AD-A184 444 GENERAL REEVALUATION REPORT UPPER SKUNK RIVER BASIN IOWA (AMES LAKE)(U) ARMY ENGINEER DISTRICT ROCK ISLAND IL JUL 87 1/3

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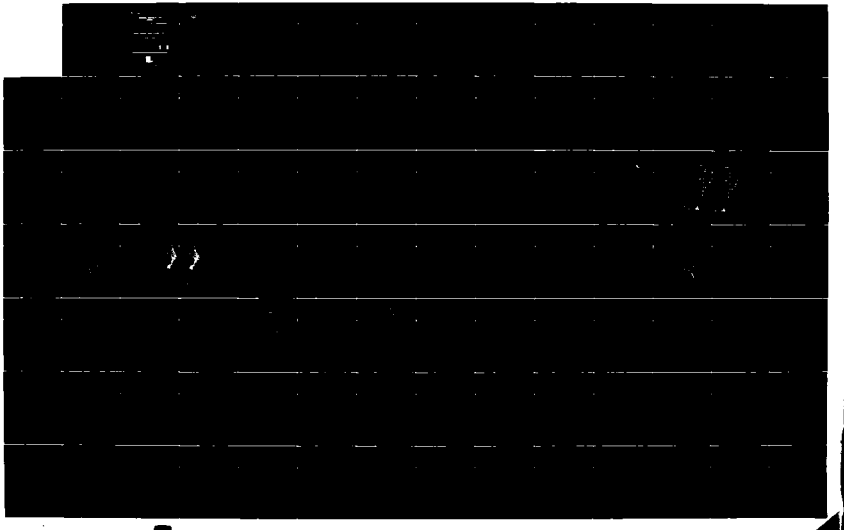

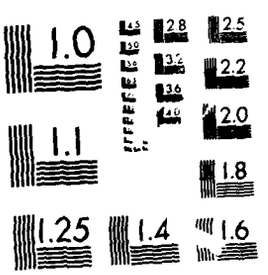

GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA

(Ames Lake)

JULY 1987

U.S. Army Corps of Engineers
Rock Island District

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
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REPLY TO
ATTENTION OF
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GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

JULY 1987

ACKNOWLEDGEMENT

Primary study team members who are familiar with the technical aspects of the study are listed below:

STUDY MANAGEMENT	Joe Ross
ENVIRONMENTAL	Karen Bahus
CULTURAL RESOURCES	Chip Smith
ECONOMIC STUDIES	Bill Morse
HYDRAULIC STUDIES	Roger Less

SYLLABUS

Congress authorized a project for Ames dam and reservoir in 1965. However, opposition to a large reservoir caused the State of Iowa to withdraw project support. The project was classified as "inactive' in 1974.

On 2 July 1984, the Ames Lake project was reclassified from "inactive" to "active" because of renewed interest. Funds were appropriated to initiate a reevaluation report in fiscal year 1985.

This General Reevaluation Study was prepared to analyze alternatives to the Ames Lake project which would satisfy the authorized project purposes of flood control, low-flow augmentation, and water-based recreation. Water supply was not a designated project purpose for the authorized project; however, based on the city of Ames' concern over their future water supply, solutions to Ames' water supply also were evaluated as part of this multiple-purpose reevaluation study.

The authorized project is not economically feasible today. Smaller reservoirs, levees, nonstructural methods, soil conservation practices, and channel modifications were studied as alternatives to the authorized project. A smaller reservoir at the authorized project site is economically feasible, having an estimated cost of $42 million and a benefit-to-cost ratio of 1.2.

The State of Iowa does not support the smaller reservoir and will not sponsor it. The city of Ames also is not interested in sponsoring the project.

It is therefore recommended that Federal involvement in the Ames Lake project be terminated at this time because the project is not acceptable and there is no State or local project sponsor.

GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

TABLE OF CONTENTS

Subject	Page
Study Authority	1
Study Purpose and Scope	1
Related Studies, Reports, and Existing Water Projects	2
Plan Formulation and Evaluation	4
Planning Objectives	4
Planning Constraints	4
Study Area	4
Review of Authorized Plan (Ames Lake)	5
As Submitted	5
Authorized Changes	5
Problems and Opportunities	6
Existing Conditions	7
Skunk River Basin Characteristics	7
Flooding	7
Water Supply	8
Water Quality	9
Recreation	9
Alternative Plans	9
Smaller Reservoirs	10
Flow Release Requirements	10
Squaw Creek Detention Reservoir (SC-1)	11
Ames Reservoir (Authorized)(SR-1)	12
Ames Reservoir (Downsized)	13
Bear Creek and Onion Creek Sites (SR-4 and SC-6) Water Supply	13
Bear Creek Water Supply Reservoir (Site SR-4)	14
Onion Creek Water Supply Reservoir (Site SC-6)	15
Ames, Iowa, Local Flood Protection	17
Downstream Agricultural Levees	19
Nonstructural Alternatives (Floodplain Management)	20
Soil Conservation Practices	20
Channel Modifications	21
Environmental Status - General	21
Environmental Concerns Common to all Alternatives	22
Water Quality	22
Threatened and Endangered Species	22
Cultural Resources	23
Major Environmental Concerns for Each Alternative	24
Authorized Plan (Ames Lake)	24
Authorized Plan (Ames Lake) Downsized	24
Downstream Agricultural Levees (Polk County)	24
Squaw Creek Detention Reservoir	25

TABLE OF CONTENTS (Cont'd)

Subject	Page
Ames, Iowa, Local Flood Protection	25
Onion Creek Water Supply Reservoir	25
Bear Creek Water Supply Reservoir	25
Coordination and Public Involvement	25
Conclusions	28
Authorized Ames Lake Project	28
Smaller Reservoirs	28
Levees	29
Nonstructural Alternatives	29
Soil Conservation Practices	29
Channel Modifications	30
Summary	30
Recommendation	30

List of Plates

No.	Title
1	Skunk River Basin
2	Authorized Project in 1965
3	Authorized Ames Reservoir Dam (plate 6 from GDM)
4	Identified Alternative Impoundment Sites
5	Detailed Study Sites Above Ames, Iowa
6	Squaw Creek Detention Dam Location and Profile
7	Squaw Creek Detention Dam Sections and Plan
8	Ames Reservoir (Downsized) Locations and Sections
9	Bear Creek Water Supply - Dam and Spillway
10	Bear Creek Water Supply - Spillway Details
11	Onion Creek Water Supply - Location, Plan and Section
12	Onion Creek Water Supply - Dam Sections
13	Ames, Iowa, Local Flood Protection
14	Study Site - Agricultural Levee

List of Appendixes

A	Hydrology and Hydraulics
B	Economic Analysis
C	Pertinent Correspondence
D	Cost Estimates

DISTRIBUTION LIST

GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

STUDY AUTHORITY

On 10 December 1964, an interim report considering a dam and reservoir near Ames, Iowa, on the Skunk River was completed by the Rock Island District in partial response to the following resolution:

> Resolved by the Committee on Public Works of the United States Senate, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the report on the Skunk River, Iowa, printed as House Document Numbered 170, Seventy-second Congress, First Session, and subsequent reports on the Skunk River, Iowa, with a view to determining the advisability of undertaking improvement for flood control and major drainage in the Skunk River Basin at this time. (Adopted 1 June 1948).

On 27 October 1965, the project recommended in the 1964 interim report for Ames Dam and Reservoir, Skunk River, Iowa, was authorized in Public Law 89-298, substantially in accordance with the recommendations of the Chief of Engineers, as modified by the Secretary of the Army, in House Document 267, Eighty-ninth Congress, first session.

In October 1973, the State of Iowa withdrew support of the project, and it was classified as "inactive" on 20 June 1974.

On 2 July 1984, the Ames Lake project was reclassified from "inactive" to "active" in response to renewed interest and funds were appropriated to initiate a reevaluation report in fiscal year 1985.

STUDY PURPOSE AND SCOPE

This reevaluation was conducted to reformulate the authorized plan to meet current problems and needs. Alternatives to the authorized plan also were considered based on requests from State agencies and governmental entities. The studies made were of reconnaissance scope.

RELATED STUDIES, REPORTS, AND EXISTING WATER PROJECTS

A report on the Skunk River, Iowa, dated 12 February 1930, was prepared by the District Engineer, Rock Island, Illinois, under authority of Section 10 of the Flood Control Act approved 15 May 1928, and was printed as House Document 170, Seventy-second Congress, first session. The investigations for that report showed that additional improvement of the river or its tributaries for flood control or flood protection was not economically feasible at that time. Studies of possible future power development indicated that there was little potential for economic hydropower development. A need for developing the streams for other beneficial water uses was not indicated.

A report of comprehensive investigations of reservoirs in the Mississippi River Basin, dated 15 December 1934, was prepared by the Mississippi River Commission and printed as House Document 259, Seventy-forth Congress, first session. Reservoir sites in the Skunk River Basin were studied as a part of this report.

A report, dated 21 January 1939, on the Mississippi River from Coon Rapids Dam to the mouth of the Ohio River, was prepared by the Division Engineer, Upper Mississippi Valley Division, and printed as House Document 669, Seventy-sixth Congress, third session. In that report, construction of certain reservoirs previously included in the comprehensive plan for control of floods on the Mississippi River was considered inadvisable at that time. The report discussed development of additional hydroelectric power at two sites on the Skunk River, but concluded that such development was not economically feasible at that time. Possible channel rectification and the construction of levees along the Skunk River in Keokuk and Washington Counties, Iowa, also were considered infeasible.

A report for flood control on the Skunk River, dated 30 March 1951, was prepared in which the District and Division Engineers recommended construction of two reservoirs, the Ames Reservoir on the Skunk River and the Gilbert Reservoir on Squaw Creek, both a few miles upstream from Ames, Iowa. However, the Board of Engineers for Rivers and Harbors, after holding a public hearing, returned the report for further study and consultation with local interests. After return of the report in October 1952, and prior to completion of the Interim Review of Reports on the Skunk River, Iowa - Ames Reservoir, dated 10 December 1964, the investigations on the Skunk River were in an inactive status.

The investigations and studies for the project document plan are contained in a report, dated 10 December 1964, on the Interim Review of Reports for Flood Control and Other Purposes on the Skunk River, Iowa - Ames Reservoir. This report was prompted by action of the Iowa Natural Resources Council, bringing attention to the fact that plans for Interstate 35 would conflict with any future development of the previously recommended Ames Reservoir. Gilbert Reservoir on Squaw Creek remains in an inactive status.

Channel straightening projects were accomplished in various reaches of the Skunk River during the period 1893 to 1927. The work was done through drainage districts organized under State laws and mainly involved Story, Jasper, Polk, and Mahaska Counties. Some 90 miles of the Skunk River and 24 miles of the North Skunk River were straightened. The entire cost of the work was paid by the abutting landowners.

In conjunction with the channel straightening in Polk County, spoil bank levees were constructed with the excavated channel material. These spoil bank levees were built along both sides of the channel, and flank levees were built along the Polk-Story County line and along the major tributaries in the Polk County reach. These levees do not meet Corps of Engineers design criteria and are not considered reliable protection against floods greater than the 2-year flood or a flood having a 50 percent chance of being equalled or exceeded in any year.

At present, a Section 22 study is underway by the Rock Island District, Corps of Engineers, to determine hydraulic and hydrologic features of the main stem South Fork Skunk River and North Skunk River. The study's objective is to provide technical data needed to enable the State of Iowa to provide more comprehensive management of the Skunk River floodplain.

A Skunk River Basin study currently is underway by the U.S. Department of Agriculture, Soil Conservation Service (USDA-SCS), to identify alternative solutions to land and water resource related problems. The study's scheduled completion date is September 1987. The Rock Island District, Corps of Engineers, coordinated with the SCS and asked for their input for the Reevaluation Study.

In their December 1985 report to the Rock Island District, the SCS investigated certain aspects of the Upper Skunk River Basin. It was mutually agreed between the Rock Island District and the SCS that the studies:

* Determine the feasibility of watershed protection (land treatment) projects
* Evaluate effects of increased amounts of soil conservation land treatment practices upon:
    - soil erosion by water
    - sediment yields to potential reservoir sites being studied by Rock Island District
    - flood peaks
    - aquifer recharge
* Address the effects of reservoir pools upon drainage
* Provide a general assessment of structural project potential above Ames, Iowa
* Inventory potential impoundment sites with less than 5 square miles of drainage area above Ames, Iowa

The studies concluded that conservation tillage would control 45 percent of the problem area, leaving 55 percent requiring additional treatment. Contour farming is needed on 27,000 acres, and both contouring and terraces are needed on 11,600 acres. These figures indicate that sheet and rill erosion is not an extensive problem. Only 7 percent, or 21,200 acres, is eroding at rates greater than 15 tons per acre per year. It was estimated that needed conservation practices could be installed in the study area using programs with anticipated levels of cost-share and technical assistance.

Very few impoundment sites are available with drainage areas less than 5 square miles and with adequate storage volume for sediment, temporary flood retention, and other beneficial uses. Several valleys that appeared to have good reservoir sites were found to have more drainage area and runoff than could be accommodated effectively by available flood storage.

PLAN FORMULATION AND EVALUATION

PLANNING OBJECTIVES

The specific objective of this General Reevaluation Study is to determine if any project can be developed which:

a. Is acceptable to State and local interests.

b. Serves the same purposes as the authorized project -- flood control, low-flow augmentation, and water-based recreation. The need for water supply in the Ames area also is addressed.

c. Meets the criteria for Federal participation in a project.

PLANNING CONSTRAINTS

The general reevaluation study efforts are restricted to the development of alternative plans which meet the same project purposes as the authorized plan. However, additions to the current project purposes, such as water supply, are considered and undertaken in accordance with current planning principles and guidelines.

STUDY AREA

The major area studied during the reevaluation is the upper portion of the Skunk River Basin (approximately 60 river miles). This area includes the headwaters of the Skunk River and its tributaries down to the mouth of

Indian Creek, which is near the town of Colfax, Iowa. The counties involved are Hamilton, Boone, Story, Polk, and Jasper. See plate 1 for the study area delineation.

This study area contains the widest portion of the Skunk River floodplain; therefore, it was determined that the most benefits could be derived from this area compared to other reaches of the basin and that the general reevaluation study efforts should be concentrated here for identifying feasible alternatives to the authorized Ames Lake project. Areas downstream in Mahaska, Keokuk, and other downstream counties could benefit by a recommended project in the upper basin. Local flood protection projects also could be studied downstream if any potential study sites can be identified. Except for Ames, urban flood damages are not common in the Skunk River Basin. Most flood damages in the basin are to agricultural land. If agricultural levees are not cost effective in the study area where the floodplain is the widest and damages are the greatest, levees would not be practical downstream of the study area where the floodplain is narrower.

REVIEW OF AUTHORIZED PLAN (AMES LAKE)

As Submitted

The plan recommended in the 1964 interim report consisted of a reservoir having a capacity of 94,000 acre-feet at the top of flood control pool elevation 968 feet NGVD (National Geodetic Vertical Datum). The estimated 100-year accumulation of sediment was 8,400 acre-feet, and 25,000 acre-feet of capacity was allocated to water supply and water quality control. The remaining 60,600 acre-feet of storage available was allocated to flood control. The dam would consist of an earthen embankment about 75 feet high and about 1,260 feet long at the crest. Outlet works would be a gated single conduit having an inside diameter of 7 feet. The spillway would be controlled by five tainter gates. The reservoir would cover about 4,350 acres of full pool and would be within banks at Story City, Iowa. Remedial work would consist of raising three roads across the reservoir, making a fourth submersible, and relocating certain telephone and power lines. Minor work would be required at Story City's sewage treatment plant. Interstate Highway No. 35, then in the advanced planning stage, would be shifted from the originally planned alignment to fit the reservoir needs.

Authorized Changes

The plan described in the 1964 report was changed prior to authorization in accordance with recommendations by the Board of Engineers for Rivers and Harbors that flood storage be increased from 3.6 inches of runoff to 5.2 inches. While only the estimate showing the increased cost of doing this work appeared in the report document, the changes would include

increasing the height of tainter gates at the dam and increasing the elevation of road relocations, land acquisition, and Story City remedial works. A pool elevation of about 976 feet NGVD was needed to provide the recommended storage. The Secretary of the Army further modified the multiple-purpose aspects of the project by stating that water supply would not be formally designated as a project purpose at that time.

The Design Memorandum No. 1, General Design Memorandum (GDM), dated 30 September 1968, incorporated all of the authorized changes. These changes included storage for 5.2 inches of basin runoff with a full flood-pool at elevation 976 feet NGVD. The GDM No. 1 further modified the authorized plan as a result of more detailed investigations. The outlet works was changed from a 7-foot inside diameter cut-and-cover conduit to a 12-foot inside diameter tunnel driven through rock in the left abutment. The conduit was increased to provide for a maximum release of 3,000 cubic feet per second (ft^3/s) (up to full channel capacity) during the non-growing agricultural season. Also, the larger conduit was needed to permit evacuation of three-forths of the flood control storage in approximately a 2-week period and to divert river flows during construction. The gated spillway was modified from one having fives gates to a single-gated structure 48 feet wide. This was made possible mainly by the incorporation of an emergency spillway 800 feet wide in erodible material on the right abutment. The larger capacity of the tunnel outlet works was another factor permitting a reduction in the required capacity of the gated spillway. The authorized plan is shown on plates 2 and 3.

PROBLEMS AND OPPORTUNITIES

The authorized project continues to be the focus of strong opposition from conservationists and upstream landowners in and adjacent to the proposed reservoir.

Conservationists object to the authorized project because of the established greenbelt area along the Skunk River from Ames to Story City and the fact that about 10 to 15 percent of all the Story County trees are located in the Skunk River Valley within the conservation pool limits of the authorized project. There would be very little established timberland surrounding the conservation pool. The loss of the buried mineral deposits within the reservoir area and historic sites such as the Soper Mill area are also concerns. Upstream landowners are concerned about the loss of agricultural land and the impacts the reservoir would have on the Story City park, golf course, roads, and waste treatment plant.

However, water resource problems and needs continue to affect the entire Skunk River Basin. Water supply and low-flow augmentation are particular needs in the Ames area, while flooding continues to be a problem throughout the basin. There is a continuing need to reduce urban and agricultural flood damages, enhance the environmental and recreational attributes of the river valley, and/or provide technical knowledge to address the water supply needs of the Ames community.

This study reevaluates the authorized Ames Lake project with current benefit-cost data. More importantly, perhaps, the study analyzes alternatives to the Ames Lake project which would satisfy the authorized project purposes of flood control, low-flow augmentation, and water-based recreation. Water supply was not a designated project purpose of the authorized project; however, based on the city of Ames' concern over their future water supply, solutions to Ames' water supply also were studied as part of this multiple-purpose reevaluation study. All of the alternatives were screened first based upon hydraulic and economic considerations. Feasible alternatives were screened further based upon environmental and social considerations and on the preferences of local interests.

EXISTING CONDITIONS

Skunk River Basin Characteristics

The Skunk River Basin in Iowa has a long, narrow configuration (plate 1), extending from Hamilton County, about 30 miles north of Ames, Iowa, southeasterly to the Mississippi River below Burlington, Iowa. The total watershed area of 4,652 square miles includes 4,355 miles drained by the Skunk River and 297 square miles of direct Mississippi River drainage. The basin covers 7.7 percent of Iowa and lies in parts of 20 counties. It is 180 miles long and has an average width of 24 miles.

The Skunk River (officially designated by the U.S. Geological Survey as the South Skunk River above the confluence with the North Skunk River in Keokuk County) begins in Hamilton County, is 64 miles long and has a fall of 680 feet down to the mouth at the Mississippi River. From Ames to the eastern Mahaska County line, the Skunk River floodplain is relatively wide, reaching a maximum width of about 2 miles in Polk County. The river meanders through a narrower natural floodplain in Keokuk, Washington, Jefferson, Henry, Des Moines, and Lee Counties. Above Ames, the river channel is predominantly unaltered and in its natural state. The Skunk River slopes about 5 feet per mile for the upper one-fourth of the river. Below Ames, for the remaining upper half of the river, the slope is about 1.5 to 3 feet per mile. For the lower one-half of the river, the slope averages about 1.2 feet per mile. The channel varies in cross-sectional area from 1,000 square feet at Ames to 5,000 square feet near its mouth at Augusta, Iowa. Bankfull flow varies from about 3,000 ft^3/s at Ames to 17,000 ft^3/s near Augusta.

Flooding

The upper Skunk River floodplain has been extensively developed for agriculture, specifically, crops and pasture. Corn, soybeans, oats, wheat, and hay are the principal crops grown in the bottomlands. Generally, the bottomland soils produce abundant crops during nonflood years.

The Skunk River frequently overflows its banks and causes extensive agricultural flooding. Most of the flooding generally occurs in June, with localized flooding occurring throughout the agricultural growing season as the result of local heavy rainfall. About 95 percent of the Skunk River Basin is in farms. Roughly 85 percent of the area subject to flooding, about 100,000 acres, is used for agriculture, so there is little urban damage from flooding.

Lands most affected by floods are located downstream from the city of Ames. Periodic flooding of the bottomlands causes extensive damage to crops and, of a lesser extent, to rural property. Only the very great floods cause damage to urban property. Ames and Story City are among the few urban areas affected, with Ames receiving the most urban damage from basin flooding.

Polk and Jasper Counties are interested in flood control projects which will protect farmland. The city of Ames expressed interest in a flood control project which would reduce flood risk in their urban area, but water supply is their primary concern. The counties of Mahaska and Keokuk have expressed interest in channel straightening as an alternative to alleviating flooding through those counties.

Water Supply

Information from previous Corps of Engineers studies showed that two-thirds of the Skunk River Basin population was served by 64 municipal water supply systems in 1971 and nearly all obtained water from ground water sources. Water usage reported in 1971 was 11.7 million gallons per day (mgd) for domestic and commercial use. Industrial use was 14.0 mgd. Water usage was estimated then to increase six times by the year 2020. Water supplies were deemed adequate for this increased need, except at Ames, where projected use would surpass output of the shallow aquifer there by around the year 2000.

During the local drought of 1977, the city of Ames was forced into emergency action to surcharge the aquifer from which they draw water. The city officials feel that additional or supplementary flow in the Skunk River or in Squaw Creek is a needed additional water resource to support the growth of the community. As stated previously, they anticipate adequate water supply, only through the year 2000. Low flows of less than 5 ft^3/s have existed in the Skunk River and Squaw Creek during periods of the last 8 years.

The city of Ames passed a resolution in February 1984 which requested the Corps of Engineers to reactivate the Ames Lake project, mainly for the "enhancement of water supply resources for the city of Ames and low-flow augmentation of the Skunk River during dry periods."

Water Quality

Natural flow in the Skunk River has dwindled to nothing during past drought periods, the latest being 1977. The Ames Water Pollution Control Plant discharges treated wastewater effluent into the Skunk River. Therefore, during dry periods the only flow downstream from Ames is treated effluent. The city of Ames and Story County are interested in low-flow augmentation to improve the Skunk River's water quality.

During the mid-1960's, the Federal Water Pollution Control Administration identified two potential oxygen sags, one below Ames and the other below the town of Newton about 40 miles southeast of Ames. Currently, Ames and Newton are building newer sewage treatment facilities, and the resulting effluent will require a lower Skunk River flow for dilution in order to maintain suitable conditions for the proliferation of fish life.

Recreation

The Skunk River is considered a warm-water fishing stream by State regulatory authorities. The Skunk River Valley includes an existing greenbelt area, and the several Story County entities are working together to preserve the natural resources of the river valley from urban development. To date, the Story County Conservation Board has acquired over 800 acres of the valley corridor for recreational purposes and enjoyment.

Any project which would be detrimental to this greenbelt area is expected to receive opposition from Story County conservationists. The greenbelt is located along the Skunk River from Ames north to Story City. This is the area where the previously authorized Ames Lake Reservoir was to be built.

ALTERNATIVE PLANS

This reevaluation study investigated possible alternatives to the Authorized Ames Reservoir Project. The Authorized Project also was reanalyzed to determine the project's present-day feasibility. The alternatives considered include:

* Smaller Reservoirs
* Levees
* Nonstructural Alternatives (Floodplain Management)
* Soil Conservation Practices
* Channel Modifications

The Skunk River's relatively flat gradient and wide floodplain (2 miles $\pm$) below Ames are not conducive to reservoir development for flood control on the main stem below Ames. Previous reports made in the 1950's and 1970's

by the Rock Island District for flood control on the Skunk River concluded that flood control reservoirs below Ames were not economically feasible. Of some 60 sites studied in the Skunk River Basin, only two could be considered for reservoir development. One was the authorized Ames Reservoir site and the other was the Gilbert Reservoir site on Squaw Creek about 2 miles northwest of Ames. The Gilbert site was never recommended for construction because of the lack of local interest.

This reevaluation study identified potential reservoir sites in the upper Skunk River Basin above Ames. These 14 sites, shown on plate 4, were identified from topographic maps as possible alternative sites to the Ames Reservoir site shown as SR-1 on plate 4.

Another structural alternative considered was levee protection to protect urban and rural areas from flooding. Levee protection was studied for the city of Ames, as shown on plate 13. A study site for agricultural levee protection was selected in Elkhart Township, Polk County, Iowa, as shown on plates 1 and 14.

Smaller Reservoirs

Preliminary hydrologic and hydraulic review of the 14 sites shown on plate 4 eliminated all but 4 from further study. Sites eliminated lacked both watershed size and storage capacity to function effectively as multi-purpose sites. All of the sites eliminated would not function even as efficient single-purpose flood control sites. Thus, those sites with greater storage potential near Ames were selected for further evaluation of their multi-purpose capabilities and water supply potential. These four sites, as identified on plate 4, include the Squaw Creek Site (SC-1), Onion Creek Site (SC-6), Bear Creek Site (SR-4), and the previously authorized Ames Lake Dam Site (SR-1). These sites are shown on plate 5.

Flow Release Requirements

The flow release requirements were updated for multiple-project purposes. Operating plans for the authorized Ames Lake project originally included a monthly varying low-flow release schedule averaging 22 ft^3/s and a two-level high-flow release schedule of 3,000 ft^3/s from December 1st to April 1st and 1,000 ft^3/s from April 1st to December 1st. For the reevaluation study, the high-flow release of 3,000 ft^3/s or 1,000 ft^3/s remained the same release of 22 ft^3/s was to satisfy water quality needs.

Through coordination with the Iowa Department of Water, Air, and Waste Management (letter included in pertinent correspondence appendix), the minimum low-flow requirement to satisfy water quality is now 2 ft^3/s. This reduction is partially attributable to the fact that Ames and Newton,

Iowa, are constructing new wastewater treatment facilities. For water supply needs at Ames, a minimum sustained low flow of 5 ft^3/s is needed on the Skunk River during low-flow periods to recharge the surficial aquifer where the city's well field is located. Low-flow releases on Squaw Creek also would provide some benefit to the well fields during drought conditions. To satisfy U.S. Fish and Wildlife concerns, a minimum low flow release of 10 ft^3/s is needed at potential reservoir outlet structures. These low-flow requirements were used to determine the adequacy of potential reservoir sites.

Squaw Creek Detention Reservoir (SC-1)

The Squaw Creek Site (SC-1), shown on plates 6 and 7, is about 8.6 miles upstream along Squaw Creek from its confluence with the Skunk River. The site is approximately 2 miles upstream from the previously studied Gilbert Dam Site. Area development necessitated moving the study site upstream from the old Gilbert site. The Gilbert site was economically justified in 1970 as a single-purpose flood control project with a benefit-to-cost ratio (BCR) of 1.6.

The Squaw Creek site was studied as a single-purpose flood control detention dam with a dry reservoir. A multi-purpose facility including flood control was not possible because of the limited storage capacity. Some specifics of the detention dam are as follows:

Controlled Drainage Area (sq. mi.)	160
Earthen Embankment Height (feet)(approx.)	52
Length, feet (approx.)	1,750
Top of Dam El. (NGVD)	962
Spillway, Saddle Type, Uncontrolled Ogee Weir with Chute and Stilling Basin	
Width (feet)	430
Crest Elevation (NGVD)	946.5
Outlet Works, Single Round Conduit, with Controlled Inlet	
Length, feet (approx.)	350
Diameter, feet	9
Reservoir	
Detention Reservoir, no Conservation Pool	
Capacity at Spillway Crest (acre-feet)	20,500
Inches of Storage	2.4
Area at Spillway Crest (acres)	1,430
Capacity at Top of Dam (acre-feet)	52,000
Inches of Storage	6.1
Area at Top of Dam (acres)	2,910
Length of Reservoir at Spillway Crest (miles)	4.75

Benefits from this detention structure would be for flood control only. The estimated cost is $25 million (see appendix D), and the BCR is 0.65.

Ames Reservoir (Authorized) (SR-1)

The previously authorized *Ames Reservoir* is shown on plate 2. The flood control pool (elevation 976 NGVD) is outlined on plate 5. The project site is located on the Skunk River just north of Ames. The authorized project provided storage for 5.2 inches of basin runoff with a full flood-pool at elevation 976 feet NGVD. The storage was increased prior to authorization from 3.6 inches of storage (Project Document Plan) at the recommendation of the Board of Engineers for Rivers and Harbors. The project was a multi-purpose project to satisfy the needs of flood control, low-flow augmentation, and recreation. Water supply was not a project purpose. The authorized project cost was estimated at $17.5 million in September 1968 and had a BCR of 1.5. Pertinent data for the authorized Ames Lake Reservoir are listed below.

Ames Lake Reservoir

	Elevation (Ft., NGVD)	Area (Acres)	Storage Acre-Feet	Inches
Top of Dam	992.0	9,200	240,000	14.7
Maximum Pool	987.5	7,500	195,000	11.6
Top of Flood Pool	976.0	5,000	124,000	7.4
Top of Conservation Pool	950.0	2,100	34,500	2.1
Top of Sediment Pool	933.0	800	8,400	0.5
Flood Control Storage	950-976	--	89,500	5.2
Conservation Storage	933-950	--	26,100	1.6

The Ames Lake Reservoir also was analyzed for low-flow or drought conditions. Reservoir releases during low-flow periods were maintained according to the current low-flow demand of 10 ft^3/s which satisfies U.S. Fish and Wildlife requirements and is greater than the minimum flow requirements of 2 ft^3/s and 5 ft^3/s for water quality and water supply needs. The maximum period of record drawdown was associated with the 22-month drought from August 1955 to June 1957 (from full conservation pool to full conservation pool). The critical duration from full conservation pool to maximum reservoir drawdown was 18 months. A period of record optimization of the elevation 950 conservation pool indicated that the reservoir has a safe yield of 18.5 ft^3/s which would satisfy present demands.

