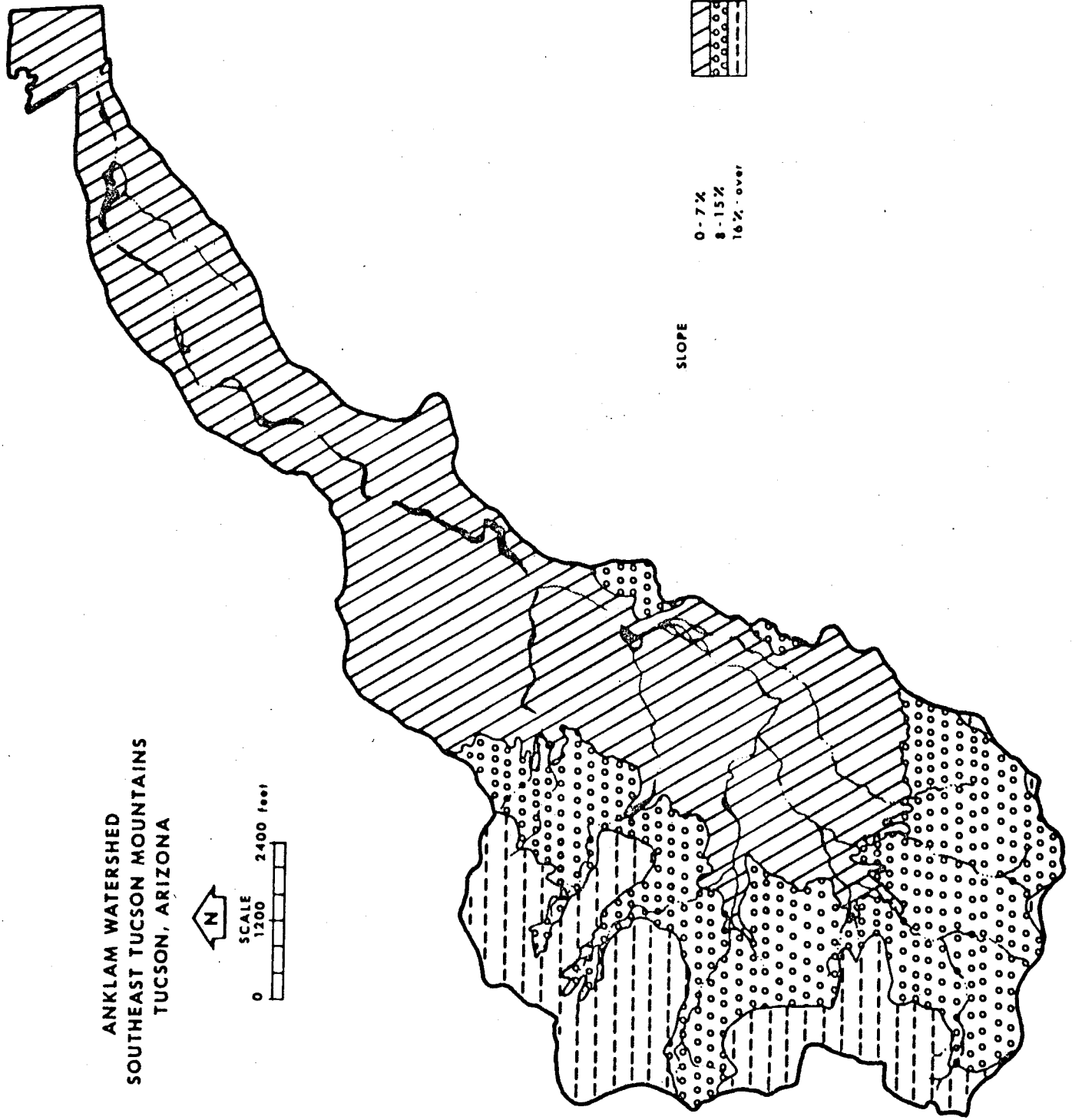


ANKLAM WATERSHED  
SOUTHEAST TUCSON MOUNTAINS  
TUCSON, ARIZONA

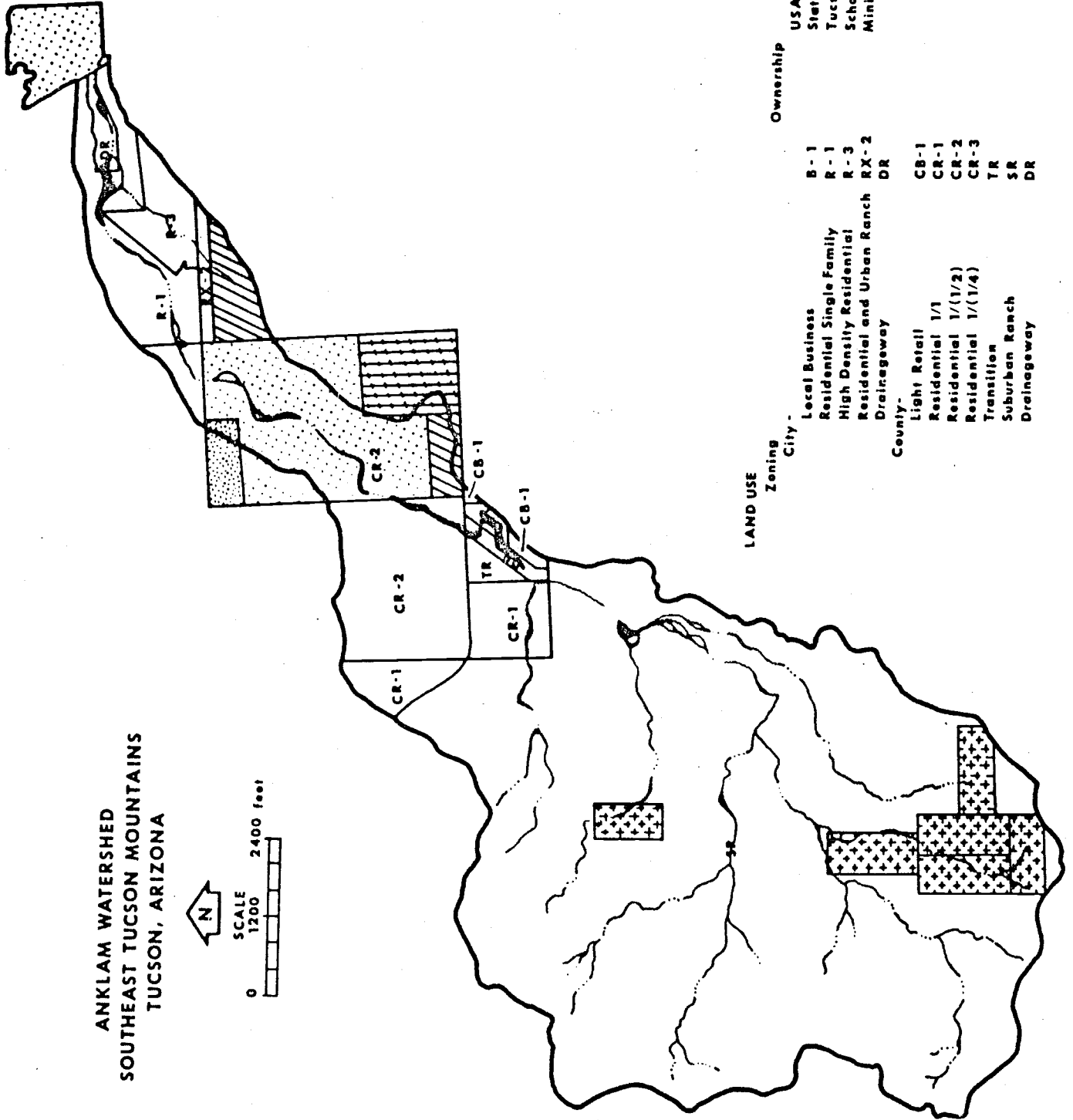


SLOPE

- 0-7%
- 8-15%
- 16% - over



ANKLAM WATERSHED  