The authorized project costs and benefits were updated to reflect current conditions. Today's estimated cost for the authorized project is $72 million (see appendix D). The BCR is 0.71. The authorized project therefore is not economically feasible.

Ames Reservoir (Downsized)

An identified alternative to the authorized Ames Lake Project to reduce the adverse impacts of the reservoir is to downsize the authorized project. Although the authorized project is not economically feasible today, it is of interest to determine whether a smaller reservoir would be feasible. The conservation pool would be lowered from elevation 950.0 feet NGVD to elevation 946.0 feet NGVD which would provide a yield of 10 ft^3/s. The limits of the flood pool are shown on plate 5. The top of the flood control pool would be lowered from elevation 976.0 feet NGVD to elevation 965.0 feet NGVD and would provide 3.0 inches of flood control storage. The top of the dam would be lowered from elevation 992.0 feet NGVD to elevation 982.5 feet NGVD. The 12-foot diameter tunnel outlet would be relocated from a tunnel bored through rock in the left abutment to a cut-and-cover conduit through the earthen dam embankment as shown on plate 8. The spillway design would be adjusted appropriately and could revert to the Project Document Plan arrangement which had a gated spillway in the left abutment with the spillway crest located on rock. Flood control storage would be reduced from 89,500 acre-feet to 51,000 acre-feet. The top of the sediment pool elevation would remain at elevation 933.0, the same as for the authorized project.

The estimated cost of the Project Document Plan to provide 3.6 inches of flood storage is $49 million. The estimated cost for a reservoir providing 3.0 inches of flood storage is $42 million (see appendix D). The respective BCR's are 1.11 and 1.21. Impacts to Story City would be minimized, but some residents, upstream landowners, and interest groups have submitted written statements opposing all reservoir development in the Skunk River Basin above Ames. They oppose any project which might interfere with farm-tile drainage, would take farmland out of production, or would impact on the existing Skunk River greenbelt.

Bear Creek and Onion Creek Sites (SR-4 & SC-6) Water Supply

Streamflow shortages in the Upper Skunk River Basin are a problem, with water supply being an acute problem during extended drought periods. The water supply need is highlighted by the periodic shortages experienced at the city of Ames which draws its water from alluvial wells (100 ± feet deep) along the Skunk River and Squaw Creek. (Iowa State University in Ames is a major water user and is included when reference is made to the city of Ames.) The authorized Ames Lake project included low-flow augmentation releases which would enhance the infiltration of river water into the well field during low-flow periods.

A site survey for other potential reservoirs in the upper basin found no sites which would be able to function as a multi-purpose site such as the Ames Lake site. This is due to the fact that all the identified sites lacked both watershed size and storage capacity to function effectively as

multi-purpose sites. Thus, reservoir sites near Ames were selected for further evaluation of their single-purpose water supply potential. Two sites were selected: one on Bear Creek which is a tributary to the Skunk River, and a site on Onion Creek which is a tributary to Squaw Creek. These sites are shown on plates 4 and 5.

The city of Ames indicated that their projected future water supply needs will be in the range of 10 million gallons per day (mgd). The existing city wells on the Skunk River and Squaw Creek furnish 8 and 3 mgd, respectively, under normal conditions. During drought conditions, their yields are reduced to 6 and 2 mgd, with supplemental help from pumping of Hallet's Quarry on the north side of town just west of Highway 69 and low-head dams in the river channels pooling the available flows. Despite this supplemental pumping, a shortage of 2 mgd exists during drought conditions. The city well field location would benefit the most from low-flow augmentation on the Skunk River; however, augmented flows on Squaw Creek also would recharge the superficial aquifer.

Bear Creek Water Supply Reservoir (Site SR-4)

The Bear Creek reservoir, located on plate 5, is the same as the Bear Creek recreational subimpoundment included in the authorized Ames Lake project. The dam would be formed in part by the Interstate 35 Highway embankment as shown on plates 9 and 10. The estimated cost for the reservoir development is $3.2 million (see appendix D). Due to the limited storage capacity and poor base flow characteristics, the reservoir would provide for no sustained low-flow releases. Outflows would occur only when streamflow causes the pool to exceed the outlet spillway crest and for emergency water supply releases which would supplement existing flows in recharging the alluvial aquifers through Ames.

The effects of sediment deposition on the reservoir pool detract from the amount of usable storage available throughout the life of the reservoir. Annual sediment yields were determined by the Soil Conservation Service as part of their contract study for the Rock Island District, Corps of Engineers, to provide input for the Upper Skunk River Basin Reevaluation Study. The determined yield was 9,900 tons per year under present watershed conditions. For their Resource Protection Plan (RPP), the sediment yield would be 6,700 tons per year. Using an in-place density of 55 lbs/ft^3, these two rates equated to 8.3 and 5.6 acre-feet of sediment per year. The 100-year sediment deposition then would be 830 and 560 acre-feet. These quantities represented inactive pool elevations of 954.5 and 951 feet NGVD for the Bear Creek reservoir.

The Bear Creek reservoir is incapable of maintaining sustained 5 ft^3/s flows throughout the two severe drought periods studied from June 1955 to May 1957 and June 1976 to August 1977. Any augmented streamflows less than 5 ft^3/s are judged to be insufficient to be a viable supplement to Ames' water supply problems. Only when the emergency releases are commenced later in the drought periods are the pool drawdowns not encroaching

into the inactive sediment pool. A zero flow analysis indicates that the Bear Creek reservoir would provide approximately 4.5 months of sustained 5 ft^3/s of augmentation to the city of Ames' well fields. Since the Bear Creek reservoir is incapable of providing sustained low-flow augmentation and resultant aquifer recharge, it must be viewed as providing only emergency releases such as Hallet's Quarry pumping did in 1977. Release and pumping rates are similar; however, the reservoir would be able to provide releases for 4.5 months before being depleted.

ONION CREEK WATER SUPPLY RESERVOIR (SITE SC-6)

The site studied for the Onion Creek water supply reservoir is 1 mile northwest of Ames on the Onion Creek tributary to Squaw Creek. The dam would be formed by an earthen embankment with a concrete chute spillway and saddle type emergency spillway as shown on plates 11 and 12. The estimated cost for the reservoir development is $9.1 million. This includes the estimated $6.5 million for lands and damages.

As with the Bear Creek Reservoir, due to limited storage capacity and poor base flow characteristics, the reservoir would provide for no sustained low-flow releases, only emergency releases.

The effects of sediment deposition in the reservoir pool detract from the amount of usable storage available throughout the life of the project. Annual sediment yields determined by the SCS were 7,000 tons per year under present watershed conditions. For the RPP, the sediment yield would be 4,800 tons per year. Using an in-place density of 55 $lbs/ft^3/s$, these two rates equate to 5.8 and 4.0 acre-feet of sediment per year; 100-year sediment deposition then would be 580 and 400 acre-feet. These quantities represent inactive pool elevations of 931 and 928 feet NGVD for the Onion Creek reservoir. A zero flow analysis indicated that the Onion Creek reservoir would provide approximately 7 months of sustained 5 ft^3/s low-flow augmentation when using area average evaporation rates.

Streamflow yield potential on both Bear and Onion Creeks is intermittent; thus, base flow is essentially zero for both streams during droughts. The Onion Creek reservoir has more usable storage and therefore is the "better" water supply reservoir from the reservoir yield standpoint, even though it is located on a drainage area 40 percent smaller than the Bear Creek reservoir. However, as previously mentioned, the estimated development cost of the Onion Creek reservoir is $9.1 million, as compared to $3.2 million for the Bear Creek reservoir.

A critical drought period analysis for the Ames Lake reevaluation determined the critical duration to be 18 months. From a hydrologic standpoint, it is felt that a water supply reservoir for Ames must provide beneficial low-flow augmentation for a minimum of 12 months. This allows a 6-month lag for the existing aquifer to become stressed in before emergency water supply releases are commenced. Neither of the two sites provide for this recommended minimum 12-month capacity. Consequently, the Bear and Onion Creek water supply sites do not appear to be viable alternatives for ensuring a reliable supply of water to the city of Ames.

Pertinent Information
Bear Creek Water Supply Reservoir

Dam:	
Location (River Mile)	1 mile above Skunk River
Legal	NW1/4, Sec. 5, T84N, R23W, Story County
Water Area (Sq. Mi.)	31
Earthen Embankment, I-35 with "Eyebrow" Dam Across Bridge Opening	
Height (Ft.)	54
Top-of-Dam (NGVD)	982
Spillway, Erodible Broad-Crested Weir (Emergency)	
Width (Ft.)	275
Crest Elevation (NGVD)	975
Service Spillway, Fixed-Crest Box Inlet, Concrete Chute	
Width (Ft.)	20
Crest Elevation (NGVD)	970
Low-Level Outlet	30" RCP
Reservoir:	
Conservation Pool (NGVD)	970
Capacity (Ac-Ft)	2,650
Capacity (Inches)	1.6
Capacity (Gallons)	8,630
Area (Acres)	160
100-Year Pool (NGVD)	975.2
SPF Flood Pool (NGVD)	979.2
100-Year RPP Sediment Pool (NGVD)	951.0

Pertinent Information
Onion Creek Water Supply Reservoir

Dam:	
Location, River Mile	0.7 mile above Squaw Creek
Legal	NE1/4, Sec. 32, T84N, R24W, Story County
Watershed Area (Sq. Mi.)	19
Earthen Embankment	
Height (Ft.)	65
Length (Ft.)	700
Top-of-Dam (NGVD)	970

Spillway, Saddle Type, Uncontrolled	
Broad-Crested Weir, Grass-Lined	
Width (Ft.)	200
Crest Elevation (NGVD)	957
Service Spillway, Fixed-Crest Box	
Inlet, Concrete Chute	
Width (Ft.)	10
Crest Elevation (NGVD)	950
Low-Level Outlet	30" RCP
Reservoir:	
Conservation Pool (NGVD)	950
Capacity (Ac-Ft)	3,100
Capacity (Inches)	3.1
Capacity (MGallons)	1,010
Area (Acres)	200
100-Year Flood Pool (NGVD)	956.9
Maximum Flood Pool (NGVD)	967.5
100-Year RPP Sediment Pool (NGVD)	928.0

The Ames Reservoir Environmental Study in 1973 addressed the "Future Water Supply Requirements and Alternative Sources of Supply at Ames." It concluded then that, "at the median population and water demand levels, the existing well field system must be augmented by another source by the year 2000." The study also concluded that low-flow augmentation through reservoir releases would definitely contribute to the water supply system at Ames.

Development of small single-purpose water supply reservoirs by local interests is not practical based on their high cost and unreliability.

In lieu of a multi-purpose reservoir, the city of Ames will have to provide another source of water to supplement their needs. Alternative plans of action considered by the city of Ames and Iowa State University include a water supply management program to preserve the groundwater source available in the Hallett quarry area and surrounding area on the north side of the city. Also, additional well fields could draw water from the valley alluvium or water table which would be a less confined system hydraulically than the present well system which is located in a confined portion of the surficial aquifer. Another source of water could be the Jordan Aquifer. The smaller city of Nevada just east of Ames has wells to the Jordan Aquifer. Ames, however, is hesitant about considering deep wells (2,700 $\pm$ feet) because of the initial cost ($2.5 million for 2 wells) and chemical costs for water softening of the bedrock water which has increased hardness and higher levels of dissolved solids.

AMES, IOWA, LOCAL FLOOD PROTECTION

The levee study area shown on plate 13 includes about 120 acres of commercial and multi-family development and open space floodplain property on the left bank of Squaw Creek located three-fourths of a mile above its

confluence with the Skunk River in Ames, Iowa. The lower part of the study area is subject to flooding from both Squaw Creek and the Skunk River. The levee project area is divided by South Duff Avenue (Highway 69).

The Federal Emergency Management Agency (FEMA) published a Flood Insurance Study (FIS) for the city of Ames in July 1980. The FIS was prepared by the Corps of Engineers under contract to FEMA. Flood profiles and flow-frequency information in the FIS were verified using current data and were considered acceptable for use in determining required levee heights. The levee alignment coincides with the FIS floodway limits based on a 1-foot increase in 100-year water surface profile in accordance with State back-water criteria.

The FIS 100- and 500-year flood profiles differ in elevation by about 1 foot. The designed levee profile coincides with the 500-year profile with 3 feet of freeboard. The maximum levee height is 10 feet and the levee fill would be obtained from excavated Ponding Areas A and B. The flank levee along the Skunk River would tie into high ground just south of Lincoln Way at Borne Avenue. Upstream along Squaw Creek, the flank levee would extend to South Fourth Street just west of Walnut Avenue. The levee would protect commercial businesses along South Duff Avenue (Highway 69) and apartment housing along South Fifth Street.

The area that the levee would protect is the most severely impacted area in Ames during a flood. Flood damage also would occur to some homes and businesses in the Skunk River floodplain from Lincoln Way south to the confluence with Squaw Creek. Also, damage would occur along Squaw Creek on the left downstream overbank from upstream of the studied project area to just upstream of the Fourth Street bridge. Flooding would occur west of Elwood Drive in the Iowa State University Center complex, but damages would be minor since structures there were designed with floodproofing measures.

Existing interior drainage facilities within the study area include the storm sewers shown on plate 13. A 45-inch sewer and a 36-inch sewer would be routed into Ponding Area A with a new outlet and gatewell located on the upstream side of South Duff Avenue. A 36-inch sewer and a 30-inch sewer east of South Duff Avenue would continue to outlet as is, with excess runoff collecting in Ponding Area B. Gatewells would have to be added at both outlets. Ponding Area A would be 5 acres in size and Ponding Area B would be about 14 acres in size. Both ponding areas would be excavated about 6 feet deep. The excavated material would be used for the levee embankment. The 100-year storm was used as the design storm for gravity flow conditions on both ponding areas. The 10-year storm was selected as the design storm for blocked gravity conditions. Peak ponding elevations were lower than the estimated non-damaging elevations at both ponding areas, and pumping would not be required.

The estimated construction cost, including real estate for the 500-year level of protection, is $1,820,000. The estimated cost for 100-year protection is $1,740,000. The BCR for both levels of protection (including future growth benefits) is less than 0.3. This lack of economic justification does not warrant any further Federal interest in providing levee protection for flooding at Ames.

Downstream Agricultural Levees

An analysis was made to determine the cost effectiveness of using agricultural levees for flood protection on the main stem of the Skunk River. A study area in Polk County was selected due to its high ratio of acres protected versus lineal feet of main stem levee. The Skunk River floodplain is typically the widest in Polk County and, thus, maximum benefits would be achieved here as compared to a river reach with a narrower floodplain. If agricultural levees are not feasible in this reach, it could be concluded that they would not be feasible in other reaches of the Skunk River. Studies were made in the early 1950's to investigate local flood protection of lands in Story County downstream from Ames, in Polk County, and in part of Jasper County. These areas have the widest floodplains in the entire basin. The plan was to provide a leveed floodway along the main stem, diversion channels to collect hill runoff and smaller streams, and leveed floodways to carry the flows of the larger hill streams into the main stem. Those studies showed this flood protection to be economically infeasible.

The selected study area, as shown on plates 1 and 14, is located in sections 14, 15, 23, 24 and 25, T. 81 N., R. 23 W., Elkhart Township, Polk County, Iowa. The levee would lie between river miles 205.2 and 208.6 on the right overbank. The project levee would total about 25,000 feet in length with 18,000 feet fronting the river and 7,000 feet serving as tiebacks. The protected area has an estimated 100-year floodplain of 1,500 acres, or 2.3 square miles. Previous studies have determined that the current levee system, a spoil bank system, provides on the average a 2-year level of flood protection.

To determine encroachments and levee offsets, a typical valley section was determined at river mile 207. Quantities and costs were estimated for agricultural levees to protect against 25-and 100-year frequency flows at the study site shown on plate 14. The encroached flood level elevations plus 3 feet of freeboard were used to determine top of levee elevations. The levee section has a top width of 10 feet and 3 horizontal to 1 vertical side slopes. Borrow was assumed available adjacent to the levee. The estimated costs, including real estate and a 25 percent contingency, are $2,750,000 and $3,200,000 for the 25- and 100-year levels of protection, respectively. These costs do not include provisions for interior drainage. The benefit-to-cost ratios are 0.23 and 0.22, respectively.

NONSTRUCTURAL ALTERNATIVES (FLOODPLAIN MANAGEMENT)

Nonstructural alternatives would typically include continuing floodplain management practices to limit development in the floodplain which would result in greater flood damage and economic losses. The city of Ames, which has the greatest potential in the Skunk River Basin for suffering urban flood damage, is participating in the regular phase of the National Flood Insurance Program. Local floodplain ordinances, as part of the program requirements, regulate development in the floodplain to minimize future flood damage.

Most of the flood damage in the basin is to agricultural land. Nonstructural measures will not stop flooding, and it is doubtful if land-use management plans could reduce economic losses. Many farms have most or all of their productive land in the floodplain, and conversion to pasture land or timber is not practical. Land evacuation also is not practical. Land in the floodplain will be subjected to continued periodic flooding.

Soil Conservation Practices

The United States Department of Agriculture, Soil Conservation Service (USDA-SCS), provided input to the Upper Skunk River Basin Reevaluation Study by contract with the Corps of Engineers, Rock Island District. The scope of work included a study of small structure sites in the Upper Skunk River Basin as an alternative to control flooding. Because of the topography, only five sites were identified as having potential as flood prevention sites with drainage areas less than 5 square miles. None of the sites identified had enough storage to provide an adequate degree of flood protection. The total drainage area controlled by the five sites only equalled 12.9 square miles, or 2 percent of the total watershed area above Ames. According to the SCS, 30 to 50 percent of the drainage area must be controlled by structures in order to effectively control flood peaks.

Public Law 83-566 authorizes the SCS to work on watersheds with drainage areas of 250,000 acres or less. Through Public Law 83-566, single-purpose flood prevention impoundments are limited to 12,500 acre-feet of storage, and multi-purpose use storage impoundments are limited to 25,000 acre-feet. Based on evaluation of the potential impoundment sites identified by the Corps of Engineers and the SCS, it is the opinion of the SCS that an adequate amount of drainage area cannot be controlled under Public Law 83-566 to provide flood control on either the Squaw Creek or Skunk River water-sheds above Ames, Iowa. The SCS report to the Rock Island District, dated December 1985, is available under separate cover.

Channel Modifications

Extensive channel modifications, including channel straightening and widening, are not cost-effective in providing flood control. Channel work in isolated areas provides very little added flow efficiency during flood events. Isolated channel modifications cannot be considered a viable alternative to reduce flooding in the basin. If funding is made available, the Rock Island District will continue to respond to requests for flood assistance under the Section 208 authority for channel snagging and clearing assistance.

Early in the reevaluation study process, the Rock Island District videotaped the entire reach of the South and North Skunk River in Keokuk County. This was done at the request of the Keokuk County Board of Supervisors to locate channel blockages, such as logjams, which were restricting channel flow. Many people who attended an informational meeting about the reevaluation study in Sigourney, Iowa, on 19 March 1985, thought that channel blockages from the Skunk River were adding to the flood problem in Keokuk County. No obstructions were seen, however. The flat river gradient, hillside erosion, and resultant sedimentation in the river channel, combined with the meandering channel and overbank vegegation, undoubtedly add to the inefficiency of the channel flow. A sterile treatment of the channel to widen, deepen, and straighten it from the mouth upstream could temporarily increase flow efficiency and reduce flood damages, but this would be economically and environmentally prohibitive.

ENVIRONMENTAL STATUS - GENERAL

The environmental impacts associated with the previously authorized Ames Lake Reservoir and alternatives were evaluated in a Final Environmental Impact Statement (FEIS) prepared by the Rock Island District (1974). Environmental data used to prepare the FEIS were obtained from the Ames Reservoir Environmental Study, prepared for the Rock Island District by the Iowa State Water Resources Research Institute (1973). Preparation of a National Environmental Policy Act (NEPA) document would require updating the database and impact analyses provided by these two documents for all feasible alternatives. The U.S. Fish and Wildlife Service (FWS) provided a Planning Aid Letter (dated 10 April 1986 and located in the correspondence appendix) which discussed background resources and preliminary impact assessment. That information has been incorporated into this report. Studies would have been necessary for each feasible alternative to assess the aquatic and terrestrial habitats impacted and to determine mitigation requirements.

ENVIRONMENTAL CONCERNS COMMON TO ALL ALTERNATIVES

WATER QUALITY

Baseline water quality data only are available from the early 1970's. Therefore, water quality data should be updated for any stream that would be considered for impoundment.

A strong possibility exists for the formation of thermal stratification in all reservoir alternatives. The drainage area would contribute high levels of nutrients to impoundments, which may become overly eutrophic, producing excessive amounts of algae and other aquatic organisms.

THREATENED AND ENDANGERED SPECIES

According to the U.S. FWS, only one species protected by the Endangered Species Act of 1973, as amended, may occur in the study area. The Indiana bat (Myotis sodalis) has been documented in Jasper County in the extreme southeastern part of the study area. The bats utilize small stream corridors with well developed riparian zones consisting of mature trees. They roost and rear young under the loose bark or in cavities of dead or dying trees. They feed over streams by flying beneath the overhanging forest canopy, occasionally dropping to the water surface to drink. Studies would have been necessary to investi-gate if suitable habitat exists in the project area.

Prairie bush clover (Lespedeza leptostachya), a species proposed to be listed as threatened, has been documented in Story County. The prairie bush clover inhabits dry, mesic native prairies that are well-drained, often gravelly, and located on hills of glacially deposited material and river terraces. Studies would have been necessary to investigate if suitable habitat exists for this species in the project area.

The bald eagle (Haliaeetus leucocephalus) is found occasionally in the tailwaters of Saylorville Reservoir, Polk County, during the winter. The reservoir alternatives could affect the bald eagle positively by providing additional open water feeding habitat in the area.

The Iowa Conservation Commission provided a list of State endangered species which may be affected by various project alternatives. No detailed surveys have been conducted in the study area. Such studies would have been necessary for each feasible alternative.

- Ames Lake Dam Site

Blacksoil prairie	Special Interest
Prairie bush clover (proposed for Federal listing)	Endangered

- Onion Creek Dam Site

Dissected grape fern	Special Interest
Coral root orchid	Special Interest
Foxtail sedge	Special Interest

- Dry Dam Site SE of Story City

Blanding's turtle	Special Interest
Prairie white-fringed orchid	Endangered
Bobcat	Endangered

CULTURAL RESOURCES

District staff prepared a report entitled Cultural Resources: Upper Skunk River Basin, Ames Lake, Iowa (February 1986) which summarizes the status of cultural resource information and related compliance requirements. Preliminary information on the Skunk River Basin was collected by staff from Iowa State University based upon archival research and a limited sample surface survey completed in 1972. The results of this study were described in the report entitled Stalking the Skunk (Gradwohl and Osborn 1972). Fourty-three (43) prehistoric and 22 historic components were located either in the field or in documents.

These archeological sites span 6,000 years of prehistory and about 150 years of the historical period. Remains range from prehistoric villages and burial mounds to historic period farmsteads, cemeteries, and mill sites.

Based upon nearly 20 years of archeological research at nearby Saylorville Lake on the Des Moines River, Corps staff were able to construct a preliminary synthesis cultural resources overview with geomorphological models. The 506 archeological sites at Saylorville Lake serve as a fairly accurate guide for determining the potentials of significant cultural resources in the Skunk River Basin. Should any feasible project plans be formalized, archeological, historical, and geomorphological investigations will have to be conducted in accordance with the recommendation of the Iowa State Historic Preservation Officer, in a letter dated 2 April 1986 (located in the correspondence appendix). This recommendation was made after review of the Corps report. The cost efficiency and timeliness of Skunk River Basin studies would be greatly facilitated by using the massive comparative database from Saylorville Lake.

MAJOR ENVIRONMENTAL CONCERNS FOR EACH ALTERNATIVE

AUTHORIZED PLAN (AMES LAKE)

Numerous significant environmental impacts would occur if this alternative were implemented. Permanent loss of 80 percent of the natural portion of the Skunk River north of Ames would occur, eliminating the excellent pool and riffle fish habitat and sport fishery (small mouth bass) occurring in this reach. The lake-type fishery expected to develop in the proposed reservoir would consist mainly of rough fish (carp, carpsucker) and some game fish if intensively managed.

Terrestrial resources and associated wildlife habitat also would be severely impacted. The conservation pool would inundate about 400 acres of forested land and full flood pool would inundate an additional 1,200 acres. This forested land is currently preserved as a greenbelt by the Story County Conservation Board. The greenbelt was developed to preserve the unique nature of this portion of the Upper Skunk River, while providing recreational opportunities for the public. With the reservoir, terrestrial resources would be reduced to mudflats at lower elevations, and to early successional herbs and water-tolerant woody species at higher elevations, depending on frequency and duration of flooding. The habitat value for wildlife would be significantly less than the value of the existing forested habitat.

AUTHORIZED PLAN (AMES LAKE) DOWNSIZED

The environmental impacts for this alternative are similar to those described for the authorized plan. Because of decreased size of the reservoir, a more abundant population of rough fish may develop. In addition, a substantial portion of the greenbelt would still be inundated.

DOWNSTREAM AGRICULTURAL LEVEES (POLK COUNTY)

This portion of the Skunk River consists of a channelized stream with a shifting sand substrate and spoil bank levees. Levee construction could cause temporary impacts to fishery resources. Some improvement in the wildlife resource may occur, providing no trees are removed from the present river bank. Levee tops and slopes could be planted with species beneficial to wildlife.

SQUAW CREEK DETENTION RESERVOIR

This alternative addressed a dry-bed reservoir for only flood control storage. There would be no water-based recreation and no lake fishery. Although a dry-bed reservoir avoids permanent inundation of terrestrial habitat, intermittent inundation by floodwaters would still cause ecological damage within the flood pool. Most of the existing plant and animal communities would be eliminated over time.

AMES, IOWA, LOCAL FLOOD PROTECTION

Use of the tentative alignment would pose little impact to fishery and wildlife resources provided that clearing of the trees along Squaw Creek is minimized. Seeding of levee top and slopes with species beneficial to wildlife could increase habitat values.

ONION CREEK WATER SUPPLY RESERVOIR

Although no fishery data are available for Onion Creek, a lake fishery could develop with good game fish populations if properly managed. However, the conservation pool of 950 feet NGVD would flood about 100 acres of mixed timber, which provides good quality habitat for a variety of small animals and birds.

BEAR CREEK WATER SUPPLY RESERVOIR

Although there are no fisheries data for Bear Creek, it should have a fauna similar to but smaller than that associated with the Skunk River. Good game fish populations could be developed in the proposed reservoir with proper management. Impacts to wildlife would be moderate due to the open nature of timber resources and because most of the area is currently pastured.

COORDINATION AND PUBLIC INVOLVEMENT

From the beginning of the reevaluation study in October 1984, the general public, as well as State agencies and the local government, were kept informed on the study.

A meeting was held in October 1984 in Ames, Iowa, with State, local, county, and city representatives to review the purpose, schedule, scope, and objectives of the study. Statements and/or comments were solicited from those in attendance on their perceptions of the study.

This meeting was followed by a public workshop in Ames on 12 December 1984. Approximately 400 people attended the workshop to exchange study information. Those who desired gave written comments and, if interested, could sign up for individual meetings with Rock Island District representatives. Approximately 80 percent of the people who attended were not in favor of the study and strongly opposed any major project on the Skunk River in the Upper Skunk River Basin above Ames. Preservation of the Skunk River Greenbelt was important to these people, and they favored soil conservation projects to control flooding from the smaller Skunk River tributaries. Alternatives to the authorized Ames Lake project were discussed, including soil conservation practices.

In February and March 1985, public informational meetings were held in the downstream communities of Oskaloosa, Pella, Colfax, and Sigourney, Iowa. The Corps provided information regarding the study and solicited public input. About 40 to 50 people attended these meetings who were in favor of flood control but not necessarily a large reservoir like the authorized Ames Lake project. Again, alternatives to the Ames project were discussed.

Meetings were held with the Iowa Department of Water, Air and Waste Management (DWAWM), the U.S. Department of Conservation - Soil Conservation Service (USDA-SCS), the Iowa Department of Soil Conservation, and the Skunk River Conservancy District (CD). DWAWM was the coordinating contact for the State of Iowa regarding the study. The Iowa Legislature established the CD in 1971 to preserve and protect the public interest in the quantity and quality of the water resources of the District for future generations through coordination of river basin and watershed management programs. The CD, which is a State governmental subdivision, works in cooperation with other agencies toward this goal. The purpose of these meetings was to coordinate the reevaluation study with the ongoing Skunk River Basin Study being done by the USDA-SCS and the Section 22 work supporting the basin study.

In January and February 1985, Corps representatives made presentations on the reevaluation study to the American Society of Civil Engineers, Water Resources Design Conference, and the Iowa Chapter of the American Fisheries Society.

In March 1985, the Corps held a public informational meeting in Story City, Iowa. Some 60 people attended this meeting, representing themselves as well as various interest groups. Groups represented included the Story City City Council; Story County; Hamilton County; Story County Farm Bureau; Sierra Club; Big Blue Stem Audubon Society; Story County Conservation Board; Jewell, Iowa; Randall, Iowa; Roland, Iowa; and the Roland-Story Board of Education. All of these groups voiced opposition to a major project on the Skunk River or its tributaries and were basically opposed to any reservoir development above Ames. Again, alternatives to the Ames Lake project were discussed at the meeting.

On 26 March 1985, Rock Island District personnel gave a briefing on the study status to the Iowa Inter-Agency Resource Council (IARC) at the invitation of DWAWM. State agencies represented, in addition to DWAWM, included the Iowa Department of Soil Conservation, Iowa Geological Society, Iowa Conservation Commission, Office of Planning and Programming, Iowa Energy Policy Council, Iowa Department of Transportation, and the Iowa Department of Agriculture. Alternatives to the authorized Ames Lake project were reviewed, which included smaller impoundments, levees, nonstructural methods, soil conservation practices, and channel modifications. Proposed cost-sharing requirements were reviewed. The council made no recommendations, but were interested in knowing the study results.