SOUTHEAST TUCSON MOUNTAINS  
TUCSON, ARIZONA

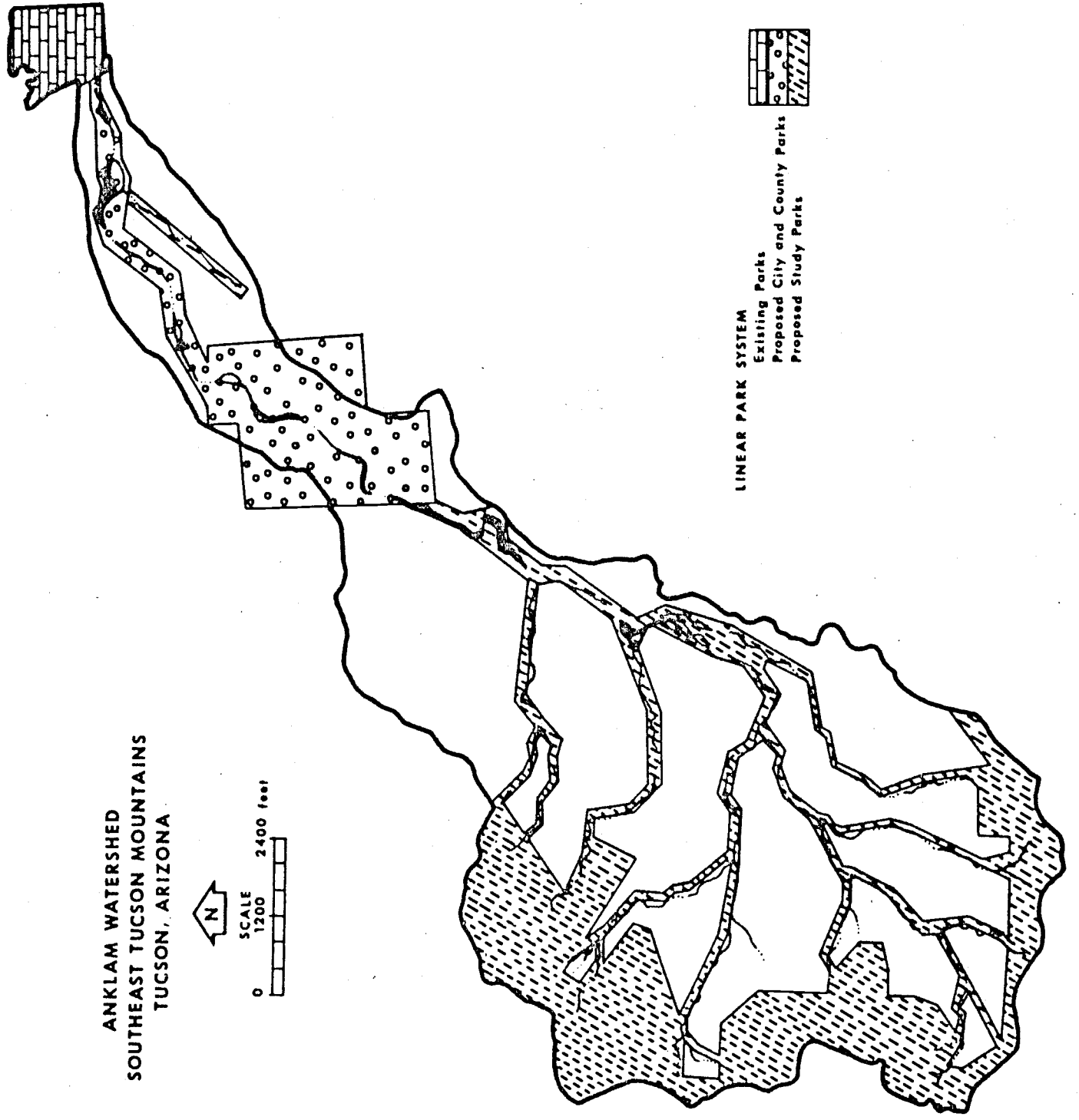
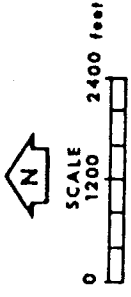


LAND USE

Zoning		Ownership	
City	County		
Local Business	Light Retail	B-1	USA
Residential Single Family	Residential 1/1	R-1	State
High Density Residential	Residential 1/(1/2)	R-3	Tucson
Residential and Urban Ranch	Residential 1/(1/4)	RX-2	School
Drainage	Transition	DR	Mining
	Suburban Ranch		
	Drainage		