In March 1985, Corps representatives met in Ames with local interest groups. Those attending the meeting were from the Story County Conservation Board, the Citizens Advisory Council to the Story County Conservation Board, the Big Blue Stem Audubon Society, and the Sierra Club. Project alternatives were discussed. It was reported that the authorized project did not appear feasible today, but that a smaller, down-scaled reservoir project may be economically feasible. The history of the Skunk River Greenbelt development was discussed.

In May 1985, a followup meeting was held with the city of Ames and Iowa State University to review water supply needs and possible sources. Single-purpose water supply reservoirs were discussed in lieu of deep well sources.

Coordination meetings were held with the USDA-SCS in May 1985 and December 1985 to discuss the scope of work and final report preparation for SCS study input to the reevaluation study.

Public Information Fact Sheets providing a 4-page status of the study were circulated in October 1985 and again in July 1986. The July 1986 study update summarized the study results to date, indicating that a down-scaled Ames Lake project appeared to be the only economically feasible alternative which would offer some reduction in basin flooding.

The Corps held a meeting on 11 August 1986 with State of Iowa and city of Ames representatives. The only economically feasible project was a down-scaled Ames Lake project with an estimated cost of $42 million. The total estimated non-Federal cost share amount was $18.25 million, with an estimated annual non-Federal operation and maintenance cost of $1.75 million. Rock Island District asked for the State of Iowa's and city of Ames' views regarding project sponsorship and implementation of such a project.

Followup letters were received in August 1986 and September 1986 from the Iowa Department of Natural Resources (IDNR) and the city of Ames. The IDNR said that they did not support the smaller reservoir, nor did they have any interest in cost-sharing the project. Furthermore, the city of Ames said that the city was not interested in sponsoring the scaled-down project.

A meeting was held on 26 August 1986 in Ames, Iowa, at the request of local interests to review study preliminary findings. The letter from the IDNR showing no support for the scaled-down reservoir was read at the meetings with (IDNR) approval. The majority of people were pleased with the IDNR letter because they were opposed to a project.

On 9 September 1986, a meeting was held with the Skunk River Conservancy District Board to review the study and lack of project support.

CONCLUSIONS

This study was conducted in accordance with the Principles and Guidelines for Water and Related Land Resources Planning for the purpose of reevaluating and reformulating the authorized plan to meet current problems and needs for flood control, low-flow augmentation, recreation, and water supply. Alternatives to the authorized plan also were evaluated. These alternatives included smaller reservoirs, levees, nonstructural methods, soil conservation practices, and channel modifications. All of the alternatives were screened first based upon hydraulic and economic considerations. Feasible alternatives then would have been screened further based upon environmental and social considerations and on the preferences of local interests and project sponsor.

AUTHORIZED AMES LAKE PROJECT

The previously authorized Ames Lake project is not economically feasible today. It has a BCR of 0.71.

SMALLER RESERVOIRS

Many sites were analyzed, but all except four were eliminated because of insufficient storage capacity. A detention dam was investigated on Squaw Creek, with a BCR of 0.65. Sites on Onion Creek and Bear Creek were studied as single-purpose water supply sites for the city of Ames. The estimated development costs for these sites, which is totally non-Federal for water supply, were $9.1 million and $3.2 million. These costs, combined with the unreliability of these sites, made this an unattractive option for a water supply source for the city of Ames.

A scaled-down reservoir at the authorized Ames Lake site is economically feasible, with a BCR of 1.2. A smaller Ames Lake project would provide 3.0 inches of flood storage at an estimated cost of $42 million. It would

provide some flood relief, augment low Skunk River flows, and provide a water supply source for Ames, although it also would mean the loss of the existing Skunk River Greenbelt and those recreation benefits that presently exist. However, mitigation efforts would provide some recreation opportunities with a dam and reservoir. The conservation pool would be at elevation 946 feet NGVD, covering 1,850 surface acres for the scaled-down reservoir. This compares to a conservation pool elevation of [illegible] feet NGVD and 2,100 surface acres for the authorized Ames Lake project. The full flood pool would be at elevation 963 feet NGVD, covering [illegible] surface acres, compared with elevation 976 feet NGVD covering [illegible] acres for the authorized project. The Project Document Plan providing 3.6 inches of flood storage had a cost of $49 million and BCR of 1.1.

LEVEES

Ames, Iowa, receives the most urban flood damage in the basin. Local flood protection projects for 500- and 100-year levels of protection for Ames would cost an estimated $1.8 million and $1.7 million, respectively, with BCR's lower than 0.3.

About 85 percent of the estimated 100,000 acres subject to Skunk River Basin flooding is used for agricultural land. Corps of Engineers studies in 1950 showed that agricultural levees were not economical then. As part of this reevaluation, agricultural levees were studied for an area in Polk County as having 1,500 acres in the 100-year floodplain. Estimated costs for 25- and 100-year levels of protection were $2.8 million and $[illegible] million, respectively, with BCR's of 0.24 and [illegible].

NONSTRUCTURAL ALTERNATIVES

The city of Ames is participating in the National Flood Insurance Program which regulates development in the floodplain to minimize flood damages. Since most of the basin land subject to flooding is crop land, land conversion or evacuation are not practical. The only conversion which would reduce flood damages would be to pastureland or to greenspace timberland. This, of course, would serve the best interests of those who presently farm the land.

SOIL CONSERVATION PRACTICES

The Upper Skunk River Basin is not conducive to watershed projects which would help to lesson the flooding problem to any appreciable degree. This and other relative information pertaining to the Upper Skunk River Basin was provided in a December 1985 report prepared by the USDA-SCS under contract with the Rock Island District, Corps of Engineers, as supplemental information to this reevaluation study.

CHANNEL MODIFICATIONS

Channel modifications such as widening and straightening would not provide an economical solution to the basin flooding.

SUMMARY

There is a significant flooding problem in the Skunk River Basin which will have a large adverse impact on the local, State, and Federal economy with the probability of catastrophic damages during large, infrequent floods.

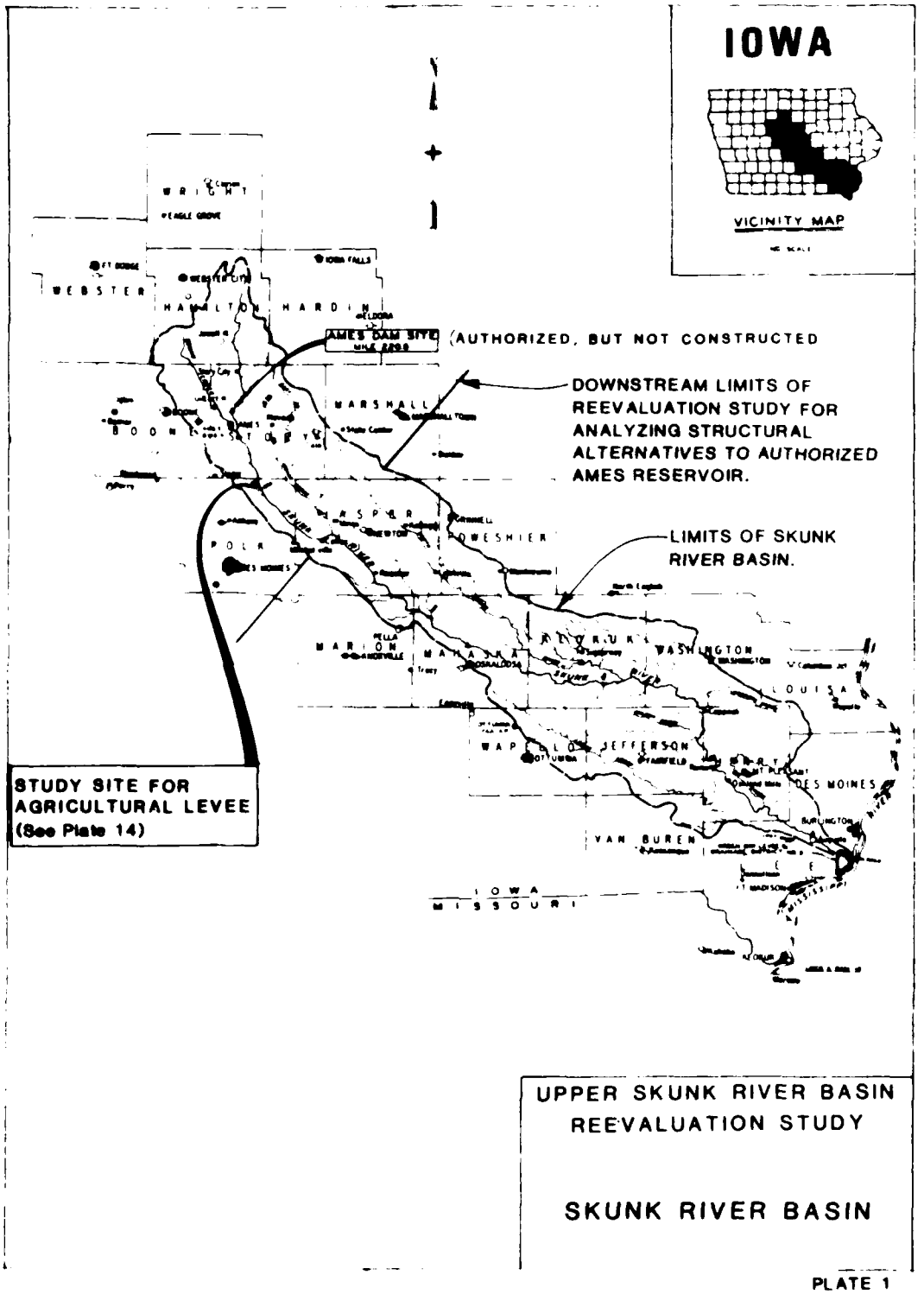
The previously authorized Ames Lake project is not feasible today. The only economically feasible project today is a scaled-down Ames Lake project at the original authorized project site. This project would have a first cost of approximately $42 million with a BCR of 1.2 and provide 3.0 inches of flood storage. The estimated non-Federal cost under the current cost-sharing guidelines would be about $18 million.

Neither the State of Iowa nor the city of Ames support this project or have an interest in sponsoring it. Letters from the IDNR and the city of Ames are included in the pertinent correspondence appendix. Furthermore, there remains strong individual opposition to the project, as indicated by the resolutions for project deauthorization included in the pertinent correspondence appendix.

RECOMMENDATION

I recommend no further Federal investigation of a scaled-down Ames Lake project due to the lack of a potential sponsor.

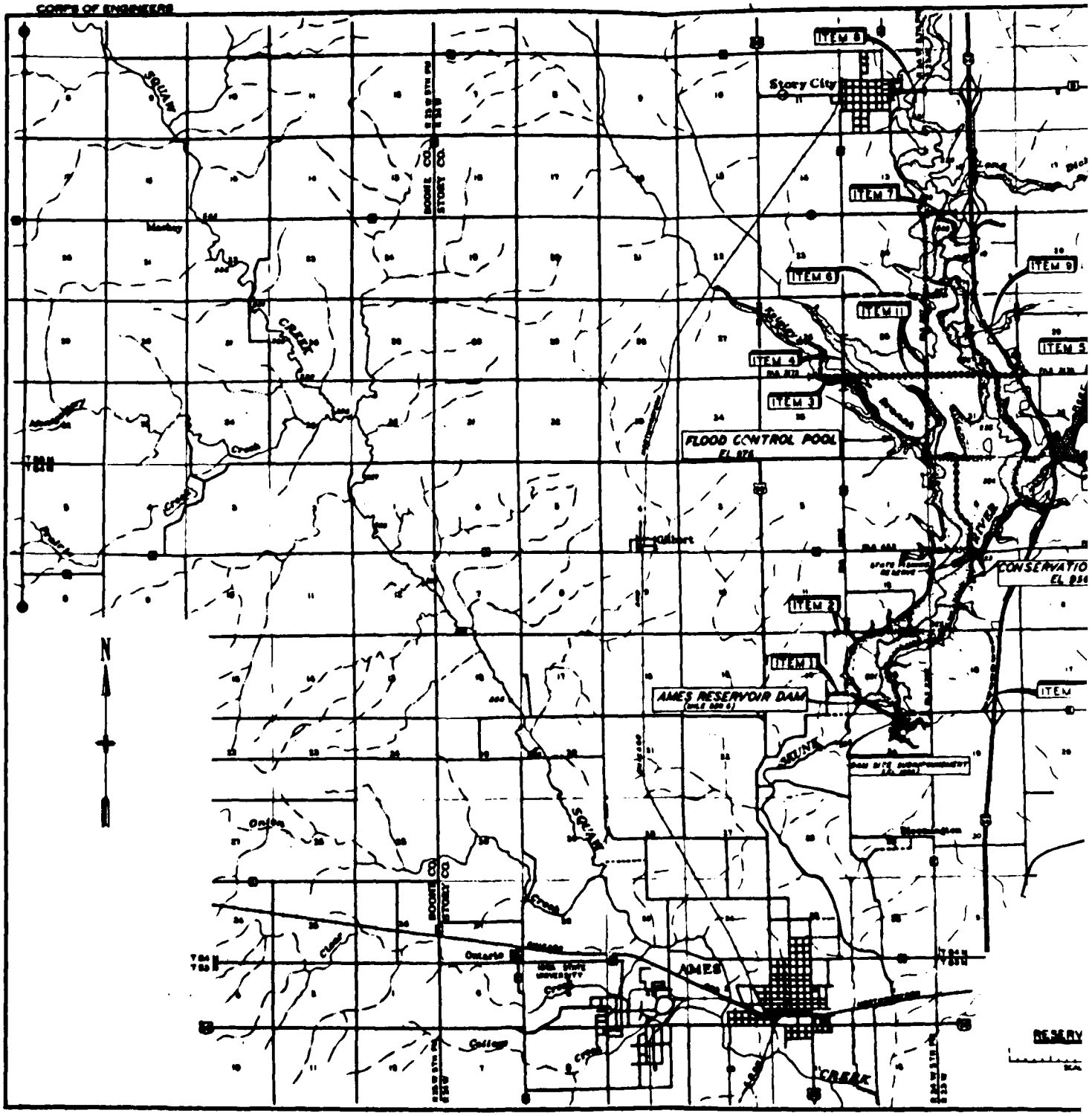
Dudley M. Hanson, P.E.
Chief, Planning Division

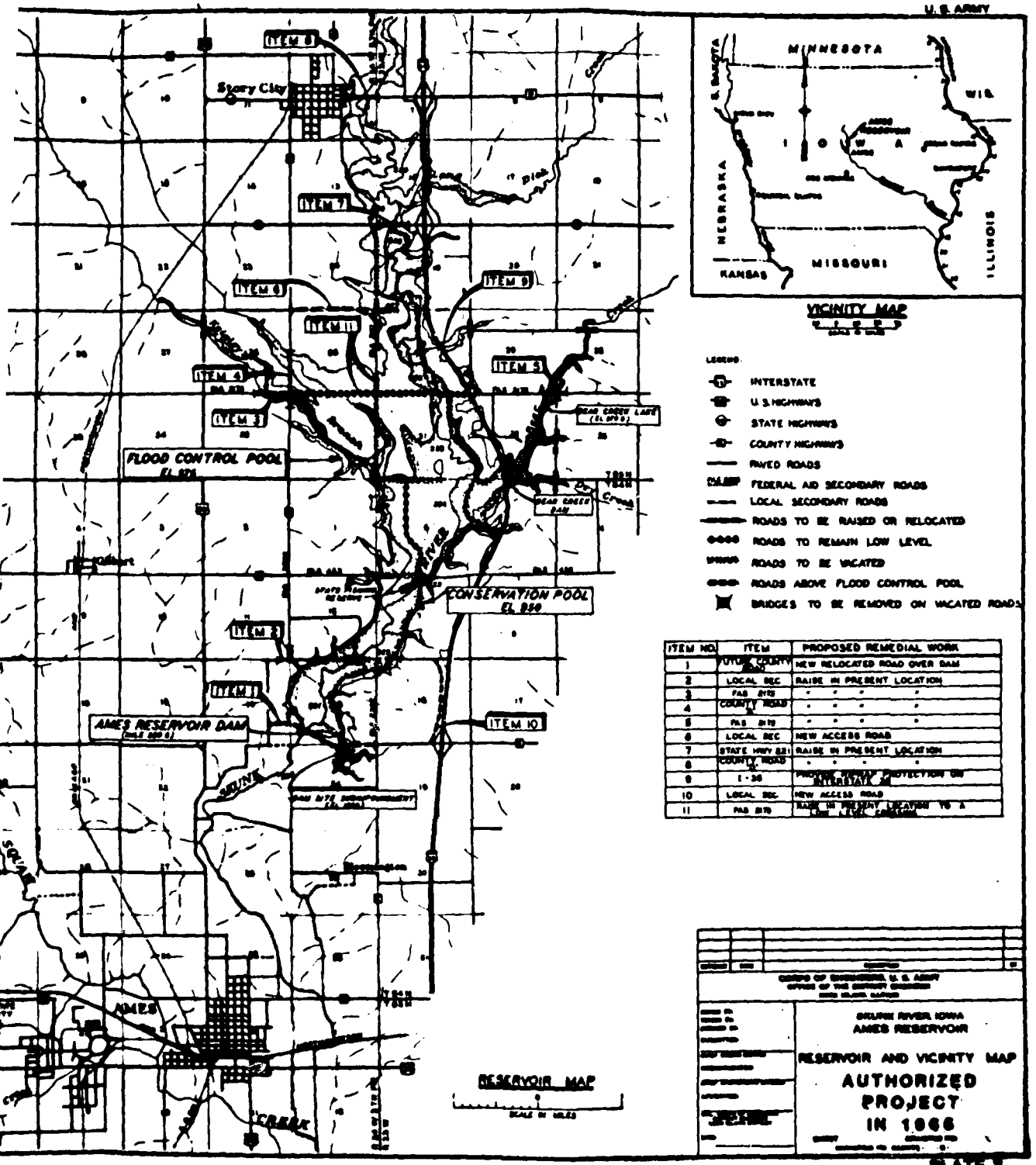


UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

SKUNK RIVER BASIN

PLATE 1


CORPS OF ENGINEERS
Story City
ITEM 8
ITEM 7
ITEM 6
ITEM 11
ITEM 4
ITEM 3
ITEM 2
ITEM 1
ITEM 9
ITEM 5
FLOOD CONTROL POOL
AMES RESERVOIR DAM
CONSERVATIO
Gilbert
Ontario
AMES
SQUAW
CREEK
BOONE CO
STORY CO
N



ITEM NO.	ITEM	PROPOSED REMEDIAL WORK
1	[illegible] COUNTY	NEW RELOCATED ROAD OVER DAM
2	LOCAL SEC	RAISE IN PRESENT LOCATION
3	FAS 3170	" " " "
4	COUNTY ROAD	" " " "
5	FAS 3170	" " " "
6	LOCAL SEC	NEW ACCESS ROAD
7	STATE HWY 521	RAISE IN PRESENT LOCATION
8	COUNTY ROAD	" " " "
9	I-35	PROVIDE HIGHWAY PROTECTION ON INTERSTATE 35
10	LOCAL SEC.	NEW ACCESS ROAD
11	FAS 3170	RAISE IN PRESENT LOCATION TO A [illegible] LEVEL

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER

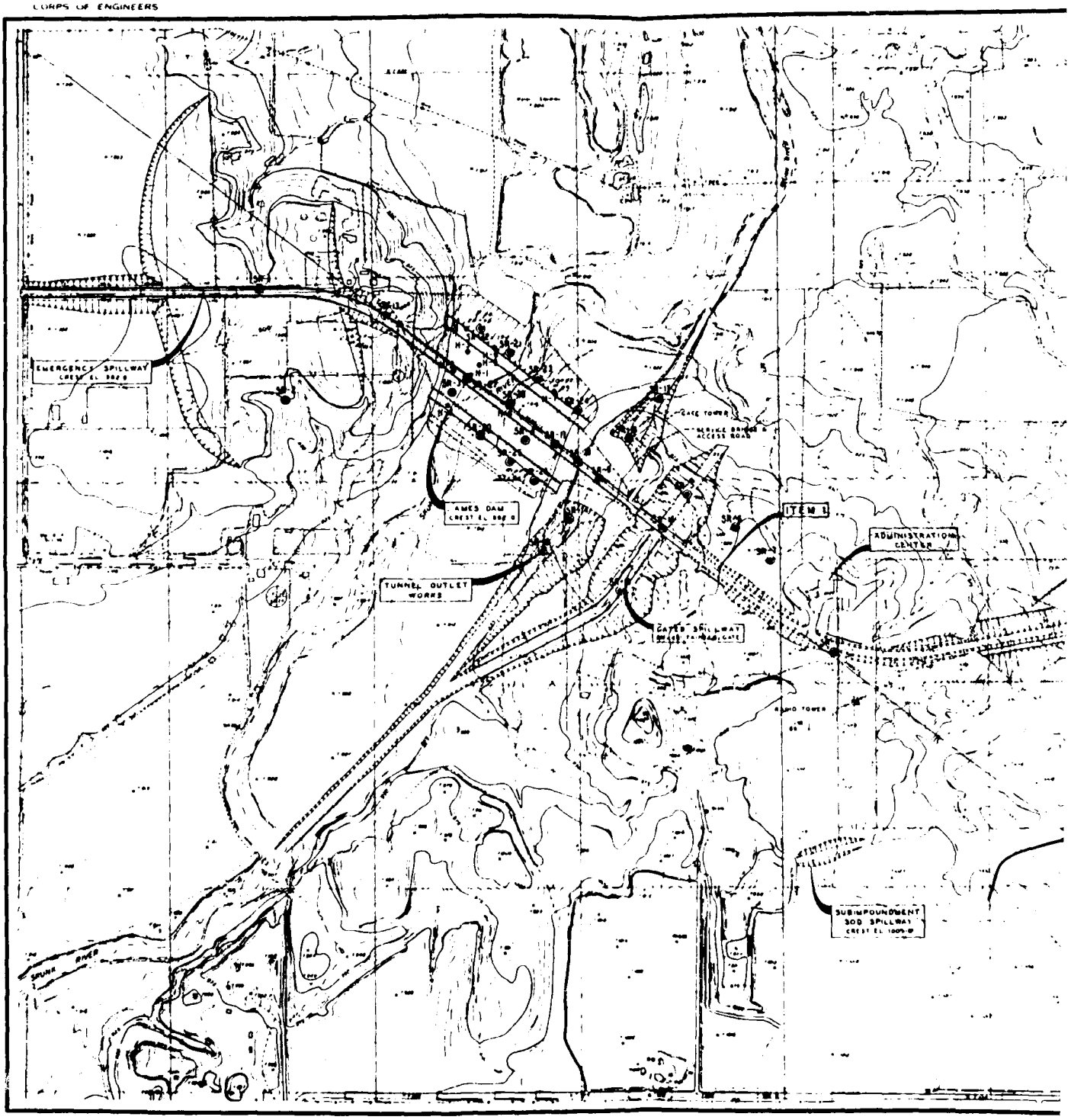
SKUNK RIVER, IOWA
AMES RESERVOIR

RESERVOIR AND VICINITY MAP

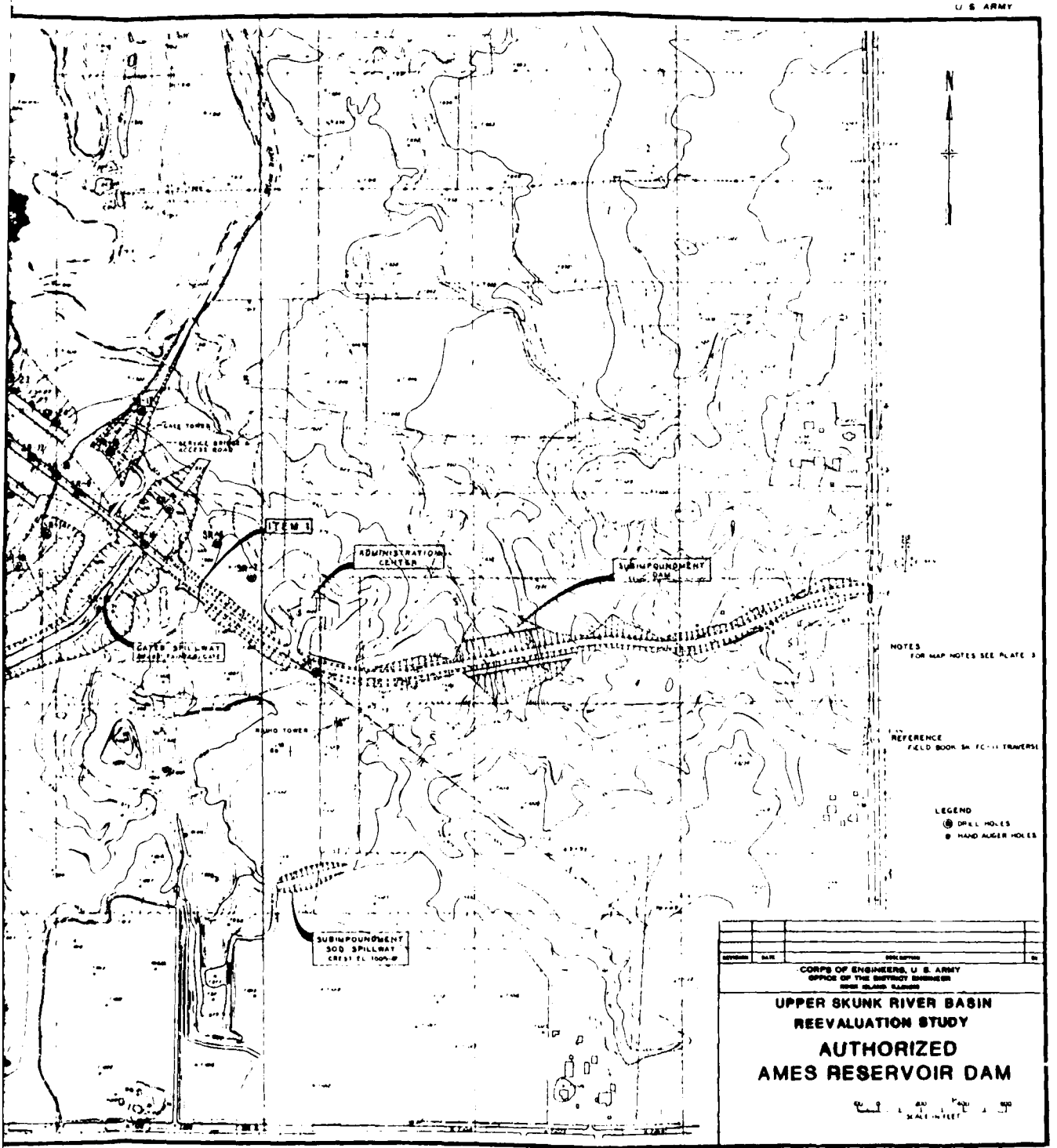
AUTHORIZED PROJECT IN 1966

PLATE 2

CORPS OF ENGINEERS



U S ARMY



CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER

UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

AUTHORIZED AMES RESERVOIR DAM

PLATE 3

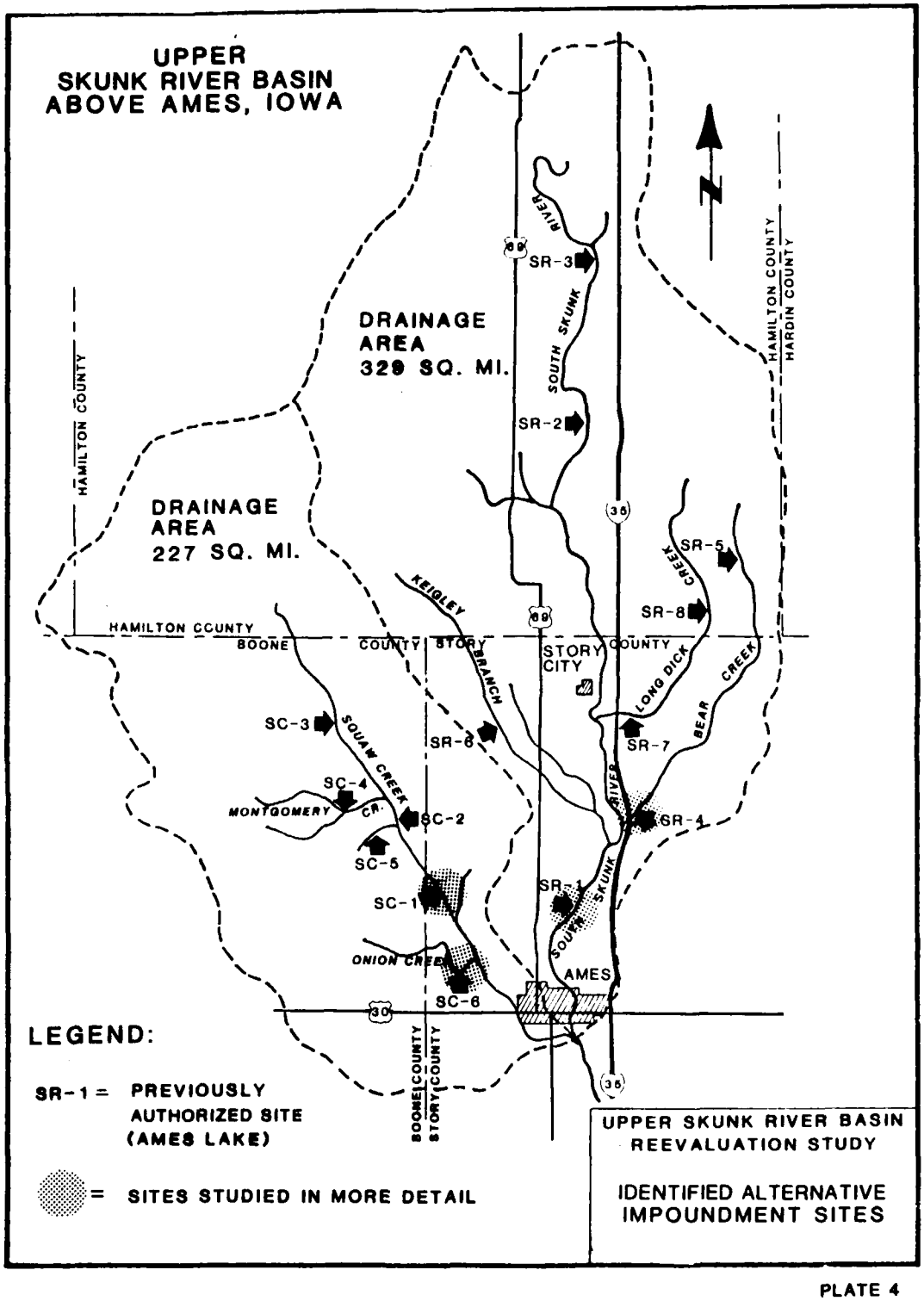
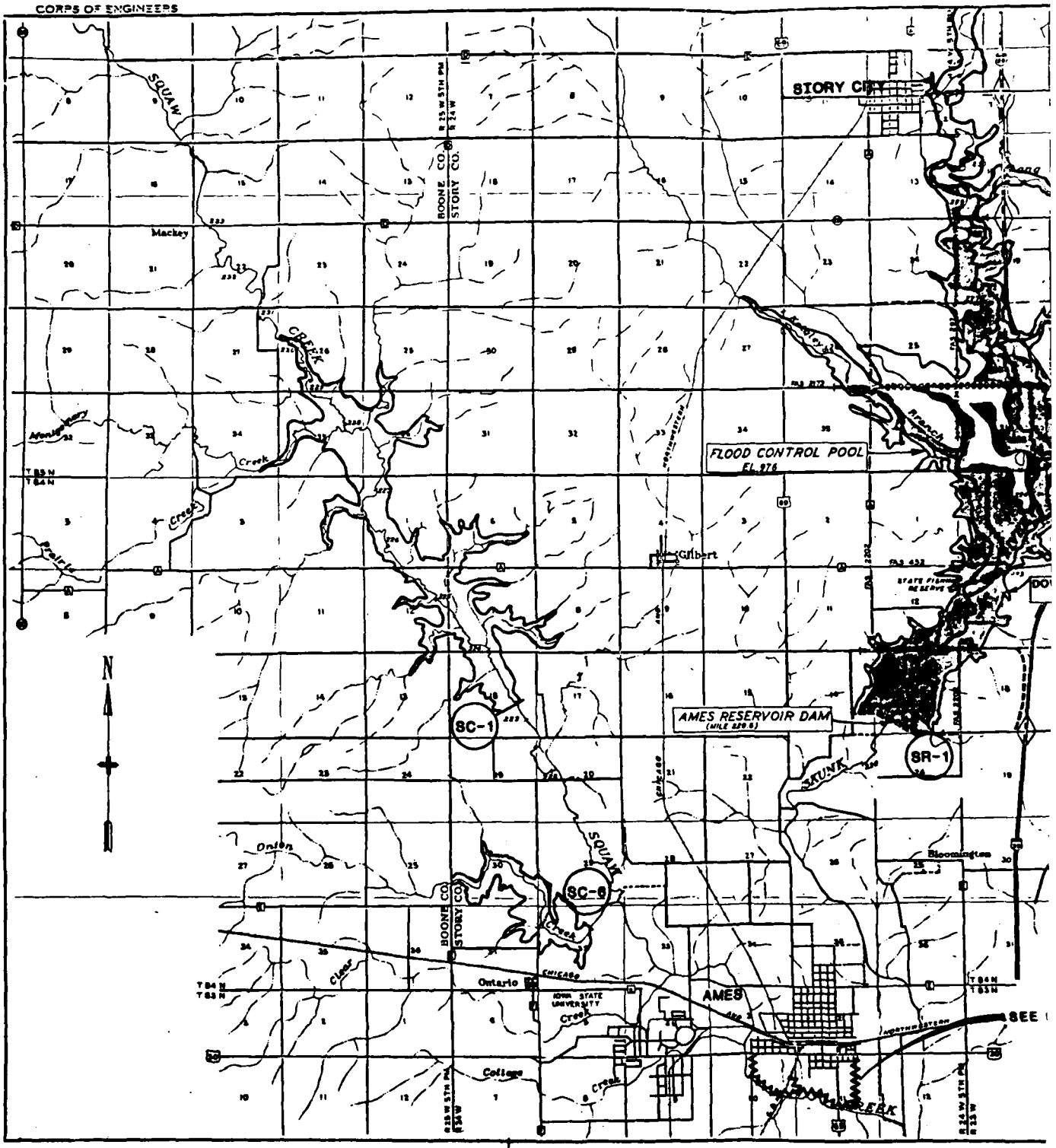
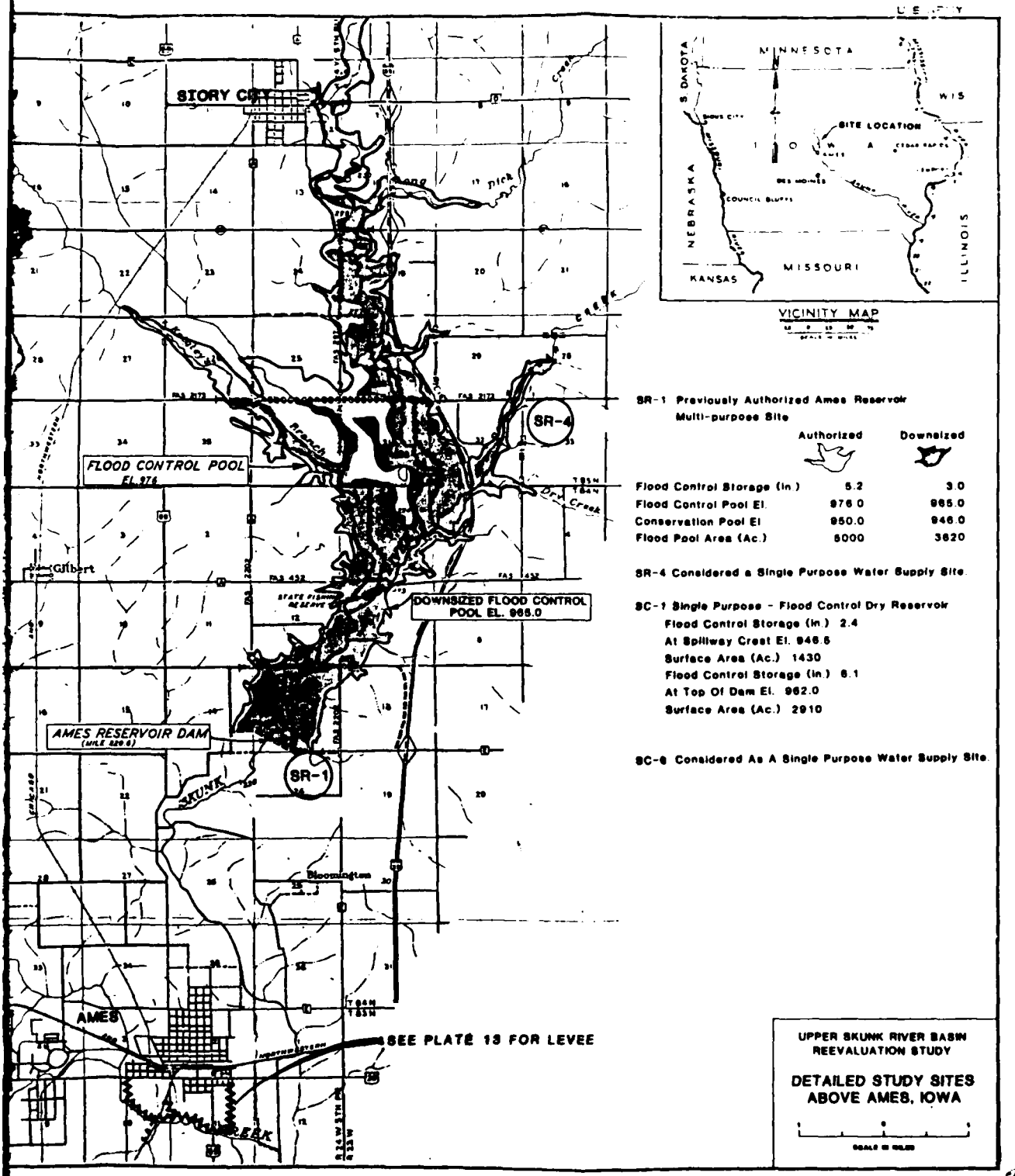

UPPER
SKUNK RIVER BASIN
ABOVE AMES, IOWA
DRAINAGE
AREA
329 SQ. MI.
DRAINAGE
AREA
227 SQ. MI.
HAMILTON COUNTY
HAMILTON COUNTY
HARDIN COUNTY
BOONE COUNTY
STORY COUNTY
STORY CITY
RIVER
SOUTH SKUNK
KEIGLEY BRANCH
LONG DICK CREEK
BEAR CREEK
SQUAW CREEK
MONTGOMERY CR.
ONION CREEK
SOUTH SKUNK RIVER
AMES
SR-1
SR-2
SR-3
SR-4
SR-5
SR-6
SR-7
SR-8
SC-1
SC-2
SC-3
SC-4
SC-5
SC-6
N
LEGEND:
SR-1 = PREVIOUSLY AUTHORIZED SITE (AMES LAKE)
= SITES STUDIED IN MORE DETAIL
UPPER SKUNK RIVER BASIN REEVALUATION STUDY
IDENTIFIED ALTERNATIVE IMPOUNDMENT SITES

PLATE 4


CORPS OF ENGINEERS
SQUAW
BOONE CO.
STORY CO.
R 25 W 5TH PM
R 24 W
STORY CITY
Mackey
CREEK
Creek
Prairie
T 85 N
T 84 N
FLOOD CONTROL POOL
EL 976
Gilbert
AMES RESERVOIR DAM
(MILE 529.8)
SC-1
SR-1
SC-6
SKUNK
Bloomington
Union
Clear
Ontario
CHICAGO
IOWA STATE UNIVERSITY
AMES
College
T 84 N
T 83 N
R 25 W 5TH PM
R 24 W
R 23 W
SEE



SR-1 Previously Authorized Ames Reservoir Multi-purpose Site

	Authorized	Downsized
Flood Control Storage (In.)	5.2	3.0
Flood Control Pool El.	976.0	966.0
Conservation Pool El	950.0	946.0
Flood Pool Area (Ac.)	5000	3620

SR-4 Considered a Single Purpose Water Supply Site.

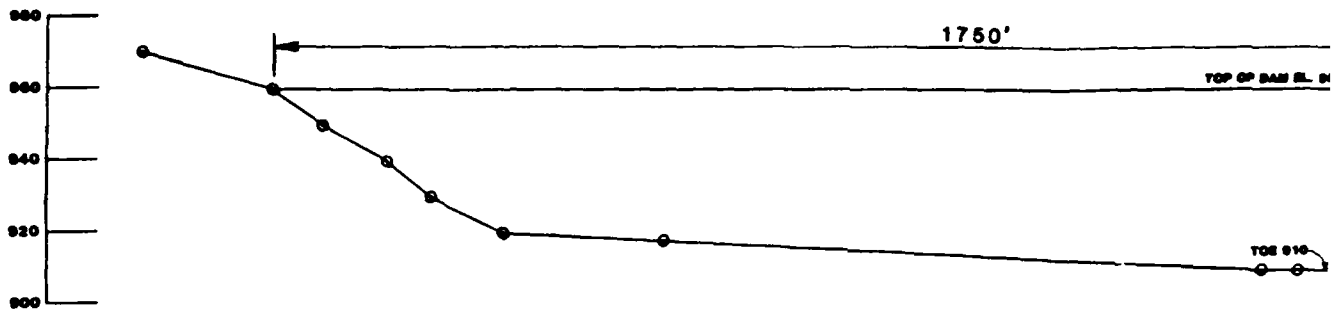
SC-1 Single Purpose - Flood Control Dry Reservoir
Flood Control Storage (In.) 2.4
At Spillway Crest El. 946.6
Surface Area (Ac.) 1430
Flood Control Storage (In.) 6.1
At Top Of Dam El. 962.0
Surface Area (Ac.) 2910

SC-6 Considered As A Single Purpose Water Supply Site.

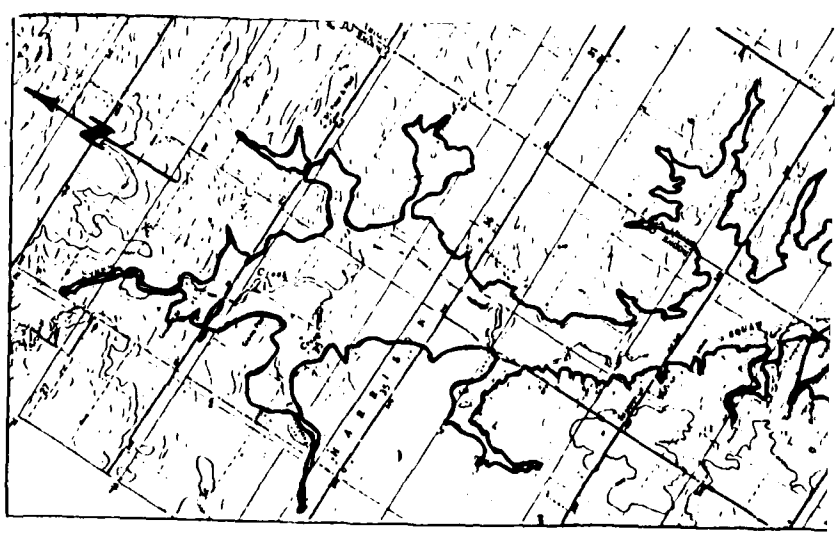
UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