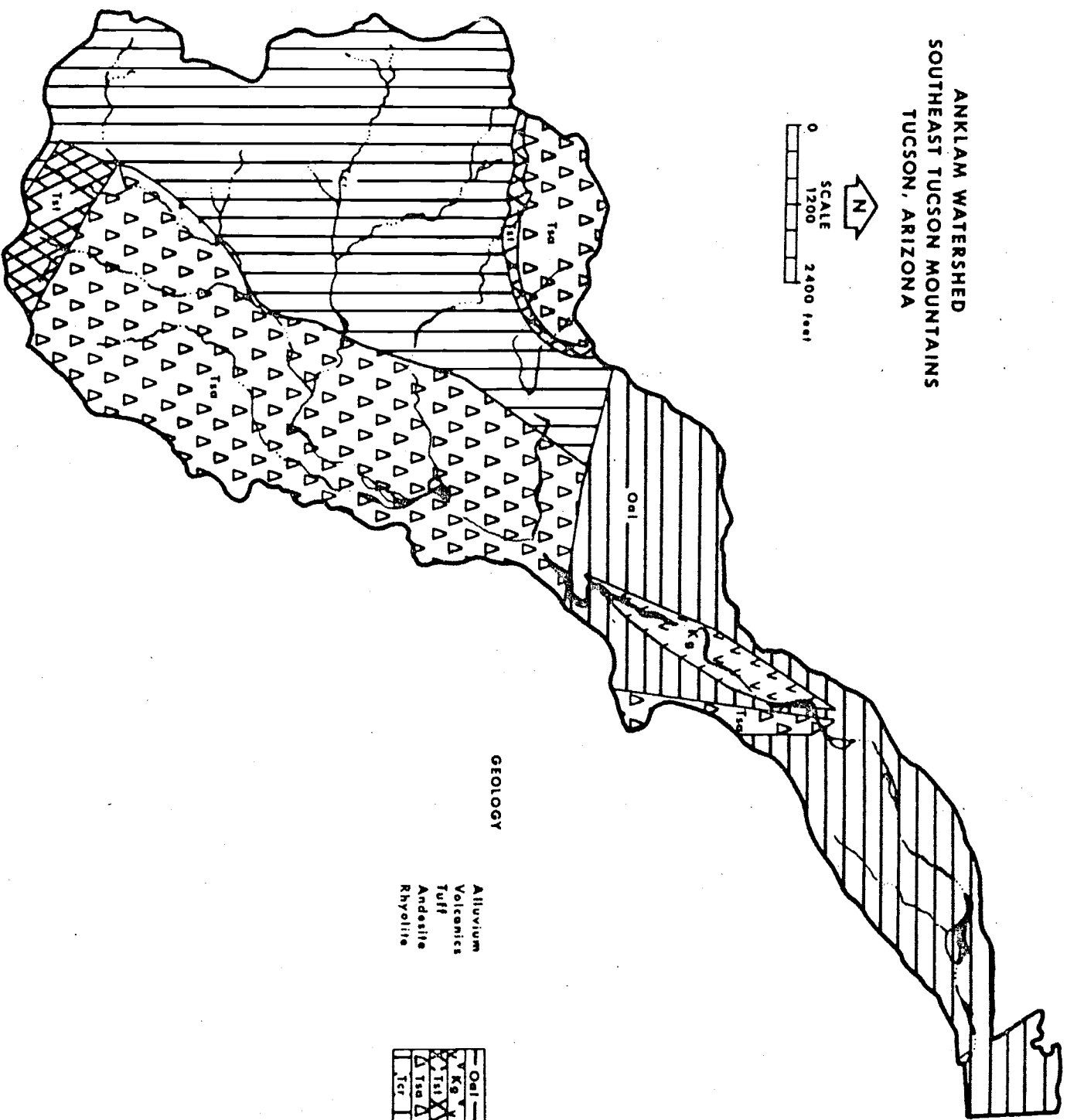
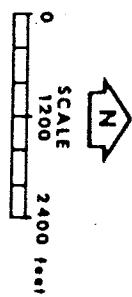
ANKLAM WATERSHED  
SOUTHEAST TUCSON MOUNTAINS  
TUCSON, ARIZONA



LINER PARK SYSTEM

- Existing Parks
- Proposed City and County Parks
- Proposed Study Parks

ANKLAM WATERSHED  
 SOUTHEAST TUCSON MOUNTAINS  
 TUCSON, ARIZONA



GEOLOGY

- Oai — Alluvium
- △ Tsd Volcanics
- △ Tsi Tuff
- △ Tsd Andesite
- △ Tcr Rhyolite

— Oai —
△ Tsd
△ Tsi
△ Tcr