DETAILED STUDY SITES ABOVE AMES, IOWA

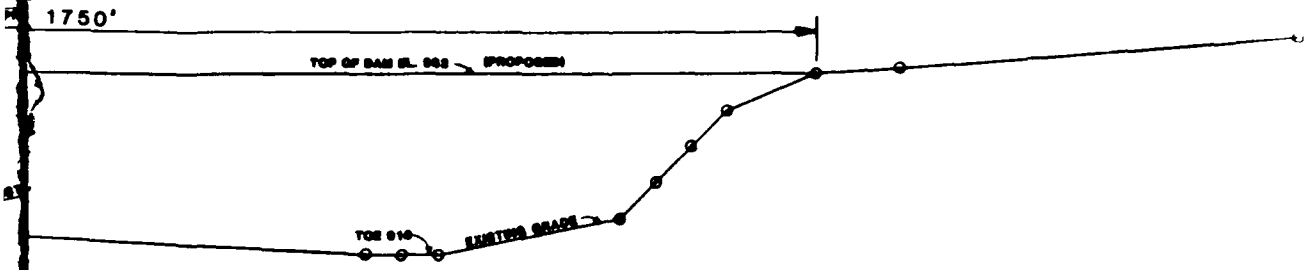
PLATE 5



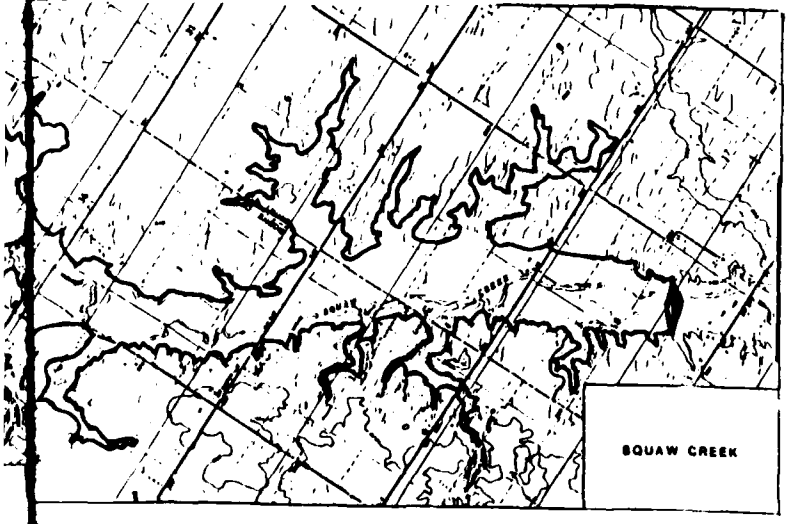
DAM PROFILE



LOCATION



DAM PROFILE



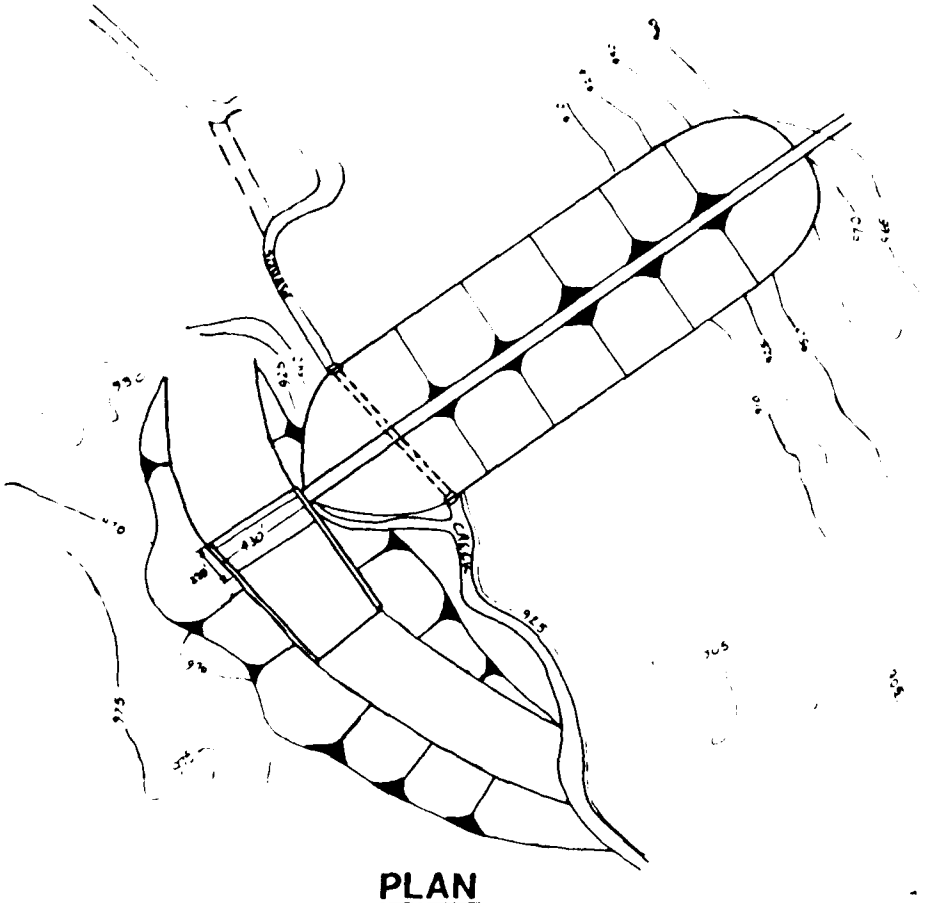
LOCATION

UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

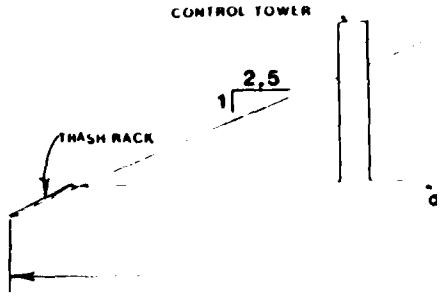
SQUAW CREEK
DETENTION DAM

LOCATION & PROFILE

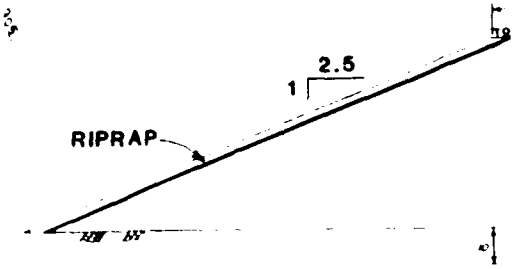
PLATE 6



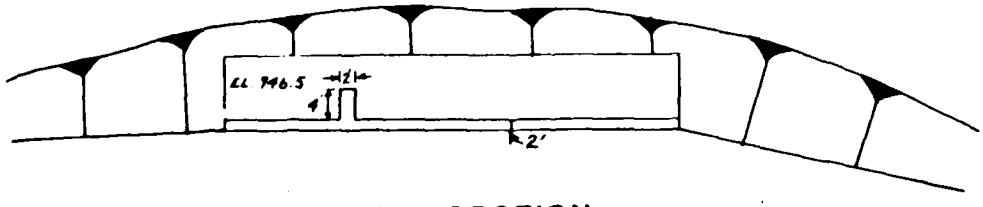
PLAN



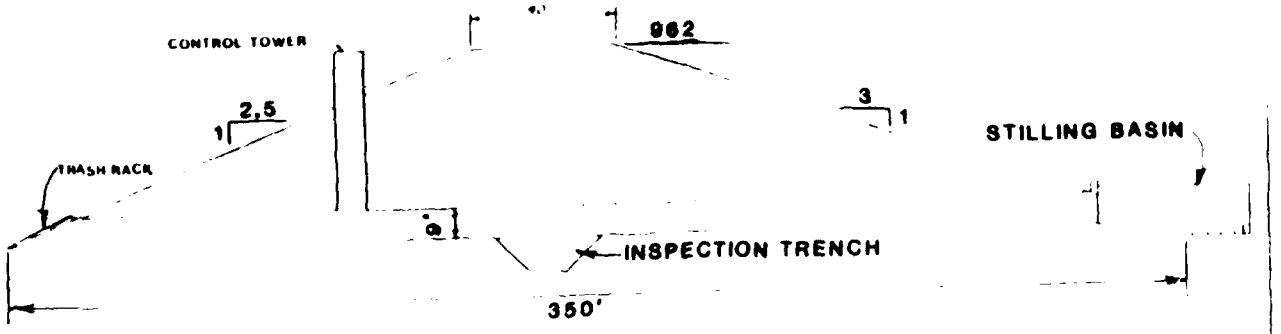
SE



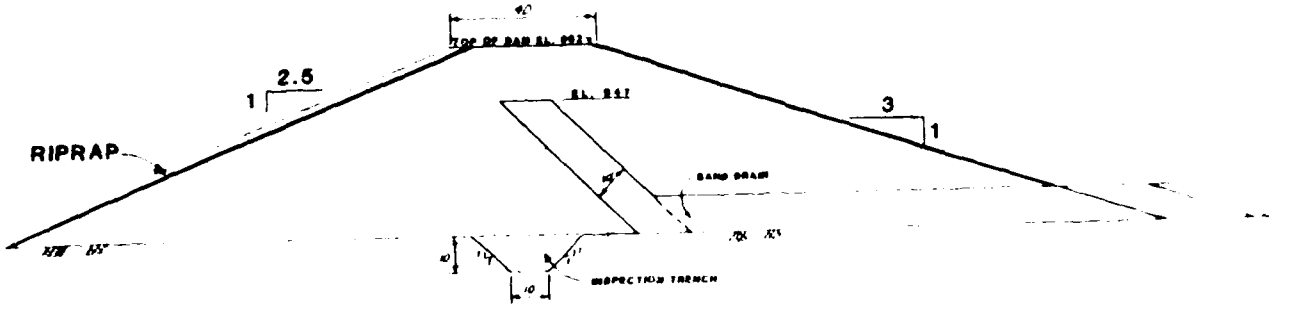
TYPIC



SPILLWAY SECTION



SECTION THRU OUTLET WORKS



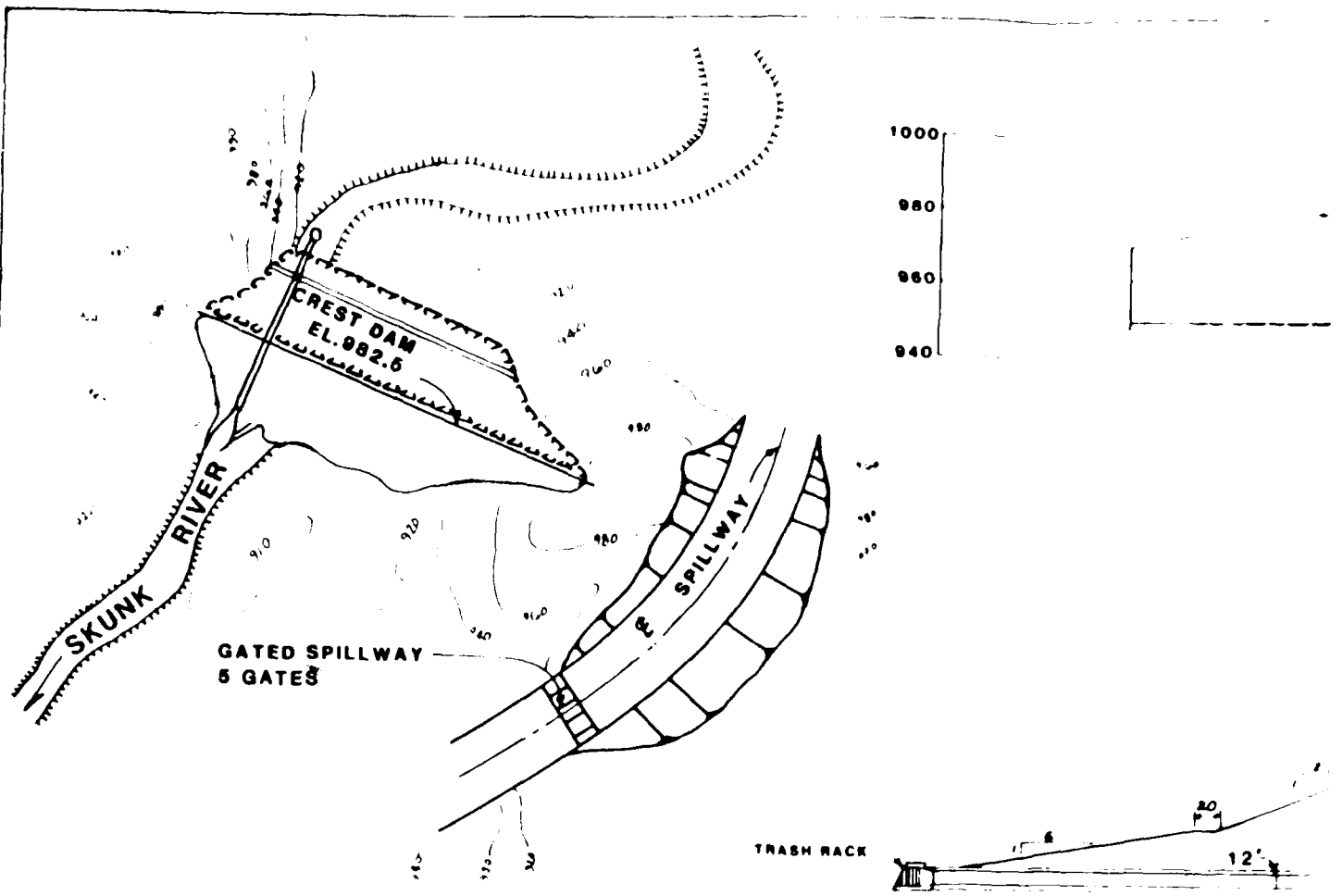
TYPICAL EMBANKMENT SECTION

UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

SQUAW CREEK DETENTION DAM

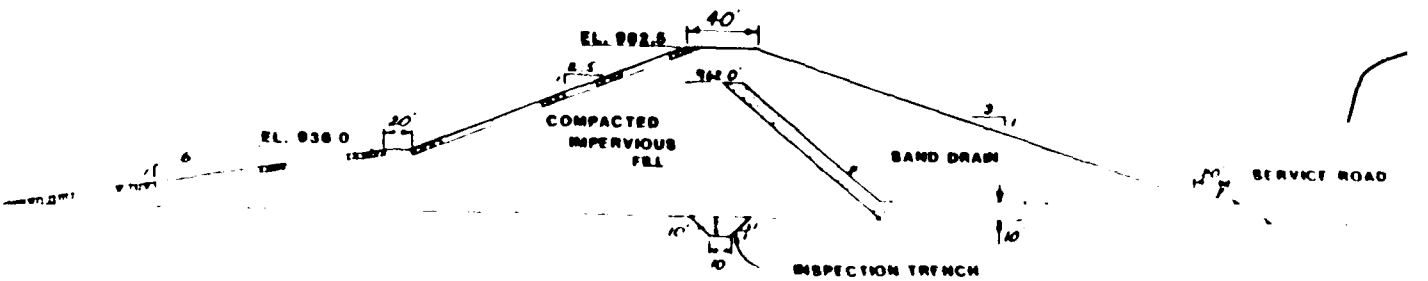
SECTIONS & PLAN

PLATE 7

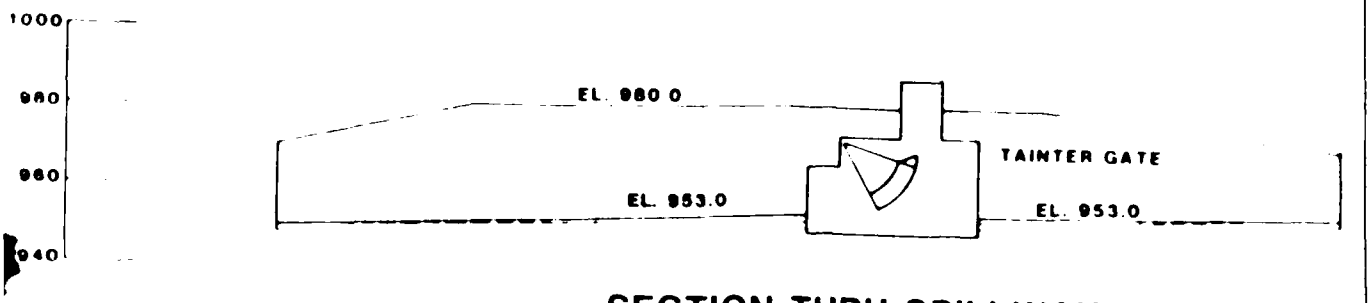


LOCATION - PLAN

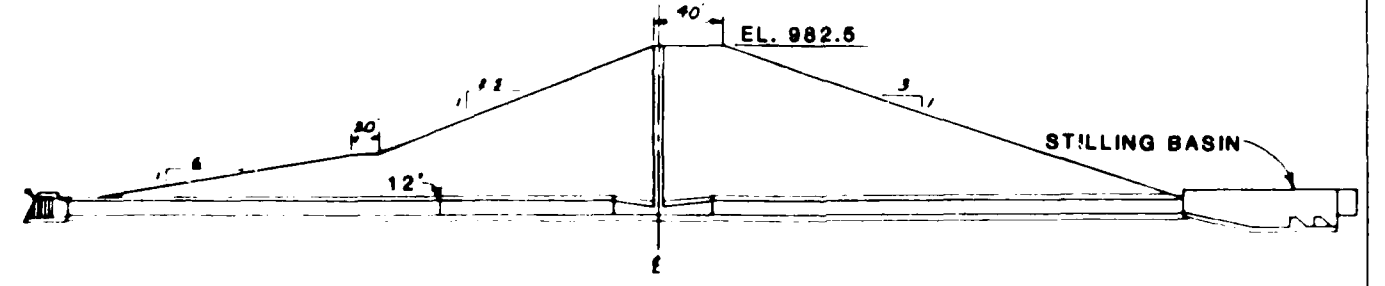
SEC



TYPICAL EMBANKMENT SECTION



SECTION THRU SPILLWAY



SECTION THRU OUTLET WORKS

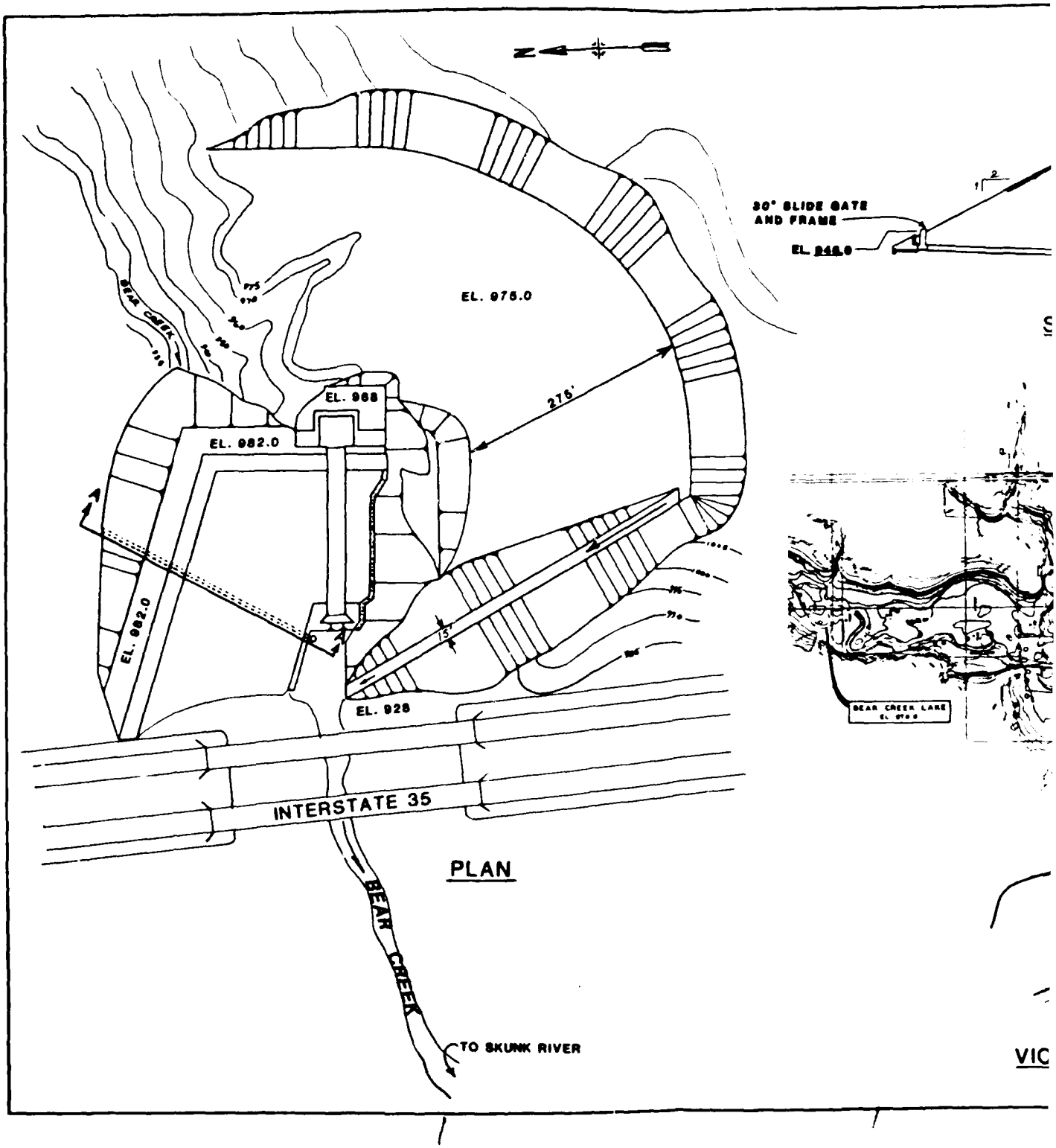
SERVICE ROAD

CTION

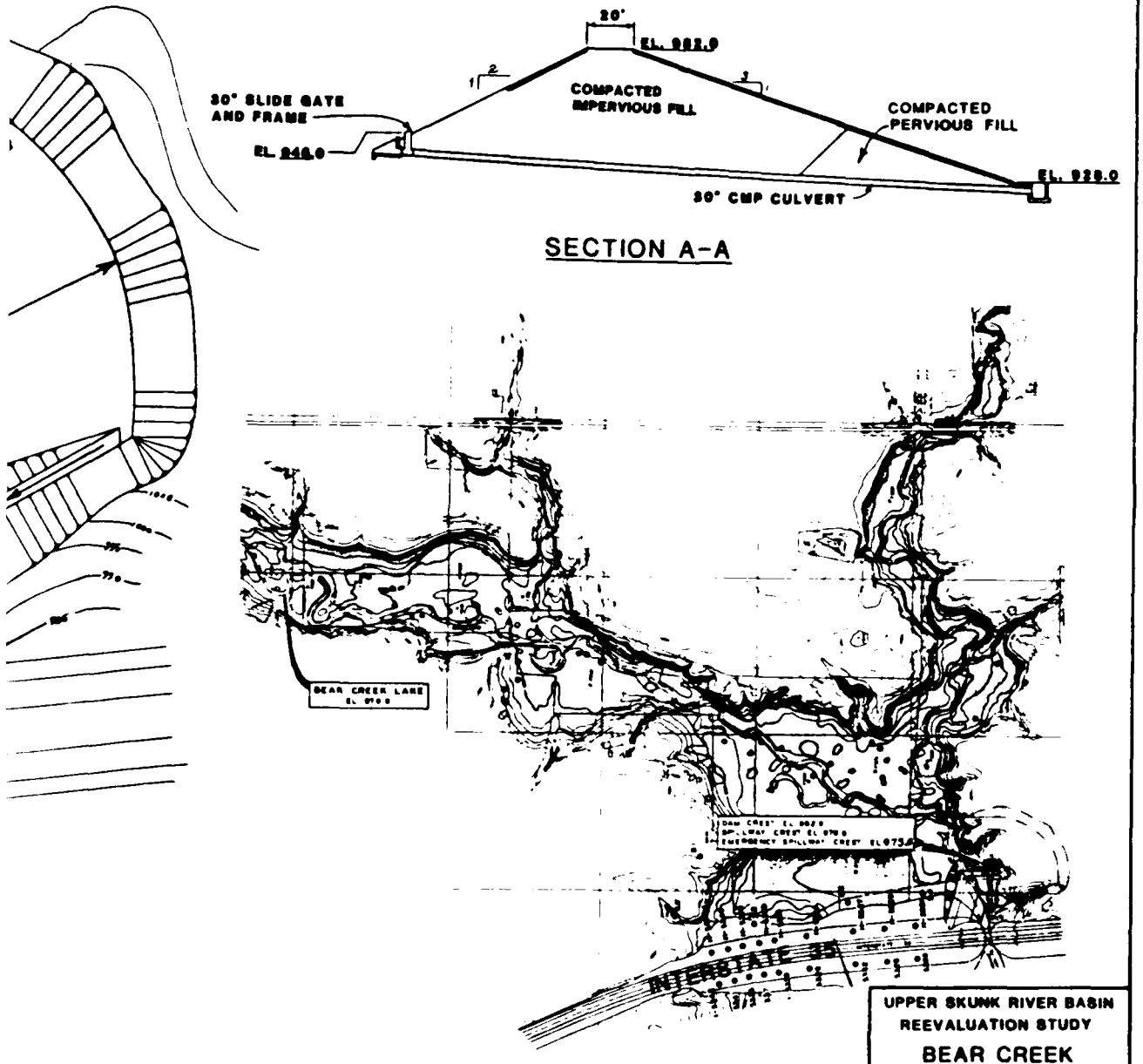
UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

AMES RESERVOIR (DOWNSIZED) LOCATION & SECTIONS

PLATE 8


EL. 975.0
EL. 968
EL. 982.0
EL. 982.0
EL. 928
276'
15'
BEAR CREEK
INTERSTATE 35
BEAR CREEK
TO SKUNK RIVER
30" SLIDE GATE AND FRAME
EL. 948.0
BEAR CREEK LAKE

PLAN



SECTION A-A

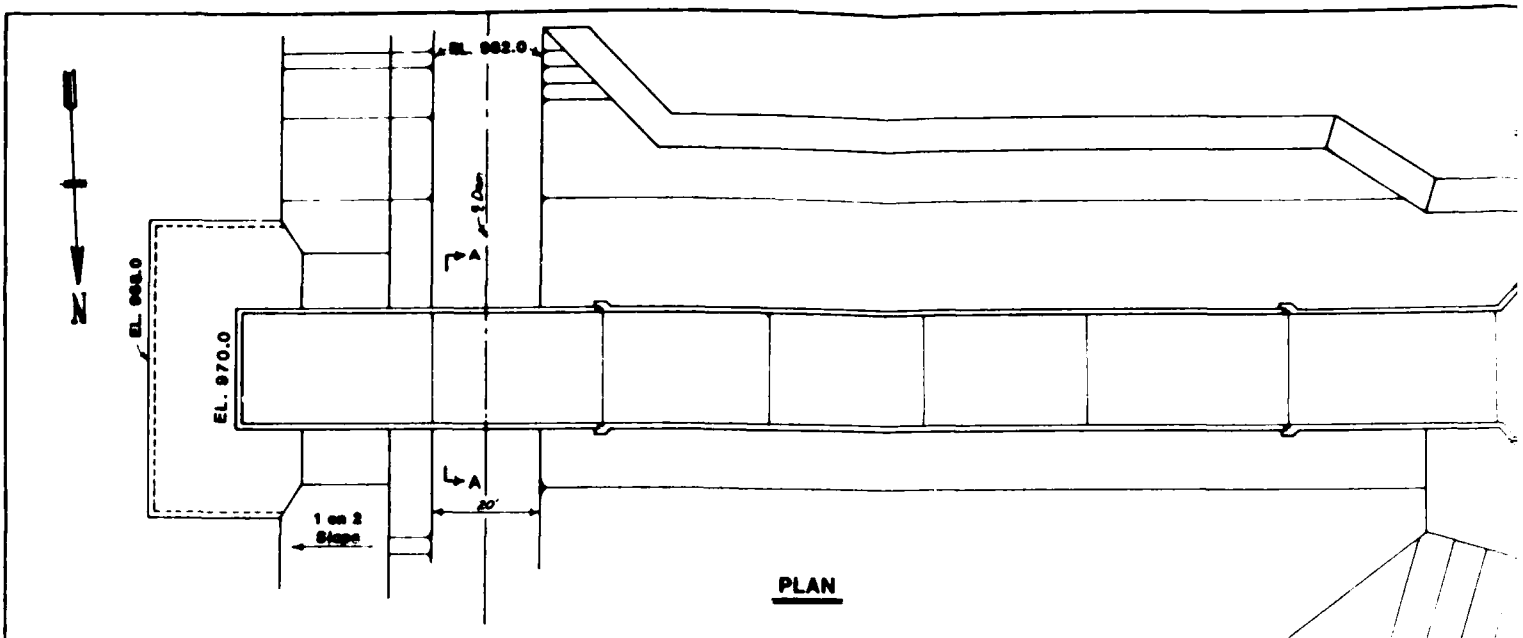
VICINITY

UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

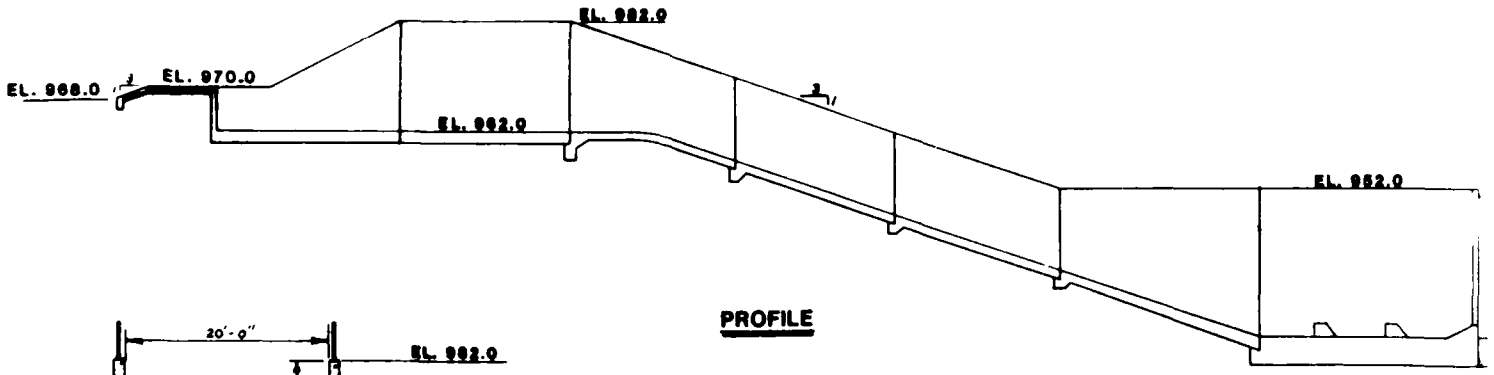
BEAR CREEK
WATER SUPPLY

DAM AND SPILLWAY

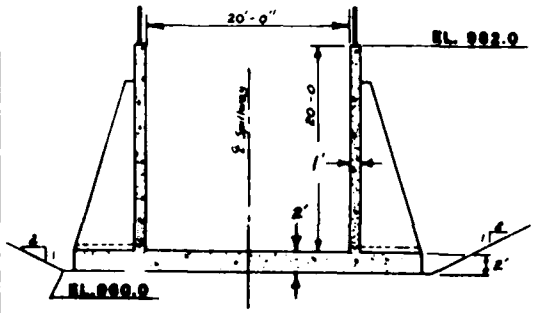
PLATE 9



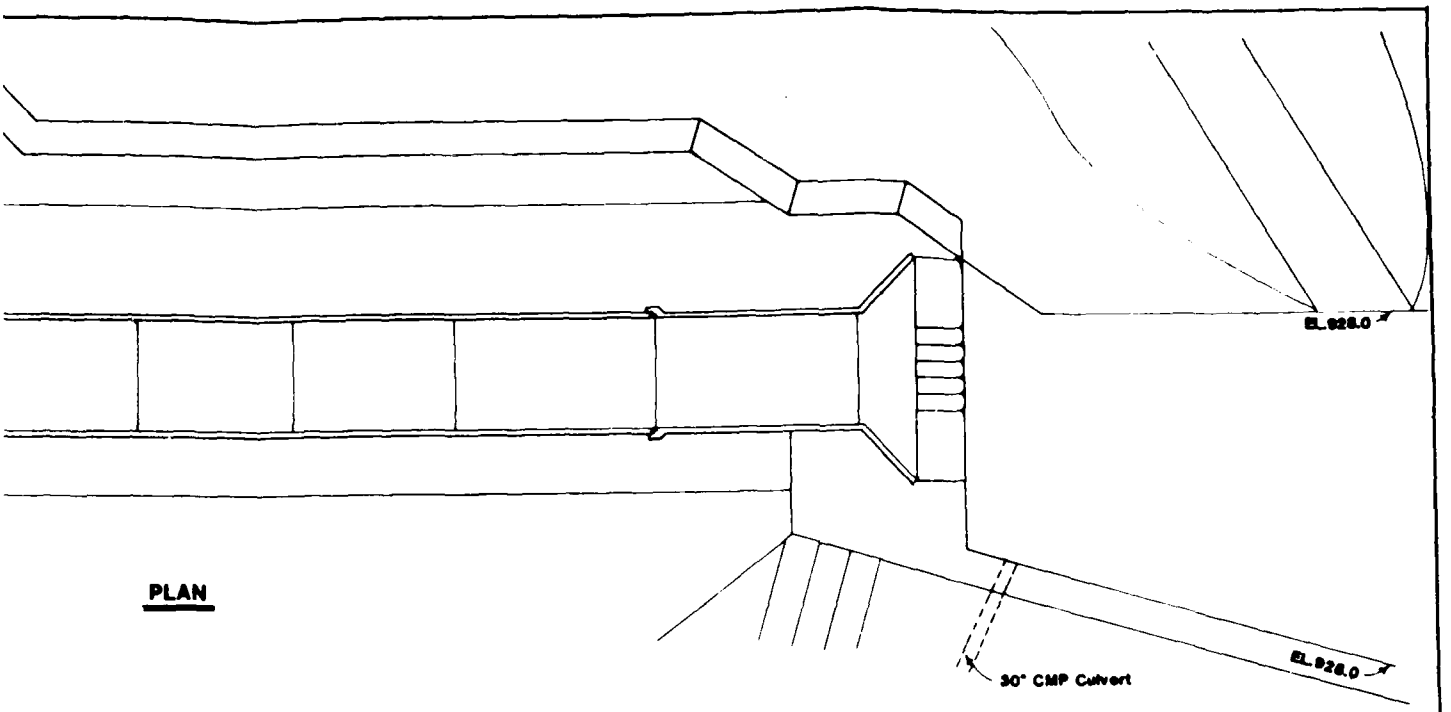
PLAN



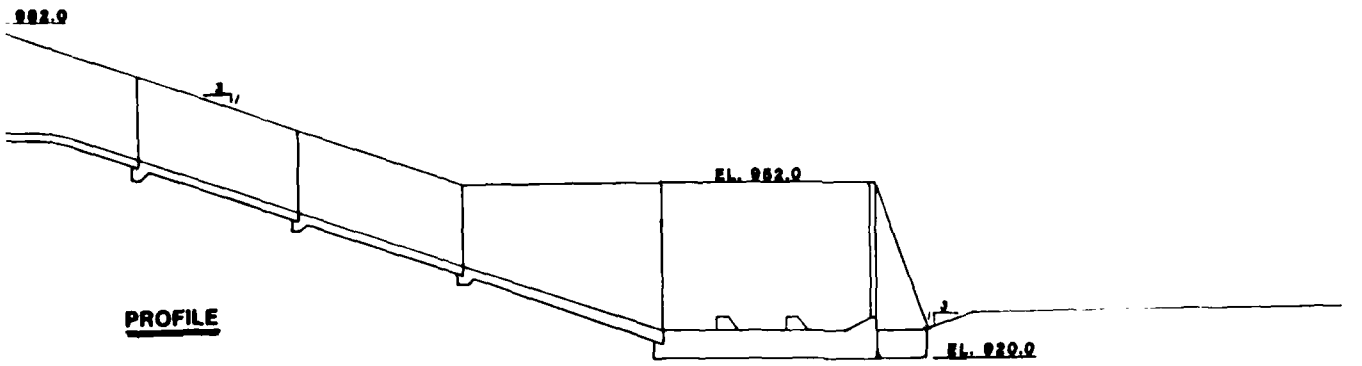
PROFILE



SECTION A-A



PLAN

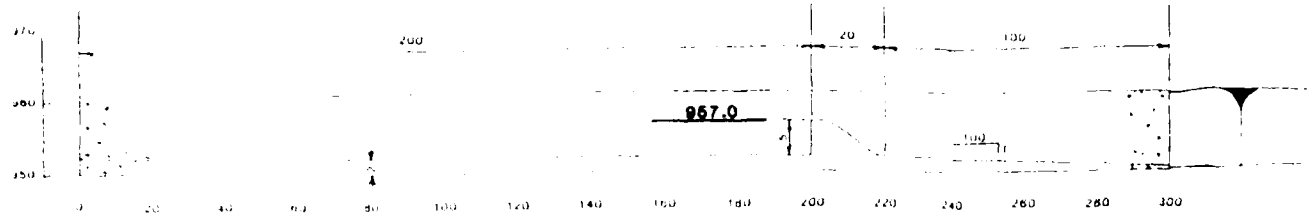


PROFILE

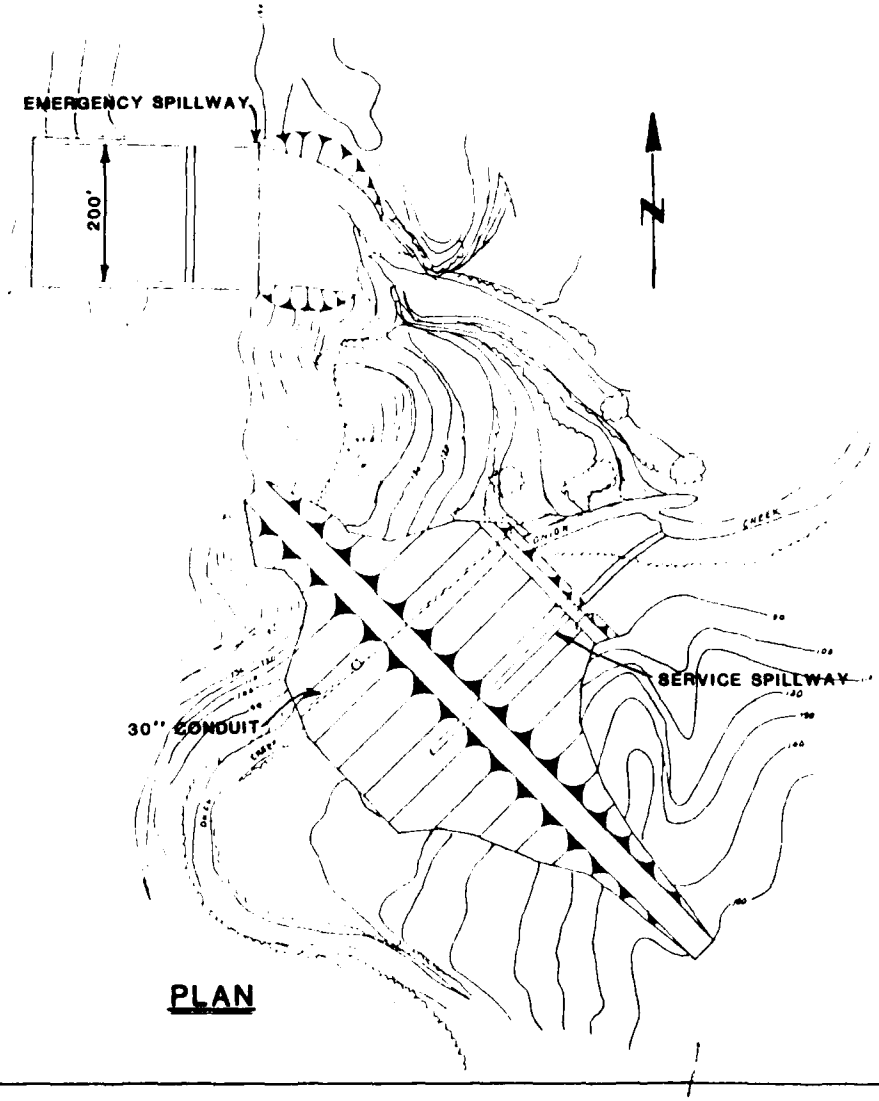
UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

BEAR CREEK
WATER SUPPLY
SPILLWAY DETAILS

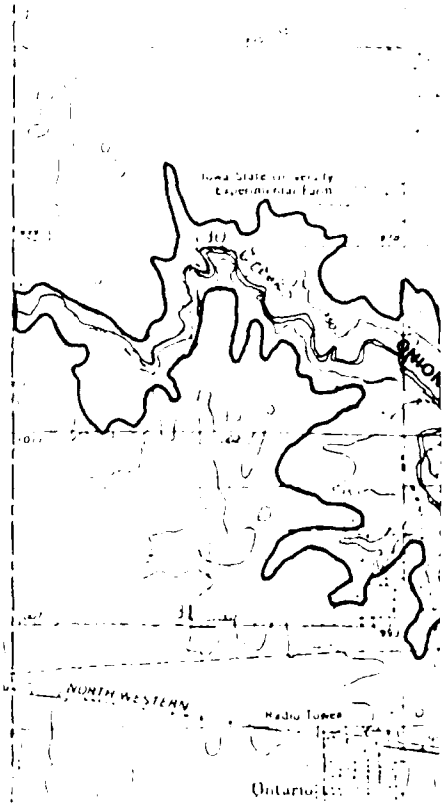
PLATE 10



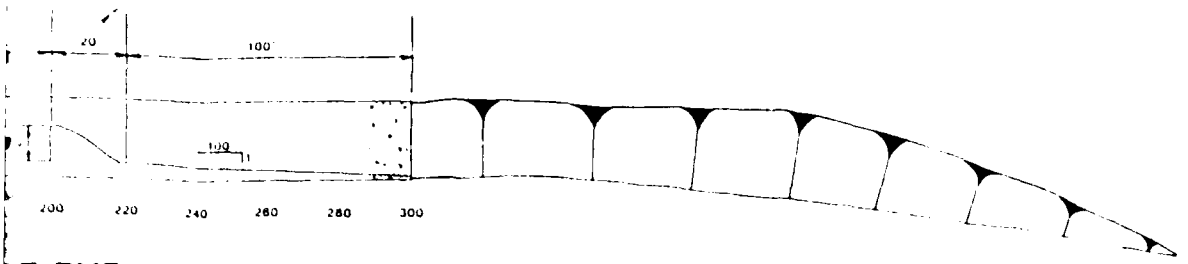
SECTION AT EMERGENCY SPILLWAY



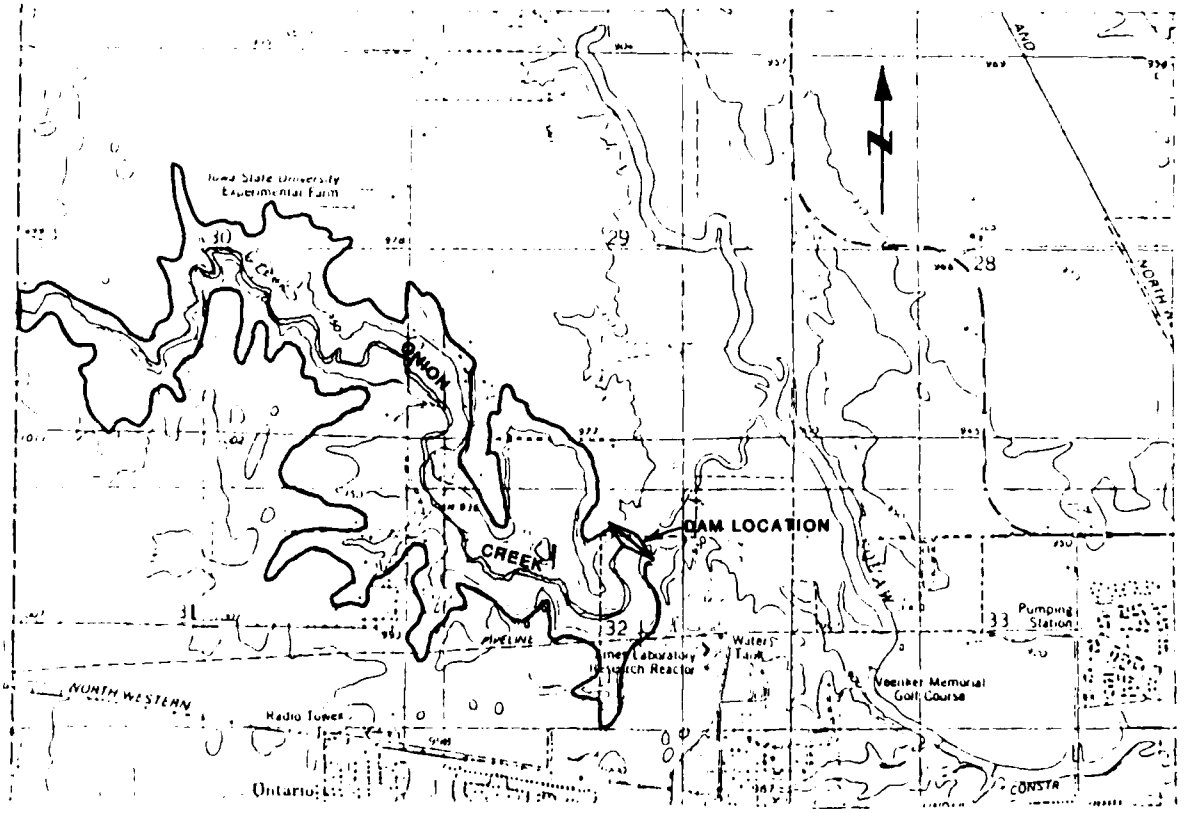
PLAN



VIC



AT EMERGENCY SPILLWAY

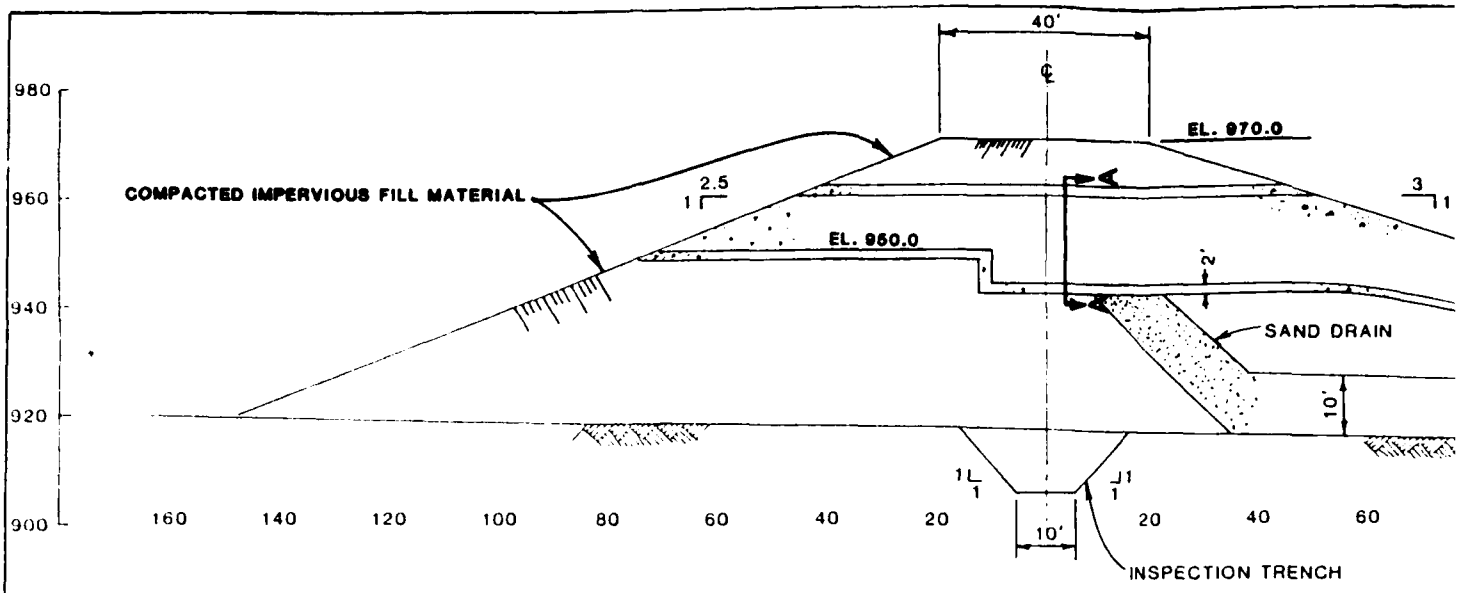


VICINITY LOCATION

UPPER SKUNK RIVER BASIN
REEVALUATION STUDY
ONION CREEK
WATER SUPPLY

LOCATION, PLAN & SECTION

PLATE 11



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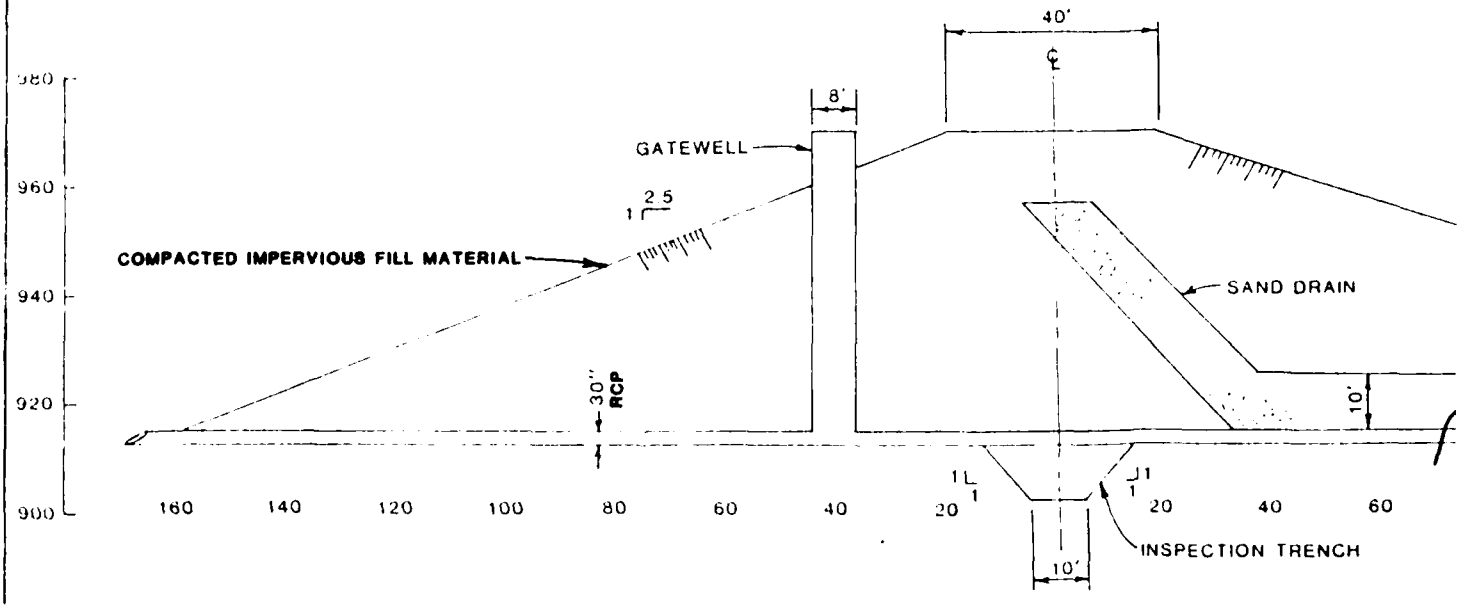

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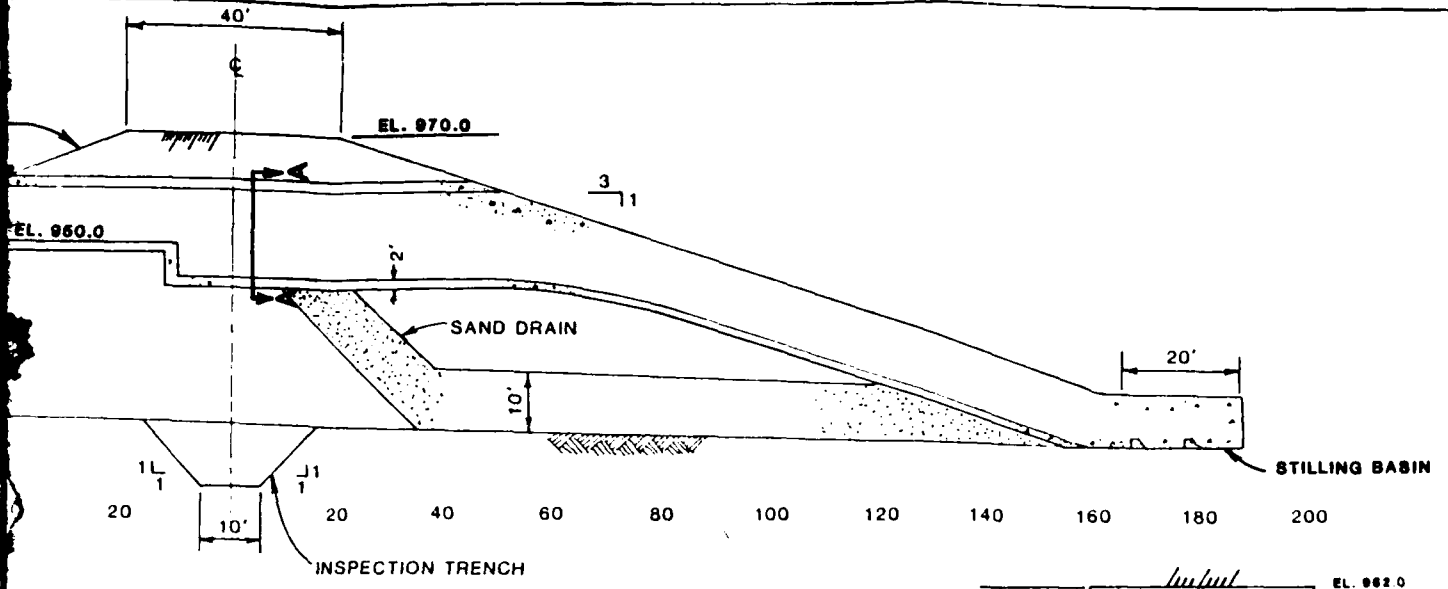

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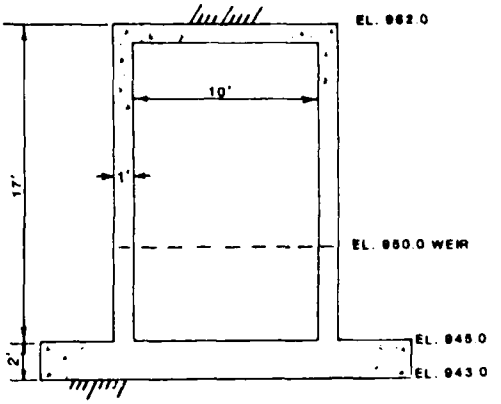
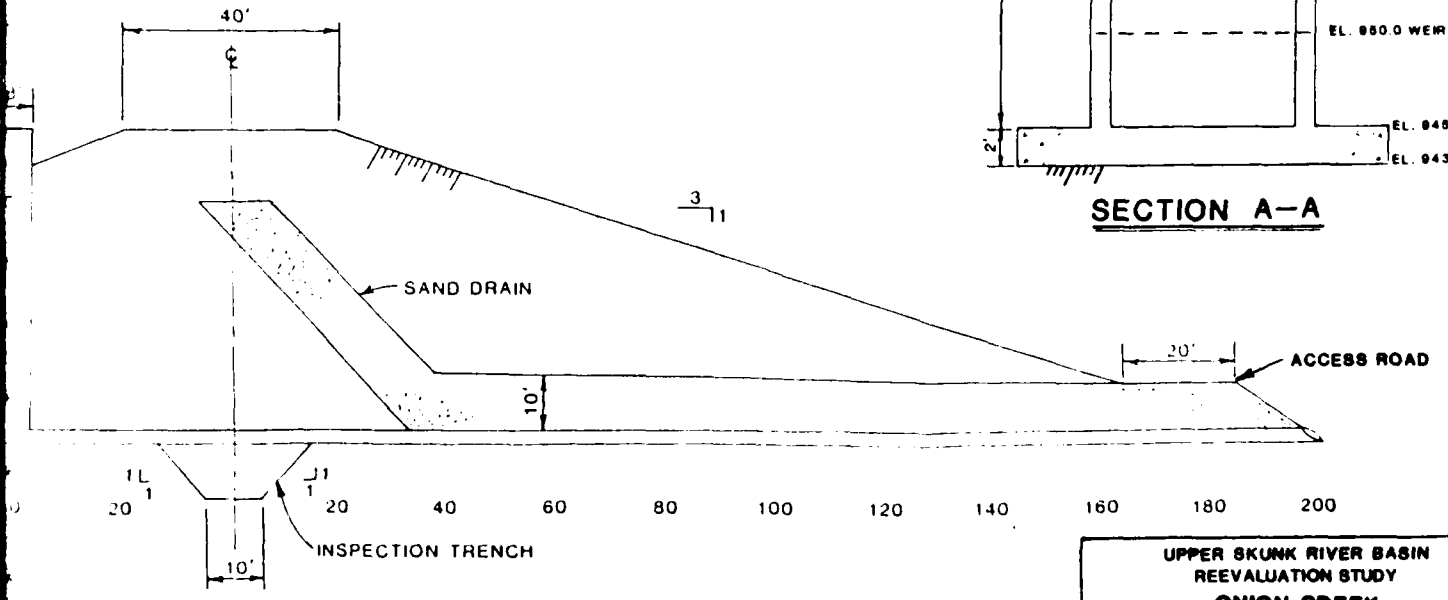


SECTION A–A



SECTION AT 30" CONDUIT

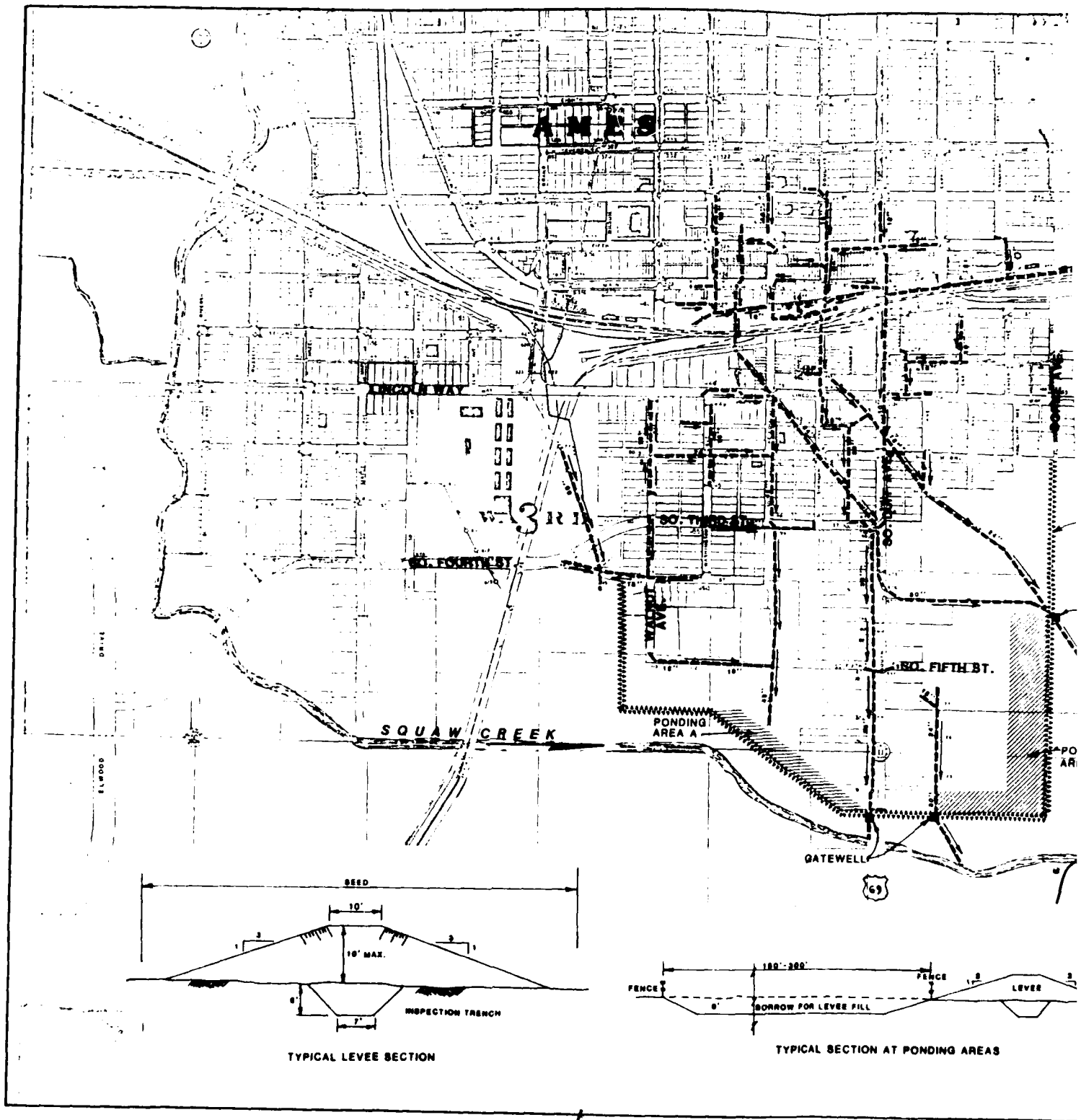
UPPER SKUNK RIVER BASIN
REEVALUATION STUDY

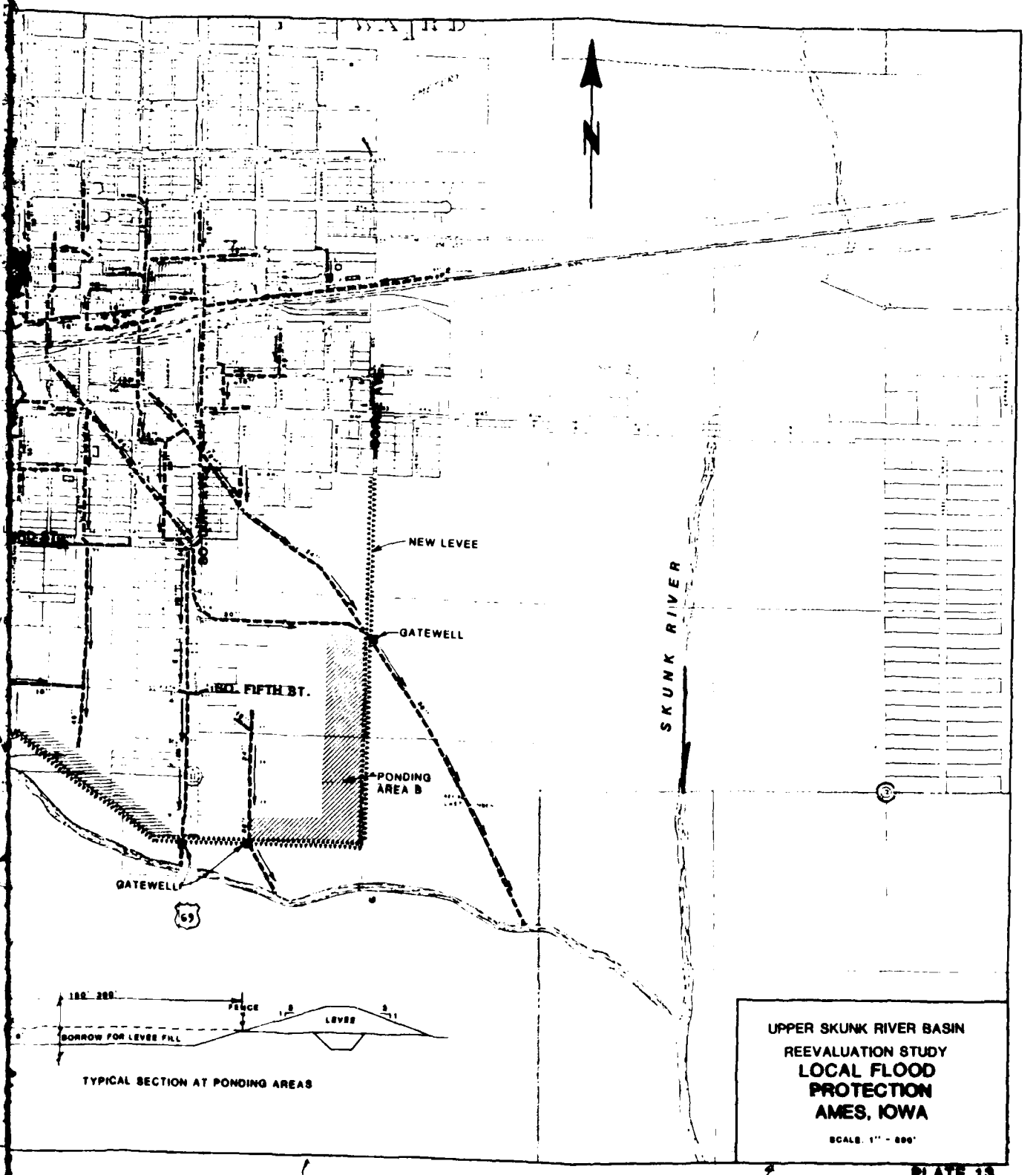
ONION CREEK

WATER SUPPLY DAM

SECTIONS

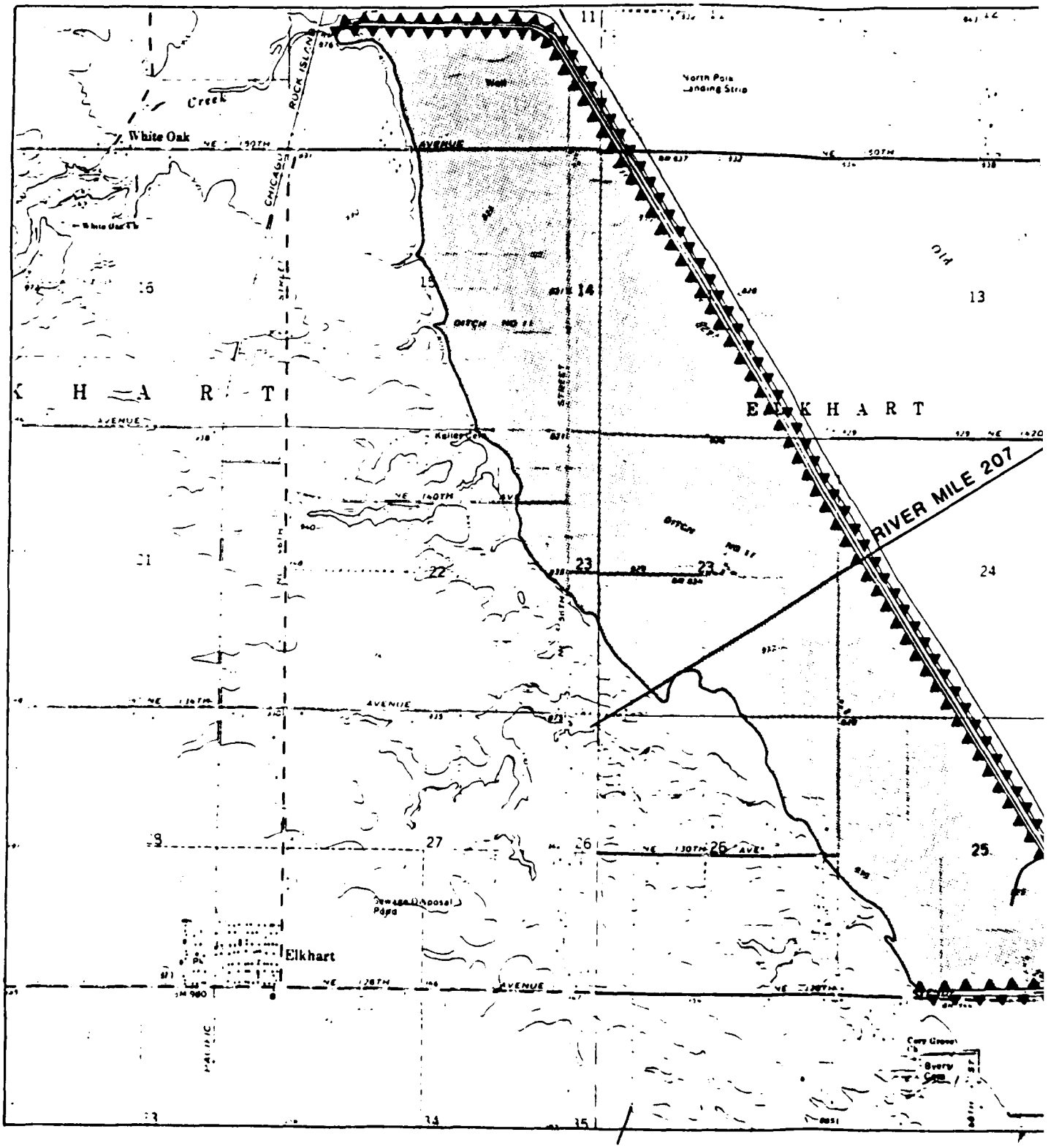
PLATE 12


AMES
LINCOLN WAY
SO. FOURTH ST.
SO. FIFTH ST.
SQUAW CREEK
PONDING AREA A
GATEWELL
69
SEED
10'
3
3
16' MAX.
8'
2'
INSPECTION TRENCH
TYPICAL LEVEE SECTION
150' - 300'
FENCE
FENCE
8'
LEVEE
BORROW FOR LEVEE FILL
TYPICAL SECTION AT PONDING AREAS



UPPER SKUNK RIVER BASIN
REEVALUATION STUDY
LOCAL FLOOD PROTECTION
AMES, IOWA
SCALE 1" = 800'

PLATE 13


White Oak
Creek
CHICAGO
ROCK ISLAND
AVENUE
STREET
DITCH
E L K H A R T
RIVER MILE 207
Elkhart
North Polo Landing Strip
Sewage Disposal Plant
Corn Grower
Avery Corn
11
12
13
14
15
16
21
22
23
24
25
26
27

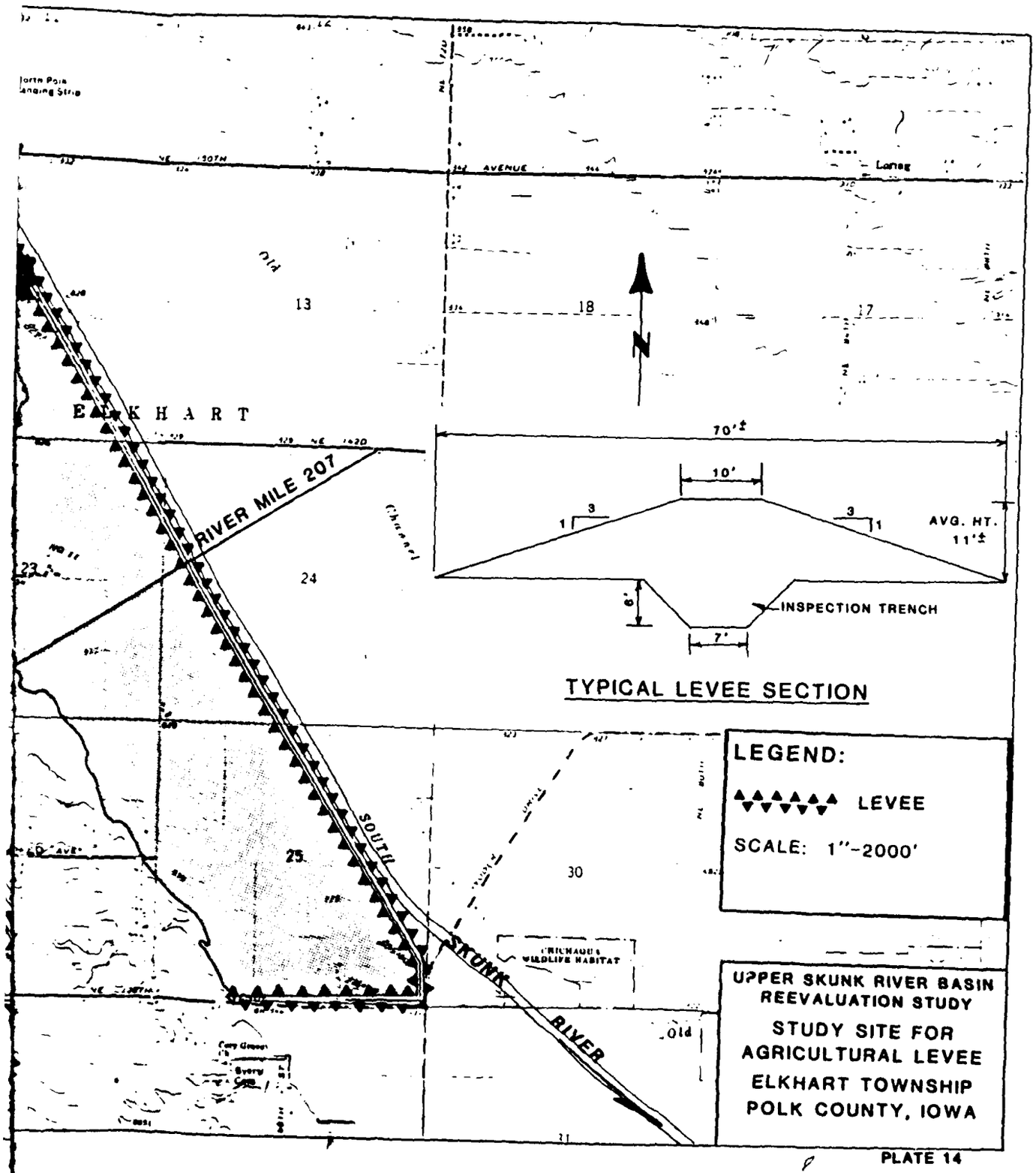

ELKHART
RIVER MILE 207
SOUTH SKUNK RIVER
13
18
17
24
25
30
23
70'±
10'
3
1
3
1
AVG. HT.
11'±
6'
7'
INSPECTION TRENCH
TYPICAL LEVEE SECTION
LEGEND:
LEVEE
SCALE: 1"-2000'
UPPER SKUNK RIVER BASIN
REEVALUATION STUDY
STUDY SITE FOR
AGRICULTURAL LEVEE
ELKHART TOWNSHIP
POLK COUNTY, IOWA

PLATE 14

LIST OF APPENDIXES

A - HYDROLOGY AND HYDRAULICS

B - ECONOMIC ANALYSIS

C - PERTINENT CORRESPONDENCE

D - COST ESTIMATES

HYDROLOGY AND HYDRAULICS

APPENDIX A

GENERAL REEVALUATION REPORT
UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

APPENDIX A
HYDROLOGY AND HYDRAULICS

TABLE OF CONTENTS

Subject	Page
SECTION 1 - INTRODUCTION	A-1
General	A-1
SECTION 2 - SKUNK RIVER BASIN CHARACTERISTICS	A-1
General	A-1
Basin Characteristics	A-2
Channel Characteristics	A-2
Climatology	A-2
Stream Gaging Stations	A-3
Flooding Characteristics and History	A-3
Flow Characteristics	A-4
SECTION 3 - METHODOLOGY	A-5
Hydrology	A-5
Hydraulics	A-7
SECTION 4 - AMES LAKE REEVALUATION	A-7
General	A-7
Site Analysis	A-8
SECTION 5 - AMES LAKE - DOWNSIZED	A-10
General	A-10
Site Analysis	A-10
SECTION 6 - SQUAW CREEK RESERVOIR	A-12
General	A-12
Site Analysis	A-13
SECTION 7 - SMALL IMPOUNDMENTS	A-14
General	A-14
Site Analyses	A-15

TABLE OF CONTENTS (Cont'd)

Subject	Page
SECTION 8 - LOCAL FLOOD PROTECTION - AMES, IOWA	A-18
General	A-18
Flood Discharges and Profiles	A-18
Discharges	A-18
Profiles	A-19
Interior Drainage	A-20
Gravity Flow Design	A-21
Blocked Gravity	A-22
Other Considerations	A-22
SECTION 9 - AGRICULTURAL LEVEES	A-22
General	A-22
Flood Discharges and Profiles	A-23
Existing Conditions	A-23
Modified Conditions	A-23
Interior Drainage	A-25
Valley Storage	A-26
SECTION 10 - WATER SUPPLY	A-27
General	A-27
Bear Creek	A-30
Onion Creek Reservoir	A-30
Summary	

List of Tables

No.	Title	Page
A-1	Floods of Record	A-4
A-2	Skunk River Flow Values	A-4
A-3	Flow Duration on Skunk River Above Ames	A-5
A-4	Skunk River Flow Frequency at Ames	A-6
A-5	Skunk River Flow Frequency Near Oskaloosa	A-6
A-6	Ames Lake Reservoir	A-8
A-7	Peak Ames Lake Reservoir Elevations	A-9
A-8	Downsized Ames Lake	A-10
A-9	Floods Reaching Full Flood Pool	A-11
A-10	Squaw Creek Detention Dam	A-14
A-11	Identified Reservoir Sites	A-16
A-12	Flow-Frequency Comparisons	A-19
A-13	Unit Hydrograph Parameters	A-20
A-14	Ponding Area Capacities	A-21

TABLE OF CONTENTS (Cont'd)

List of Tables (Cont'd)

No.	Title	Page
A-15	Polk County Agricultural Levees	A-24
A-16	Unit Hydrograph Parameters	A-25
A-17	Peak Ponding During High River Conditions	A-26
A-18	Loss of Valley Storage Impacts	A-26
A-19	Bear Creek Water Supply Reservoir	A-29
A-20	Onion Creek Water Supply Reservoir	A-31

List of Plates

No.	Title
A-1	General Study Area
A-2	Frequency Analysis, Skunk River Above Ames
A-3	Frequency Analysis, Skunk River Below Squaw Creek
A-4	Frequency Analysis, Skunk River Near Oskaloosa
A-5	Frequency Analysis, Skunk River at Augusta
A-6	Frequency Analysis, Squaw Creek in Ames
A-7	Rating Curve, Skunk River Gage Above Ames
A-8	Rating Curve, Skunk River Gage Below Squaw Creek
A-9	Rating Curve, Skunk River Gage at Oskaloosa
A-10	Rating Curve, Skunk River Gage at Augusta
A-11	Rating Curve, Squaw Creek Gage in Ames
A-12	Ames Lake Damsite, Squaw Creek Basin, Skunk River Basin Above Ames, and Gage Stations
A-13	Ames Lake - Monthly Reservoir Inflow
A-14	Ames Lake - 950 Pool Operational Hydrographs
A-15	Stage-Frequency, Skunk River Below Squaw Creek
A-16	Stage-Frequency, Skunk River at Oskaloosa
A-17	Stage-Frequency, Skunk River at Augusta
A-18	Stage-Frequency, Skunk River Below Squaw Creek
A-19	Stage-Frequency, Skunk River at Oskaloosa
A-20	Ames Lake - Monthly Reservoir Inflow
A-21	Ames Lake - 946 Pool Operational Hydrographs
A-22	Stage-Frequency, Skunk River Below Squaw Creek
A-23	Stage-Frequency, Skunk River at Oskaloosa
A-24	Stage-Frequency, Skunk River at Augusta
A-25	Stage-Frequency, Skunk River Below Squaw Creek
A-26	Stage-Frequency, Skunk River at Oskaloosa
A-27	Squaw Creek Dam, Squaw Creek Basin, Skunk River Basin Above Ames, and Gage Stations
A-28	Stage-Frequency, Squaw Creek in Ames
A-29	Stage-Frequency, Skunk River Below Squaw Creek

TABLE OF CONTENTS (Cont'd)

List of Plates (Cont'd)

No.	Title
A-30	Stage - Frequency, Skunk River at Oskaloosa
A-31	Identified Alternative Impoundment Sites
A-32	Squaw Creek Levee, Ames Iowa
A-33	Flood Profiles, Squaw Creek
A-34	Flood Profiles, Skunk River
A-35	Ames - Interior Area A - 100-Year Gravity Flow
A-36	Ames - Interior Area B - 100-Year Gravity Flow
A-37	Ames - Interior Area A - 10-Year Blocked Gravity
A-38	Ames - Interior Area B - 10-Year Blocked Gravity
A-39	Study Site for Agricultural Levee, Elkhart Township, Polk County, Iowa
A-40	Polk County Interior Runoff Hydrographs
A-41	Polk County Study Area. Skunk River Ag Levees Interior Ponding
A-42	Skunk River Agricultural Levees, Polk County, Iowa, Interior Flooding, 84-Inch Gravity Outlet
A-43	Loss of Valley Storage Impacts
A-44	Water Supply Sites, Squaw Creek Basin, Skunk River Basin Above Ames, and Gage Stations
A-45	Bear Creek - 1956 Drought With 5 Ft^3/s Releases
A-46	Bear Creek - 1977 Drought With 5 Ft^3/s Releases
A-47	Onion Creek - 1977 Drought With 5 Ft^3/s Releases

GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

APPENDIX A

HYDROLOGY AND HYDRAULICS

SECTION 1 - INTRODUCTION

GENERAL

This appendix includes the hydrologic and hydraulic analysis of the Upper Skunk River Reevaluation Study's alternatives for flood control, low-flow augmentation, and water supply within the Upper Skunk River Basin. Included in the analysis is a reevaluation and a downsizing of the authorized Ames Lake project. Additional alternatives, including smaller tributary reservoirs and levees, were studied for providing flood protection and water supply along various reaches of the river from the stream gage near Oskaloosa, River Mile 147.3, to the upper reaches of the basin. The hydrologic and hydraulic analysis was conducted on a reconnaissance level using existing data to determine the beneficial impacts of each alternative. Hydraulic design was limited primarily to the conceptual sizing of structures such that construction costs could be projected. The Skunk River Basin is shown on plate A-1.

SECTION 2 - SKUNK RIVER BASIN CHARACTERISTICS

GENERAL

The Skunk River Basin is located in Iowa, extending from the north-central region of the state to the Mississippi River in the southeast. A total watershed area of 4,652 square miles includes 4,355 square miles drained by the Skunk River and 297 square miles of direct Mississippi River drainage near Fort Madison and Keokuk. Nearly all of the basin land is utilized as farmland, with 77 percent in cropland. The basin covers 7.7 percent of Iowa and lies in parts of 20 counties. The basin has a long, narrow configuration with a length of 180 miles and a maximum width of 40 miles. Its average width is 24 miles.

The Skunk River (now officially designated by the U.S. Geological Survey (USGS) as the South Skunk River above the confluence with the North Skunk River) begins in Hamilton County about 264 river miles upstream from its mouth. The total fall from source to mouth, 9 miles below Burlington, Iowa, is about 680 feet.

BASIN CHARACTERISTICS

Physiographic conformation of the Skunk River Basin was determined by glacial activity and subsequent periods of erosion. The basin is divided into an upper area of youthful topography covered by Wisconsin drift and a lower area of more mature topography in which the river and tributaries have extensively eroded into older drifts and bedrock beneath. In the Wisconsin drift, the upper one-fourth of the basin, the topography is gently rolling and natural drainage is poor, although runoff has been accelerated by artificial drainage. From the source to 5 miles above Ames, the river valley is narrow and shallow. At this point, the bluffs rise to a height of 75 to 100 feet above the riverbed and continue until immediately above Ames where the river enters a preglacial valley.

Immediately below Ames, the Skunk River is joined by Squaw Creek and the valley widens considerably. The lower three-fourths of the basin consists of loess-covered ridges and level uplands with floodplains that are mature and well developed. Typically, abrupt topographic relief occurs between uplands and stream valleys in the lower region.

CHANNEL CHARACTERISTICS

From Ames to the eastern Mahaska County line, the Skunk River floodplain is relatively wide, reaching a maximum width of about 2 miles in Polk County. The formerly meandering river in this reach now flows in a straightened channel. This straightening was accomplished in the early 1900's by several drainage districts organized under State law. In Keokuk, Washington, Jefferson, Henry, Des Moines, and Lee Counties, the river meanders naturally through narrower floodplains. Above Ames, the channel is predominantly unaltered and in its natural state.

Average channel slopes of the Skunk River are 5 feet per mile for the upper one-fourth of the river, 1.5 to 3 feet per mile for the next one-fourth, and 1.2 feet per mile for the lower one-half. The channel varies in cross-sectional area form 1,000 square feet at Ames to 5,000 square feet near its mouth. Bankfull flow varies from about 3,000 cubic feet per second (ft^3/s) at Ames to 17,000 ft^3/s near Augusta, Iowa.

CLIMATOLOGY

Weather in the Skunk River Basin is characterized by hot, humid summers and cold winters, typically described as mid-continental. The weather is dominated by warm, moist air moving from the Gulf of Mexico and cold, dry air moving from the Arctic polar regions. Rainfall is adequate for crop growth if properly distributed. Droughts have occurred when rainfall has been inadequate.

The U.S. Weather Bureau maintains numerous weather stations in the basin. Normal annual precipitation varies from 35 inches in the lower basin to 30 inches in the upper basin. Average annual snowfall ranges from 24 to 34 inches, respectively. Average annual runoff for the Upper Skunk River Basin is 5.5 inches. Average annual pan evaporation for central Iowa is about 50 inches, with lake evaporation running about 70 percent of pan evaporation values.

STREAM GAGING STATIONS

There are three active stream gaging stations on the Skunk River: above Ames (mile 228.1), near Oskaloosa (mile 147.3), and at Augusta (mile 12.5). Drainage areas at the gages are 315, 1,635, and 4,303 square miles, respectively. An inactive gage exists below the Squaw Creek confluence below Ames (mile 222.6) with a drainage area of 556 square miles. Also in the Upper Skunk River basin is a gage in Ames on Squaw Creek with a drainage area of 204 square miles.

FLOODING CHARACTERISTICS AND HISTORY

The Skunk River frequently overflows its banks, resulting in extensive agricultural flooding. Most of the flooding generally occurs in June with localized flooding occurring throughout the growing season as the result of local heavy rainfall. Floods of lesser magnitude sometimes occur during the spring snow and ice thaw in conjunction with moderate rainfall. Flood records at the stream gage above Ames are available for the period from October 1920 to September 1927 and October 1932 to September 1984.

Discharges for major floods above Ames are listed on table A-1, along with the corresponding flow at the downstream Ames and Oskaloosa gages. It should be noted that, for some floods, the peak discharge at upstream gages is greater than the peak discharges at downstream gages. This is a result of attenuation due to valley storage.

TABLE A-1

Floods of Record

Date	Discharge, ft^3/s Above Ames	Below Ames	Oskaloosa
June 1954	8,630	7,980	5,420
May 1944	8,060	10,000	37,000
June 1947	6,550	---	20,000
March 1960	6,210	9,260	14,800
June 1974	5,780	7,800	9,280
March 1951	5,320	---	6,700
April 1965	5,260	7,340	11,200
June 1975	5,230	14,700	9,740
July 1983	5,150	---	10,900
June 1984	5,020	---	12,200
March 1979	4,980	9,430	11,100

FLOW CHARACTERISTICS

Skunk River streamflow varies significantly throughout the year and at times drastically from year to year. The bulk of the streamflow occurs during high river stages, which roughly parallel the distribution and seasonal variability of precipitation. The average flow and 7Q10 flow of the Skunk River at the gaging stations are listed in table A-2. The average flow is the arithmetic mean of all surface flow during the period of record for the site. The 7Q10 flow is the minimum average streamflow expected to occur during 7 consecutive days with a recurrence interval of 10 years as predicted by the period of record. This flow level has been established for water quality control purposes. Flow-duration values for the Skunk River above Ames are shown on table A-3.

TABLE A-2

Skunk River Flow Values

Location	Drainage Area (mi^2)	Average Flow (ft^3/s)	7Q10 Flow (ft^3/s)
Above Ames	315	150	0.1
Below Squaw Creek	556	295	0
Oskaloosa	1,635	890	10
Augusta	4,303	2,350	30

TABLE A-3

Flow Duration on Skunk River Above Ames

Flow (ft^3/s)	Percent of Time Equalled or Exceeded
0	100.0
1	95.3
2	91.5
3	87.3
4	84.7
5	82.6
10	75.1
20	65.4
50	48.5
100	32.8
200	19.0
300	12.6
400	8.9
500	6.7
1,000	2.5
2,000	0.7

SECTION 3 - METHODOLOGY

HYDROLOGY

Three methods were used in computing hydrographs and flow frequencies within the Skunk River Basin. One method, the U.S. Water Resources Council Bulletin #17B Guidelines for Determining Flood Flow Frequency methodology was used for determining flow-frequency relationships on those stream reaches that were gaged. The Rock Island District's Draft Report Skunk River Basin Flow-Frequency Study documents the Bulletin #17B Modified Log-Pearson Type III flow-frequency analysis on the Skunk River.

Of note is the introduction of a skew factor into the statistical analyses. In the 1960's, a zero skew was used in the flow-frequency studies. Present methodology dictates gaged station adopted skews of -0.4 above Ames and -0.5 below Ames on the Skunk River. Adopting negative skews decreases flow-frequency values compared to using a zero skew. Table A-4 lists a comparison of flow-frequency values for the two Skunk River gages at Ames. Plates A-2 and A-3 show the present flow-frequency curves for the Skunk River gages near Ames.

TABLE A-4

Skunk River Flow Frequency at Ames

Frequency	Flow (ft^3/s)			
	Above Ames		Below Ames	
	1968	1985	1968	1985
2-Year	2,700	3,070	4,900	6,110
10-Year	6,100	5,690	10,950	10,400
50-Year	10,500	7,830	18,000	13,600
100-Year	12,500	8,680	22,100	14,700
200-Year	15,100	9,510	26,400	15,900

A comparison of the 1968 and present flow frequencies at the Oskaloosa gage shows a significant reduction in higher flow values despite the current station adopted skew of +0.2. This is due to the 1968 design study's correlation of Skunk River flows at Oskaloosa with those at Augusta resulting in a significant over-estimate. The now-recognized characteristic of flow attenuation at the Oskaloosa gage is documented in the Skunk River Basin Flow-Frequency Study. Table A-5 lists a comparison of flow-frequency values at the Oskaloosa gage. Plate A-4 shows the present flow-frequency curve.

TABLE A-5

Skunk River Flow Frequency Near Oskaloosa

Frequency	Flow (ft^3/s)	
	1968	1985
2-Year	8,050	8,250
10-Year	20,000	15,500
50-Year	35,500	23,200
100-Year	44,000	26,900
200-Year	54,000	30,800

At Augusta, a comparison of the 1968 and present flow frequencies also shows a significant reduction in the higher flow values. This is due to the use of a station adopted skew of -0.3 instead of the zero skew analysis used in the 1960's. The current flow-frequency plot and data are shown on plate A-5.

The Log-Pearson Type III flow-frequency plots for the Squaw Creek gage in Ames are shown on plate A-6. An adopted station skew of 0.0 was used for the Squaw Creek Basin. A comparison of past analyses on Squaw Creek is discussed in Section 8.

The second hydrologic method used was the method presented in the Skunk River Basin Flow-Frequency Study for ungaged reaches of the Skunk River. This method was used to determine values on the Skunk River in Polk County for the agricultural flood control levee alternative.

The third hydrologic method used was for interior areas, ungaged tributary streams, and the upper reaches of the Skunk River and Squaw Creek. Synthetic unit hydrographs were obtained using Clark's technique. Clark's is based on the drainage area, time of concentration, and a basin storage attenuation constant. Flood hydrographs were computed by applying rainfall/runoff derived from Technical Paper No. 40 to the unit hydrographs.

HYDRAULICS

Water surface stages for floods of selected recurrence intervals were determined at index stations for determining reservoir flood control benefits. These index stations were the four gaging stations on the Skunk River and the gage on Squaw Creek in Ames. The current USGS discharge rating curves shown on plates A-7, A-8, A-9, A-10, and A-11 were used in determining the stage-frequency curves. For the Squaw Creek local flood protection levee analysis, the water surface profiles from the Ames Flood Insurance Study were used for the initial evaluation. On the Skunk River through Polk County, approximate profiles were computed by the U.S. Army Corps of Engineers' computer program HEC-2-Water Surface Profiles. The HEC-2 model was calibrated to experienced flood profiles.

SECTION 4 - AMES LAKE REEVALUATION

GENERAL

The Ames Lake project would be a multi-purpose reservoir located in central Iowa. The project site is on the Skunk River at River Mile 220.6 near the northern city limits of Ames, Iowa. The dam site is shown on plate A-12. Project documents specified an 85-foot-high dam which would impound runoff from an upstream drainage area of 314 square miles. Pertinent data concerning the authorized reservoir project are summarized on table A-6. Operating plans originally included a monthly varying low-flow release schedule averaging 22 ft^3/s and a two-level high-flow release schedule of 3,000 ft^3/s from December 1 to April 1 and 1,000 ft^3/s from April 1 to December 1.

TABLE A-6

Ames Lake Reservoir

	Elevation (Feet NGVD) a/	Area Acres	Storage Acre-Feet	Inches
Top of Dam	992.0	9,200	246,000	14.7
Maximum Pool	987.5	7,500	195,000	11.6
Top of Flood Pool	976.0	5,000	124,000	7.4
Top of Conservation Pool	950.0	2,100	34,500	2.1
Top of Sediment Pool	933.0	800	8,400	0.5
Flood Control Storage	950-976	---	89,500	5.2
Conservation Storage	933-950	---	26,100	1.6

a/ National Geodetic Vertical Datum of 1929

SITE ANALYSIS

The sequential operation of historic record for the Ames Lake project was remodeled and updated to Water Year 1983 using the U.S. Army Corps of Engineers' HEC-5 Simulation of Flood Control and Conservation Systems computer program. The HEC-5 model utilized average monthly flows on the Skunk River and average monthly evaporation rates. Input parameters included the revised low-flow release schedule reflecting current requirements of a constant 10 ft^3/s and a seepage factor of 5 ft^3/s. Plots of the operational reservoir pool elevation hydrographs and monthly inflows are found on plates A-13 and A-14.

The period of historic record for simulated reservoir operation dates from October 1920 to September 1927 and October 1932 to September 1983. The period from October 1927 to September 1932 represents synthetic data. Reservoir elevations during periods of flood control storage, elevation 950-976, on the plates are approximations based on average monthly inflows and outflows. Thus, the Rock Island District's computer program Ames Reservoir Flood Control Simulator was used during periods of flooding to determine maximum reservoir pools and outflows based on daily inflows. Five floods have occurred in the 58 years of record which would have resulted in the reservoir pool exceeding elevation 970. Table A-7 summarizes these events. As listed, none of the flood events reached the full flood pool elevation of 976 feet NGVD.

TABLE A-7

Peak Ames Lake Reservoir Elevations

Date	Reservoir Elevation (Feet NGVD)
June 1944	974.5
June - July 1947	973.8
July - August 1969	973.4
June - July 1974	973.0
July 1983	972.6

The reservoir holdouts determined by the Ames Reservoir flood control simulation were used to modify natural flows recorded at the Skunk River gage located immediately below the Squaw Creek confluence south of Ames. The natural flow-frequency values at this gage are presented in section 3. The modified flow-frequency was computed using the same methodology with the modified peak flows in an all-year annual event analysis. The natural and modified flow-frequency curves then were applied to the rating curve for this index station to obtain the resultant stage-frequency curves. These stage-frequency curves were used to determine the flood control benefits of the reservoir and are shown on plate A-15.

Similarly, a modified flow-frequency analysis at the downstream gaging stations near Oskaloosa and Augusta was performed. For modified conditions, Ames Reservoir holdouts were routed using the Tatum successive average lag method. Travel times of 3 and 7.5 days were used. Routed holdouts were subtracted from the natural flows and a modified flow frequency was computed. The resultant stage-frequency curves are shown on plates A-16 and A-17.

Most of the flood damages on the Skunk River are agricultural damages; thus, a crop-year analysis was done. The crop-year time period used was April 1 through December 1. The analysis consisted of the same process as was used for the all-year analysis, except for only using peak flows which occurred during the crop-year. First, natural crop-year flow values were developed at the downstream index stations. Next, Ames Reservoir holdouts determined from the flood control reservoir simulation were routed downstream and subtracted from the natural flows and a modified flow-frequency was computed. The resultant crop-year natural and modified stage-frequency curves at the gages below Ames and near Oskaloosa are shown on plates A-18 and A-19, respectively.

Reservoir releases during low-flow periods were maintained at the required 10 ft^3/s flow. The maximum draw down period was associated with the 22-month drought from August 1955 to June 1957 (from full conservation pool to full conservation pool). The critical duration from full conservation pool to maximum reservoir drawdown was 18 months. An HEC-5 period of record optimization of the 950 conservation pool indicated the reservoir to have a safe yield of 18 ft^3/s.

A preliminary evaluation of the maximum reservoir outlet capacities using present day methodology, HEC Probable Maximum Storm - HMR52 indicated that the maximum pool would increase from 987.5 to 988.6, resulting in 3.4 feet of freeboard instead of 4.5 feet. Original design required 3.7 feet. Future freeboard studies may dictate a slight increase in dam height or spillway width; but, overall, the original Ames Lake outlet capacities are acceptable for present reevaluation studies. A Standard Project Flood (SPF) routing from the earlier design studies would remain unchanged with a peak reservoir level of 981.8 feet NGVD, and peak inflows and outflows of 43,950 ft^3/s and 28,700 ft^3/s, respectively. Thus, no major modifications to the original dam design are necessary.

SECTION 5 - AMES LAKE - DOWNSIZED

GENERAL

One of the studied alternatives to the authorized Ames Lake project is to reduce the cost and adverse impacts of the reservoir by downsizing the project design. The scenario investigated was to optimize the conservation storage at a safe yield of 10 ft^3/s and to provide 3.0 inches of flood control storage. Reservoir pool levels, spillway elevations, and top-of-dam elevations were analyzed with the new parameters and revised accordingly. Pertinent data concerning the downsized Ames Lake Reservoir alternative are summarized on table A-8.

TABLE A-8

Downsized Ames Lake

	Elevation (Feet NGVD)	Area Acres	Storage Acre-Feet	Inches
Top-of-Dam	988.6	6,100	138,000	9.4
Maximum Pool	976.8	4,150	113,000	7.8
Top Flood Control Pool	965.1	3,500	68,900	4.6
Top Conservation Pool	946.0	1,850	26,950	1.8
Top Sediment Pool	933.0	850	8,400	0.5
Flood Control Storage	946-965	--	41,950	3.0
Conservation Storage	933-946	--	18,550	1.1

SITE ANALYSIS

The sequential operation of historic record for the downsized Ames Lake Reservoir was modeled using the HEC-5 computer program. Once again, the HEC-5 model utilized average monthly flows on the Skunk River, average monthly evaporation rates, a 5 ft^3/s seepage factor, and a similar flood control operating plan for reservoir releases as the authorized project.

An HEC-5 yield optimization indicated that 26,650 acre-feet of storage was required to provide 10 ft^3/s as a safe yield. This optimization includes a sediment pool of 8,400 acre-feet and 5 ft^3/s of seepage. The 26,650 acre-feet storage value equates to a reservoir pool elevation of 946 feet NGVD. Three inches of basin flood storage equates to 50,250 acre-feet of needed storage above 946 feet NGVD, resulting in a full flood pool elevation of 965 feet NGVD.

Plots of the operational reservoir pool elevation hydrographs and monthly inflows are found on plates A-20 and A-21. Again, the time period from October 1927 to September 1932 represents synthetic data. Reservoir elevations during periods of flood storage are approximations based on average monthly inflows and outflows. Thus, a convolution of previous and new data from the Ames Reservoir - Flood Control Simulator computer model was used during periods of flood storage to determine reservoir pools and outflows based on daily inflows. Eight floods have occurred in the 58 years of record which would have resulted in the reservoir pool reaching full flood pool. Table A-9 lists these events.

TABLE A-9

Floods Reaching Full Flood Pool

June 1944
June-July 1947
June 1954
April 1965
July-August 1969
June 1974
June-July 1975
May 1983

As with the 5.2 inches of flood control storage analysis, the reservoir holdouts determined by the Ames Reservoir flood control simulation were used to modify natural flows recorded at the Skunk river gage located immediately below the Squaw Creek confluence south of Ames. The 3.0-inch analysis revealed that the modified all-year Skunk River peak flows at this location changed only slightly when compared to the 5.2-inch reservoir. However, reservoir holdouts after the peak flow occurred decreased in years when full flood pool was reached. This is due to full flood pool being reached after the peak inflow had been routed through. Consequently, the 3.0-inch reservoir's modified period-of-record Skunk River stage-frequency curve below Ames closely reflects the 5.2-inch reservoir curve. The 3.0-inch reservoir modified stage-frequency curve is shown on plate A-22. This similarity will not hold true for future events when full flood pool is reached before the peak flow arrives. Future studies will need to analyze the increases in flow duration and potential flow frequencies based on a downsized 3.0-inch flood control pool.

Routing the 3.0-inch reservoir holdouts to the gage near Oskaloosa showed a flow increase when compared to the 5.2-inch reservoir in the modified all-year peak flows on the Skunk River for those years when full flood pool was reached. The resultant stage-frequency curves are shown on plate A-23. Likewise, modified 3.0-inch reservoir holdouts were routed to Augusta with the resulting stage reductions being negligible as shown on plate A-24.

A crop-year (April 1 to December 1) analysis also was performed for the Skunk River below Ames and the Oskaloosa index stations. The resultant stage-frequency curves are shown on plates A-25 and A-26.

A preliminary spillway evaluation was conducted using the Project Document Plan (December 1964) arrangement which had a gated spillway in the left abutment with the spillway crest located on rock at elevation 953 feet NGVD, and a 12-foot (revised from 7-foot) diameter cut and cover conduit outlet through the earthen dam. This evaluation was performed to determine a revised top-of-dam elevation based on a Spillway Design Flood (SDF) routing and the SPF pool level. Both flood routings were started on a full flood pool of 965 feet NGVD. The SPF pool level is 967.5 feet NGVD with a peak inflow of 44,000 ft^3/s and a peak outflow of 37,900 ft^3/s. The SDF routing indicated a peak pool elevation of 976.8 feet NGVD with a peak inflow of 96,830 ft^3/s and a peak outflow of 75,250 ft^3/s. Using previous freeboard allowances would place the top-of-dam at elevation 982 feet NGVD.

SECTION E - SQUAW CREEK RESERVOIR

GENERAL

An identified alternative to potentially solving some of the Upper Skunk River Basin water resources problems is a reservoir on the main stem of Squaw Creek. An August 1971 report by the Rock Island District entitled Skunk River, Iowa - Review of Reports for Flood Control and Major Drainage found a dam site on Squaw Creek, the Gilbert Reservoir at River Mile 7.1 above the Skunk River, to be economically feasible. Due to strong opposition and lack of local support, the project was not recommended for authorization.

The 1971 dam site has been eliminated as a potential site due to extensive development in the immediate area during the past 10 years. The main concentrations of development are in the Squaw Valley, Hickory Hills, and Deer Run subdivisions, all located within the first mile upstream of the Gilbert site. Thus, a site was selected approximately 1.5 miles upstream. The dam site and reservoir limits are shown on plate A-27. Reservoir storage capacity at the new site is reduced from the previous site, making the present dam site a marginal site due to limited storage.

Other locations for a Squaw Creek reservoir have even worse characteristics. Only 6.1 inches of basin storage exists at the proposed top-of-dam. Allowing for freeboard and a reservoir surcharge head to pass emergency spillway flows leaves very limited storage for flood control and conservation purposes. Therefore, it was determined that a detention reservoir, i.e., no conservation pool, would be evaluated, thus maximizing the flood control benefits. Pertinent data concerning the Squaw Creek Reservoir are listed on table A-10.

SITE ANALYSIS

A synthetic unit hydrograph was developed for the upstream 160-square-mile watershed. Rainfall and runoff characteristics were determined and applied to the unit hydrograph to develop runoff hydrographs for selected frequencies. Reservoir holdout hydrographs were computed based on constant reservoir outflows at each frequency. The reservoir holdouts were routed downstream to the index stations in the same manner as were the Ames Lake holdouts. Revised flow frequencies were then computed. The flow frequencies represent the case where rainfall is assumed to fall uniformly throughout the basin. The stage versus frequency relationships at the index stations are shown on plates A-28, A-29, and A-30 for both natural and modified conditions. The Squaw Creek reservoir in combination with various other small reservoirs is addressed in section 7 of this appendix. As shown on the plates, the downstream reductions from a Squaw Creek reservoir are significantly reduced once Squaw Creek enters the Skunk River.

Spillway sizes and elevations were based on routings of the Probable Maximum Flood (PMF) through the reservoir. Limited storage and dam height exist; thus, a rather wide emergency spillway is needed to pass the PMF. The outlet conduit was sized to pass 1,600 ft^3/s (10 ft^3/s per square mile of drainage area) at the full flood pool elevation of 946.5 feet NGVD. Spillway and outlet data and dimensions also are listed in table A-10.

TABLE A-10

Squaw Creek Detention Dam

Parameter	
Drainage Area Controlled	160 sq. mi.
Earthen Embankment Height	52 feet
Embankment Length	1,750 feet
Top-of-Dam Elevation	962 feet NGVD
Conservation Pool	None
Flood Control Pool	946.5 feet NGVD
Storage	20,500 acre-feet
Basin Storage	2.4 inches
Area	1,440 acres
Maximum Flood Pool	958.7 feet NGVD
Storage	45,000 acre-feet
Basin Storage	5.3 inches
Area	2,360 acres
Outlet Works: Single concrete conduit with controlled inlet,	
Diameter	9 feet
Length	350 feet
Spillway: Saddle type, uncontrolled ogee weir with chute and stilling basin	
Width	200 feet
Crest Elevation	946.5 feet NGVD

SECTION 7 - SMALL IMPOUNDMENTS

GENERAL

A number of small impoundment reservoirs instead of one large reservoir is a concept which has been repeatedly mentioned as an alternative. A reservoir site survey of the Upper Skunk River Basin by the Corps and the U.S. Department of Agriculture - Soil Conservation Service found the number of sites to be very limited and those which were identified to be less than ideal sites. As mentioned in Section 2 concerning the Skunk River Basin characteristics, the physiographic conformation of the upper basin is youthful topography covered by Wisconsin drift with very little relief. The topography does not lend itself to the development of a large number of impoundment structures. (Also see SCS Input Report.)

In addition to the two main stem dam sites on the Skunk River and Squaw Creek, 17 other smaller sites were identified in the 556-square-mile upper basin. Twelve (12) sites were identified by the Corps of Engineers and 5 by the SCS. The Corps concentrated on sites with drainage areas greater than 5 square miles and the SCS on sites with drainage areas less

than 5 square miles. The sites are not all independent, as some sites lie in the upper pool reaches of downstream sites. Table A-11 lists the 17 sites, along with pertinent data, and plate A-31 shows the location of each. The five SCS sites are addressed by the SCS in its report.

SITE ANALYSES

From the 12 Corps of Engineers identified dam sites, those providing at least 3 inches of basin runoff storage were selected for further evaluation of potential flood control benefits. As with the Squaw Creek reservoir, synthetic unit hydrographs were developed by the Clark Technique for the upstream watersheds. Rainfall and runoff characteristics were determined and applied to the unit hydrographs to develop runoff hydrographs for selected frequencies. Reservoir holdout hydrographs were computed based on a constant reservoir outflow at each frequency. The reservoir holdouts were routed downstream via the Tatum method to the index stations. Revised flow frequencies then were computed. The flow frequencies represent the case where rainfall is assumed to fall uniformly throughout the basin. The stage versus frequency relationships at the index stations were determined for both natural and modified conditions for each of the eight studied small sites and in various combinations including the Squaw Creek detention site addressed in section 6.

The results indicated negligible to no flood control benefits below Ames on the Skunk River with the most notable alternatives being those combinations which included the Squaw Creek site from section 6. Thus, further evaluation of these sites was determined to be infeasible based on the negative outcome of the Squaw Creek reservoir. It is obvious that if overflow spillways were to be located and sized, physical constraints would cause significant cost and design problems at most of the sites. In summary, if a small reservoir site could be physically built in the Upper Skunk River Basin above Ames, its impacts on downstream flood control would be negligible. Also, a large number of small sites which could collectively reduce downstream flooding simply do not exist. Thus, this alternative was not evaluated in additional detail.

TABLE A-11

Identified Reservoir Sites

Site	Location	Top-of -Dam (NGVD)	Pool Area (Acres)	Storage (Ac-Ft)	Drainage Area (mi^2)	Basin Storage (Inches)
SR-2	Skunk River @ Ellsworth S25, T87N, R24W Hamilton County	1,080	585	10,475	54.5	3.6
SR-3	Skunk River @ Co. Rd. D41 S25, T88N, R24W Hamilton County	1,160	560	7,960	28.0	5.3
SR-4	Bear Creek @ Interstate 35 S5, T84N, R23W Story County	990	510	8,300	31.0	5.0
SR-5	Bear Creek @ Co. Rd. D65 S23, T85N, R23W Hamilton County	1,115	118	890	8.0	2.1
SR-6	Keigley Branch @ State Hwy. 221 S16, T85N, R24W Story County	1,015	1,425	12,900	28.8	8.4
SR-7	Long Dick Creek @ Interstate 35 S18, T85N, R23W Story County	990	240	2,820	33.0	1.6
SR-8	Long Dick Creek @ County Line S34, T86N, R23W Story/Hamilton Co.	1,070	140	1,360	24.0	1.1
SR-9 SCS Site	Unnamed Tributary above Ellsworth S13, T87N, R23W Hamilton County	1,100	62	480	4.5	3.7

TABLE A-11 (Cont'd)

Site	Location	Top-of-Dam (NGVD)	Pool Area (Acres)	Storage (Ac-Ft)	Drainage Area (mi^2)	Basin Storage (Inches)
SC-2	Squaw Creek above County Line S1, T84N, R25W Boone County	960	1,170	15,740	140.0	2.1
SC-3	Squaw Creek @ Mackey S15&16, T84N, R25W Boone County	1,010	1,575	22,660	78.0	4.8
SC-4	Montgomery Creek @ Prairie Creek S34, T85N, R25W Boone County	1,000	470	7,640	31.8	4.5
SC-5	Lundys Creek near Mouth S2, T84N, R25W Boone County	970	96	1,530	8.2	3.5
SC-6	Onion Creek near Mouth S32, T84N, R24W Story County	970	406	8,380	19.0	8.3
SC-7 SCS Site	Unnamed Tributary near Zenorsvilleite S12, T8N, R25W Boone County	1,000	100	650	3.5	5.1
SC-9 SCS Site	Unnamed Tributary near County Line S12, T8N, R25W Boone County	980	35	280	1.6	7.0
SC-9 SCS Site	Unnamed Tributary near County Line S7, T8N, R24W Story County	950	70	480	1.9	6.4
SC-10 SCS Site	Unnamed Tributary near County Line S36, T8N, R25W Boone County	950	49	275	1.4	3.9

SECTION 8 - LOCAL FLOOD PROTECTION - AMES, IOWA

GENERAL

The project area for this flood control alternative includes about 120 acres of commercial and multi-family development and open space floodplain property on the left bank of Squaw Creek located three-fourths of a mile above its confluence with the Skunk River in Ames, Iowa. The site and studied levee alignment are shown on plate A-32. The lower part of the study area is subject to flooding from both Squaw Creek and the Skunk River. The drainage areas of Squaw Creek and the Skunk River at this location are 227 and 329 square miles, respectively. Below the confluence, the combined drainage area is 556 square miles. The levee project area is divided by South Duff Avenue (U.S. Highway 69). The flood of record occurred in June 1975 with peak discharges on Squaw Creek of 11,300 ft^3/s and on the Skunk River below Squaw Creek of 14,700 ft^3/s.

FLOOD DISCHARGES AND PROFILES

DISCHARGES

In July 1980, the Federal Emergency Management Agency (FEMA) published a Flood Insurance Study (FIS) for the city of Ames. The FIS was prepared by the Corps of Engineers under contract to FEMA. The study text contains flood profiles and flow-frequency information for the approved FIS. This information was verified using current flow data from the USGS gaging stations and the Skunk River Basin Flow-Frequency Study data in a Water Resources Council Bulletin #17B analysis. This alternative for local flood protection includes expected probability in the flow-frequency values.

The Bulletin #17B flows on Squaw Creek were higher than those used in the FIS. This was due to the FIS hydrologic study using an adopted station skew of -0.4 in its Log-Pearson Type III analysis. Present data and methodology dictate that a skew of 0.0 should be used. The FIS discharges on the Skunk River through Ames correspond closely with a current analysis. However, the FIS discharges below Ames on the Skunk River are higher. The FIS values used a -0.4 skew and were correlated to the upstream Skunk River gage, resulting in a conservatively high estimate. A Bulletin #17B analysis using an adopted station skew of -0.5 and no correlation yields a lower flow-frequency estimate. The FIS values versus the study values are listed in table A-12.

TABLE A-12

Flow-Frequency Comparisons

	10-Year	50-Year	100-Year	500-Year
Squaw Creek				
Flood Insurance Study	5,730	8,230	9,260	11,600
Bulletin #17B with Exp. Prob.	5,700	9,370	11,300	16,800
Skunk River, Above Ames				
Flood Insurance Study	5,930	8,150	8,990	10,700
Bulletin #17B with Exp. Prob.	5,750	8,030	8,970	11,100
Skunk River, Below Ames				
Flood Insurance Study	10,900	15,530	17,410	21,630
Bulletin #17B with Exp. Prob.	10,600	14,200	15,600	18,700

PROFILES

The existing FIS profiles were verified by comparison with the gaging station rating curves and the June 1975 flood profiles. The FIS profiles calibrated favorably with the above discharge-profile data. The present increases in the flow-frequency values versus the FIS result in only slight increases in the flood profiles. Thus, the FIS profiles were judged to be acceptable for the initial reconnaissance of this alternative. The Squaw Creek and Skunk River profiles from the FIS are shown on plates A-33 and A-34.

The project levee alignment coincides with the FIS floodway limits based on a 1-foot floodway. Thus, State backwater criteria would be satisfied. However, the city of Ames has adopted a 0.1 foot floodway for regulatory purposes. Thus, a variance to the city of Ames floodplain management ordinance would need to be obtained.

INTERIOR DRAINAGE

Existing interior drainage facilities include two major and two minor storm sewers outletting into Squaw Creek. Plate A-32 shows the location of each of the outlets and also the general study area. In addition, general watershed overland flow patterns slope toward the levee alignment. Outlets 1 and 2 serving Area A would be routed into Ponding Area A with a new outlet and gatewell located upstream of South Duff Avenue. Outlets 3 and 4 serving Area B would continue to outlet "as is" with excess runoff collecting in Ponding Area B. Gatewells would need to be installed on both outlets 3 and 4 interconnecting them to the ponding area.

Unit hydrographs for the interior basin Areas A and B were computed by the U.S. Army Corps of Engineers' computer program HEC-1 - Flood Hydrograph Package using the Clark unit hydrograph technique. The Clark technique is based on a watershed's drainage area, time of concentration (Tc), and a basin storage attenuation constant (R). An average flow velocity of 2.75 feet per second was determined and used to compute the time of concentration of each basin. The attenuation constant was estimated as .5 Tc for both areas as urbanization has resulted in limited basin storage. Values of Tc, R, and drainage area are shown in table A-13.

TABLE A-13

Unit Hydrograph Parameters

Parameter	Area A	Area B
Drainage Area, acres	107	205
Tc, minutes	30	40
R, minutes	15	20

Runoff hydrographs in the levee study area were derived by convolution of the unit hydrographs with rainfall excess values computed using T.P. No. 40, Rainfall Frequency Atlas of the United States. An initial abstraction of 0.5 inch and a constant loss rate based on a Runoff Curve Number of 85 were used. Runoff hydrographs were computed for the 10-year and 100-year rainfall events for both interior basin areas.

Ample open space land exists in the protected area for creating ponding areas. The two studied areas were located immediately landward of the project levee. Their locations are shown on plate A-32. Ponding Area A collects the runoff from the areas served by storm sewers 1 and 2. Likewise, Ponding Area B collects the runoff from storm sewers 3 and 4. The ponding areas will require excavation with the desired storage capacities listed in table A-14. Ponding Area A would be 5 acres in size and B would be 14 acres. Nondamaging ponding elevations were estimated to be 883 and 881 feet NGVD for A and B, respectively.

TABLE A-14

Ponding Area Capacities

Storage Elevation (NGVD)	Ponding Area A (Acre-Feet)	Ponding Area B (Acre-Feet)
876	0.0	0.0
878	6.5	24.5
880	14.0	50.0
882	22.3	76.3
884	31.3	--

GRAVITY FLOW DESIGN

For reconnaissance level studies, the 100-year storm was selected to be the design storm for gravity flow conditions on both interior basins.

Ponding Area A

Outlet capacities were computed for a new outlet to Squaw Creek basin on a 200-foot concrete pipe placed at 875.5 feet NGVD, or approximately 1.5 feet above the 50 percent duration flow. An HEC-1 modified-Puls routing method was used to determine the adequacy of various sized outlets. A 36-inch concrete pipe was found to provide acceptable outflow capacity. The peak ponding elevation for a 100-year storm was 881.9 feet NGVD. The runoff hydrograph and ponding elevation are shown on plate A-35.

Ponding Area B

Outlet capacities were computed for a single outlet to Squaw Creek based on a 350-foot concrete pipe placed at 875.0 feet NGVD. A modified-Puls routing method was again used to determine the adequacy of various sized outlets. A 36-inch concrete pipe was found to provide acceptable outflow. The two existing outlets that will be utilized were estimated to have a combined capacity slightly greater than the modeled outlet. Outlet 3 is a 30-inch concrete pipe which runs about 400 feet to the river from the project levee alignment. Outlet 4 is a 36-inch concrete pipe running 2,400 feet to the river. The peak 100-year ponding elevation was 880.7 feet NGVD for the modeled single 36-inch outlet. The 100-year runoff hydrograph and ponding elevation are shown on plate A-36. Utilizing the existing two outlets would reduce this ponding elevation slightly.

BLOCKED GRAVITY

The 10-year storm was selected to be the design storm for the blocked gravity conditions on both interior basins.

Ponding Area A

Under blocked gravity conditions (high river stages) a gatewell closure would be needed on the new 36-inch outlet. The 10-year runoff hydrograph was routed into Ponding Area A with no outflow. The resultant peak ponding elevation was 882.6 feet NGVD. This is lower than the estimated nondamaging elevation; thus, pumping would not be necessary at this design level. The runoff hydrograph and ponding elevation are shown on plate A-37.

Ponding Area B

Utilizing the two existing outlets would require a gatewell closure and diversion structure on both lines. The 10-year runoff hydrograph was routed into the ponding area with no outflow. The peak ponding elevation was 879.8 feet NGVD. This elevation is nondamaging; thus, pumping would not be necessary. The 10-year runoff hydrograph and ponding elevation are shown on plate A-38.

OTHER CONSIDERATIONS

The Iowa Department of Transportation and the city of Ames are studying the feasibility of rerouting the U.S. Highway 69 reach between Lincolnway and the Squaw Creek bridge on South Duff Avenue. The new potential route would extend Grand Avenue south through the Chicago-Northwestern Railroad right-of-way. This line is no longer active. South of South Fourth Street, the route would turn east and run to South Duff Avenue. This coincides roughly with the project levee alignment. With coordination, the new roadway embankment could potentially be used jointly as a flood control levee. At the upstream end, additional property would be included in the project area along with another storm sewer outlet. At the downstream end, east of South Duff Avenue, the levee would remain as currently studied.

SECTION 9 - AGRICULTURAL LEVEES

GENERAL

An analysis was made to determine the effectiveness of using levees for flood protection on the main stem of the Skunk river. For initial appraisal, a study area in Polk County was selected due to its high

ratio of acres protected versus lineal feet of levee. The studied site and levee alignment are shown on plate A-39. The Skunk River floodplain is typically the widest in Polk County and thus maximum benefits would be achieved here as compared to a river reach with a narrower floodplain. If agricultural levees are not feasible in this reach, it can be assumed they would not be feasible in other reaches of the Skunk River. If determined to be feasible, further evaluation of this alternative is warranted.

The selected study area is located in Sections 10, 11, 14, 15, 23, 24 and 25, T. 81 N., R.23 W. (Elkhart Township), Polk County, Iowa. The levee would lie between River Miles 205.2 and 209.1 on the right overbank. The Skunk River has a drainage area of 688 square miles at this location. The project levee would total about 27,500 feet in length with 20,500 feet fronting the river and 7,000 feet serving as tiebacks. The protected area has an estimated 100-year floodplain of 1,600 acres (2.7 square miles). Interior drainage is typical and totals 6,355 acres (9.9 square miles). Previous studies have determined that the current levee system provides, on the average, a 2-year level of flood protection.

FLOOD DISCHARGES AND PROFILES

EXISTING CONDITIONS

Natural all-year flow-frequency relationships for the Skunk River at this location were computed based on the methodology in the Skunk River Basin Flow-Frequency Study. Water surface profiles were estimated using experienced flood profiles. To determine encroachments and levee offsets, a typical valley section was determined at River Mile 207. A bankfull channel capacity of 4,000 ft^3/s from previous studies and overbank elevations from USGS topographic maps were used in a preliminary HEC-2 analysis. In accordance with State of Iowa floodplain development criteria, 1-foot maximum backwater effect levee alignments were computed for the selected floods. Discharges, flood levels, and levee offsets are listed on table A-15 for River Mile 207. Since these are estimated profiles, future detailed studies would require more accurate HEC-2 backwater profiles.

MODIFIED CONDITIONS

A combination of flood protection from upstream reservoirs and on-site levees was an identified alternative. Sections 4, 5, 6, and 7 found that only three reservoirs provided significant flood control. These are the two alternatives at the Ames Lake site and the most downstream Squaw Creek reservoir. Modified flows and profiles were estimated for the study area at River Mile 207. An HEC-2 backwater model was used to determine modified levee offsets with the 5.2-inch Ames Lake flow reductions. These data, along with the crop-year data, also are shown in table A-15.

TABLE A-15

Polk County Agricultural Levees

Flow-Frequencies

Freq. Rec. Int. Years	Flow (ft^3/s) All-Year Natural	All-Year Modified	Crop-Year Natural	Crop-Year Modified
2	6,400	3,630	5,770	3,140
5	9,300	5,940	8,420	5,250
10	11,100	7,550	10,120	6,780
25	13,300	9,630	12,160	8,810
50	14,800	11,140	13,630	10,330
100	16,200	12,700	15,100	12,000
200	17,600	14,200	16,500	13,500
500	19,300	16,200	18,300	15,700

Flood Elevations

Freq. Rec. Int. Years	Elevation (NGVD) All-Year Natural	All-Year Modified	Crop-Year Natural	Crop-Year Modified
2	829.6	827.0	829.3	829.0
5	830.7	829.4	830.4	829.0
10	831.2	830.1	831.0	829.8
25	832.2	830.8	831.7	830.5
50	832.7	831.3	832.2	831.0
100	833.2	831.9	832.7	831.6
200	833.6	832.5	833.3	832.2
500	834.2	833.2	833.9	833.0

Levee Offset for Given Protection Level

Rec. Int. Years	Offset (Feet) Natural	Modified
10	165	125
25	190	155
50	205	170
100	220	190
200	225	195
500	230	200

INTERIOR DRAINAGE

The interior drainage area consists of about 5.7 square miles of upland watershed and 4.3 square miles of river valley land. Drainage Ditch No. 11 is the primary existing drainage feature. Runoff hydrographs were developed by HEC-1 from T.P. No. 40 Rainfalls and Clark's Unit Hydrograph Technique. Unit hydrograph parameters are shown in table A-15 and the runoff hydrographs are shown on plate A-40. Both a gravity outlet and permanent pumping were evaluated for handling the interior flooding. The gravity outlet consisted of an 84-inch RCP with flap gate placed at elevation 821.0 NGVD. An upstream flow-duration analysis indicated that the gravity outlet would need closure about 4 days per crop-year, April 1 to October 31, on the average. The pumping capacities evaluated were .4 and 0.50 inches of interior basin runoff per day. These rates are equivalent to 30,300 and 38,000 gallons per minute. Topographic characteristics are very flat, making natural ponding (temporary inundation of low-lying crop ground) a practical necessity. Existing elevation storage-area characteristics are shown on plate A-41. A comparison of the gravity outlet versus permanent pumping showed that both relied on ponding, as neither came close to passing the peak interior runoff flows.

The gravity outlet peak ponding elevations were slightly less than for permanent pumping. However, evacuation times were considerably less for the gravity outlet. In addition, overall evacuation times also would be shorter for the gravity outlet for the larger interior rainfalls even with the outlet being closed for the average estimated closure time of 4 days per crop-year. Thus, an 84-inch RCP gravity outlet with a trashrack closure is recommended for handling the interior flooding. This system does rely on temporary inundation of crop ground for ponding purposes. The outlet would be located in the SE1/4 of Section 15 upstream of Lider Drive.

TABLE A-15

Unit Hydrograph Parameters

Parameter	
Drainage Area	9.99 Sq. Mi.
Time of Concentration	3.33 Hours
Attenuation Constant, R	2.50 Hours

A collector ditch would run immediately landward of the levee for 6,000 feet starting at the present Drainage Ditch No. 11 outlet to the Skunk River and ending at the new 84-inch outlet. A 10-foot bottom width channel, 4 feet deep with 3H:1V side slopes running on a 0.075 percent slope, is recommended for the collector ditch. Ponding elevation versus time duration curves for selected recurrence interval storms under gravity flow conditions are shown on plate A-42. During high Skunk River conditions,

no outflow would occur; thus, the total interior runoff would be temporarily ponded. Table A-17 lists the peak ponding elevations and areas inundated for selected interior storms.

TABLE A-17

Peak Ponding During High River Conditions

Frequency (Years)	Elevation (Feet NGVD)	Area (Acres)
1	825.2	195
2	825.5	260
5	826.5	450
10	826.9	540
25	827.4	630
50	827.7	695
100	828.0	750

VALLEY STORAGE

The Skunk River Basin Flow-Frequency Study documented a peak flow attenuation characteristic on the Skunk River through this reach. Most streams do have flow attenuation; however, on the Skunk River it appears to be significant. Much of this can be attributed to the broad, flat floodplains of the middle reaches of the Skunk River. Plate A-43 from the flow-frequency study shows the "flattening out" of the discharge-drainage area curves between drainage areas 556 and 1,635 square miles. If the Skunk River were to be extensively leveed downstream of Ames, much of the valley storage would be eliminated and peak discharges would increase. An estimation of these increases would be straightlining the curves on plate A-43 between 556 square miles and the lower end of the Skunk River. The resulting percentage of discharge to drainage area increases are listed table A-18. In accordance with State of Iowa law, future studies would have to clearly show that the loss of valley storage caused by the construction of a levee will not increase peak flood stages or discharges if a level of protection beyond the 10- to 25-year range is proposed. These criteria appear to be a limiting factor on the level of protection which could be provided.

TABLE A-18

Loss of Valley Storage Impacts

Drainage Area (mi^2)	% of Peak Discharge Increase 2-Year	100-Year
556	0	0
750	12	13
1,000	24	20
1,635	50	38
2,000	42	23
3,000	26	0
4,000	6	0

SECTION 10 - WATER SUPPLY

GENERAL

Periodic stream flow shortage in the Upper Skunk River Basin are a chronic problem with water supply being an acute problem during extended drought periods. The water supply need is highlighted by the periodic shortages experienced at the city of Ames which draws its water from alluvial wells along the Skunk River and Squaw Creek. The Ames Lake project included low-flow augmentation releases which would enhance the infiltration of river water into the well field during low-flow periods. A site survey for other potential reservoirs in the upper basin found no sites which would be able to function as a multi-purpose site such as the Ames Lake project. This is due to the fact that all the identified sites lacked both watershed size and storage capacity to function effectively as multi-purpose sites. Thus, reservoir sites near Ames were selected for further evaluation of their single-purpose water supply potential. Two sites were selected, a Bear Creek reservoir adjacent to the Skunk River and an Onion Creek site adjacent to Squaw Creek and are shown on plate A-44.

The city of Ames has indicated that their projected water supply needs for the future will be in the range of 10 million gallons per day (mgd). The existing wells on the Skunk River and Squaw Creek furnish 8 and 3 mgd, respectively, under normal conditions. During drought conditions, their yields are reduced to 6 and 2 mgd with supplemental help from pumping of Hallet's Quarry and low-head dams in the river channels pooling the available flows. This leaves a shortage of 2 mgd during drought conditions. The emergency pumping rate from Hallet's Quarry in the 1977 drought was approximately 3 mgd (4.5 ft^3/s).

From the data it can be approximated that during drought periods, two-thirds of the river flows in the 2 through 10 ft^3/s range passing through Ames will infiltrate into the adjacent alluvial aquifers serving the well fields. The ability of the Bear Creek and Onion Creek reservoirs to provide supplemental or alternative low-flow augmentation through Ames on the Skunk River and Squaw Creek can be evaluated based on a critical period reservoir simulation of experienced droughts and also a zero flow analysis where both the receiving river flow and the reservoir inflows are assumed to be zero. Due to the well field layout, low-flow augmentation on the Skunk River from Bear Creek would be the most beneficial.

BEAR CREEK

The Bear Creek reservoir is the same as the Bear Creek recreational sub-impoundment included in the authorized Ames Lake project. The dam would be formed by the Interstate 35 highway embankment. Pertinent reservoir and spillway data are listed on table A-19.

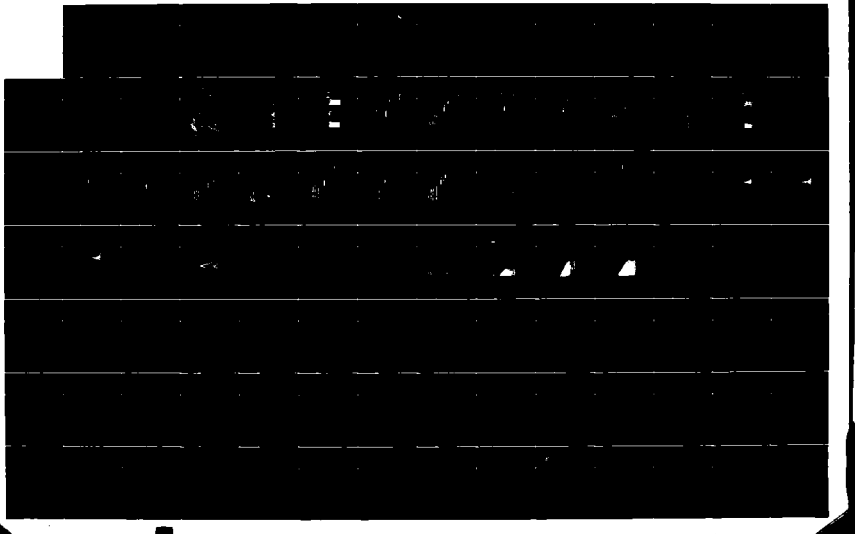
Due to the limited storage capacity and poor base flow characteristics, the reservoir will provide for no sustained low-flow releases. Outflows will occur only when streamflow causes the pool to exceed the outlet spillway crest and for emergency water supply releases which will supplement existing flows in recharging the alluvial aquifers through Ames. Two severe drought periods in the 60-year period of record, June 1955 - May 1957 and June 1976 - August 1977, were analyzed. For simulation purposes, the ungaged Bear Creek reservoir inflows were assumed to be equal to the ratio of the drainage areas times the recorded Skunk River flows above Ames. The Skunk River drainage area at the gage is 315 square miles and the Bear Creek watershed is 31 square miles. Thus, the Bear Creek flows used were 10 percent of the corresponding Skunk River flows. The HEC-5 Reservoir Simulation Program was used to simulate releases and downstream flows. The alternative of maintaining a 5 ft^3/s flow rate at the Skunk River gage above Ames with emergency releases from the Bear Creek reservoir starting at various times into the experience drought periods was studied. Any augmented streamflows less than 5 ft^3/s are judged to be insufficient to be a viable solution to Ames' water supply problems. The results are graphically shown on plates A-45 and A-46.

The effects of sediment deposition on the reservoir pool reduce the amount of usable storage available throughout the life of the project. Annual sediment yields determined by the SCS in their contract study were 9,900 tons per year under present watershed conditions. For their Resource Protection Plan (RPP), the sediment yield would be 6,700 tons per year. Using an in-place density of 55 lbs/ft^3, these two rates equate to 8.3 and 5.6 acre-feet of sediment per year. The 100-year sediment deposition then would be 830 and 560 acre-feet. These quantities represent sediment pool elevations of 954.5 and 951 feet NGVD for the Bear Creek reservoir.

As shown on plates A-45 and A-46, the reservoir is incapable of maintaining sustained 5 ft^3/s flows throughout the two droughts at the gage above Ames on the Skunk River without drafting on either of the sediment pool storages. Only when the emergency releases are commenced later in the drought periods are the pool drawdowns not encroaching into the sediment pool. A zero flow analysis indicated that the Bear Creek reservoir would provide approximately 4.5 months of sustained 5 ft^3/s low-flow augmentation when using average monthly evaporation rates. It is estimated this would be providing about 2 to 3 ft^3/s of augmentation to the city of Ames well fields. Since the Bear Creek reservoir is incapable of providing sustained low-flow augmentation and resultant aquifer recharge, it must be viewed as providing only emergency releases and temporary relief such as Hallet's Quarry pumping did in 1977.

AD-A184 444 GENERAL REEVALUATION REPORT UPPER SKUNK RIVER BASIN IOWA (AMES LAKE)(U) ARMY ENGINEER DISTRICT ROCK ISLAND IL JUL 87 2/3

UNCLASSIFIED F/G 13/2 NL



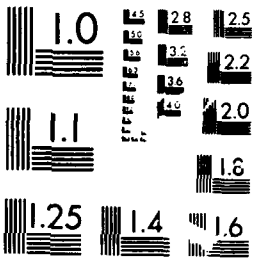


TABLE A-19

Bear Creek Water Supply Reservoir

Dam:	
Location, River Mile	1 mile above Skunk River
Legal	NW1/4, Sec. 5, T84N, R23W, Story County
Watershed Area, Sq. Mi.	31
Earthen Embankment, I-35 with "eyebrow" dam across bridge opening	
Height, Ft.	54
Top-of-Dam, NGVD	982
Spillway, erodible broad-crested weir	
Width, Ft.	275
Crest Elevation, NGVD	975
Service Spillway, fixed-crest box inlet, concrete chute	
Width, Ft.	20
Crest Elevation, NGVD	970
Low-Level Outlet	30" RCP
Reservoir:	
Conservation Pool, NGVD	970
Capacity, Ac.-Ft.	2,650
, Inches	1.6
, MGallons	8,630
Area, Acres	160
100-Year Flood Pool, NGVD	975.2
SPF Flood Pool, NGVD	979.2
100-Year RPP Sediment Pool, NGVD	951.0

ONION CREEK RESERVOIR

The Onion Creek reservoir is located 1 mile northwest of Ames on the Onion Creek tributary to Squaw Creek. The dam would be formed by an earthen embankment with a concrete chute spillway and saddle-type emergency spillway. Pertinent reservoir and spillway data are listed on table A-20.

As with the Bear Creek reservoir, due to limited storage capacity and poor base flow characteristics, the reservoir will provide for no sustained low-flow releases, only emergency releases. The June 1976 - August 1977 drought falls in the current-day 21-year period of record at the Lincoln Way Squaw Creek gage and thus was utilized to evaluate the Onion Creek site. For simulation purposes, the ungaged Onion Creek reservoir inflows were assumed to be equal to the ratio of the drainage areas times the recorded Squaw Creek flows in Ames. The Squaw Creek drainage area at the gage is 204 square miles and the Onion Creek watershed is 19 square miles. Therefore, the Onion Creek flows used were 10 percent of the corresponding Squaw Creek flows. Again, the HEC-5 Reservoir Simulation Program was used to simulate releases and downstream flows. The alternative was evaluated of maintaining 5 ft^3/s at the Squaw Creek gage at Lincoln Way with emergency releases from Onion Creek reservoir starting at various times into the experienced drought. The results are shown on plate A-47.

The effects of sediment deposition in the reservoir pool take away from the amount of usable storage available throughout the life of the project. Annual sediment yields determined by the SCS were 7,000 tons per year under present watershed conditions. For the RPP, the sediment yield would be 4,800 tons per year. Using an in-place density of 55 lbs/ft^3, these two rates equate to 5.8 and 4.0 acre-feet of sediment per year. The 100-year sediment deposition then would be 580 and 400 acre-feet. These quantities represent inactive pool elevations of 931 and 928 feet NGVD for the Onion Creek reservoir. As shown on plate A-47, the reservoir is capable of maintaining sustained 5 ft^3/s flows throughout the 1976-1977 drought at the Squaw Creek gage without encroaching into the inactive sediment pools. A zero flow analysis indicated that the Onion Creek reservoir would provide approximately 7 months of sustained 5 ft^3/s low-flow augmentation when using area average evaporation rates.

SUMMARY

Streamflow yield potential on both Bear and Onion Creeks is intermittent; thus, base flow is essentially zero for both streams during droughts. The Onion Creek reservoir has more usable storage and thus is the "better" water supply reservoir from the reservoir yield standpoint, even though it is located on a drainage area 40 percent smaller than the Bear Creek reservoir. A critical drought period analysis for the Ames Lake reevaluation determined the critical duration to be 18 months. From a hydrologic standpoint, it is felt that a water supply reservoir for Ames must

TABLE A-20

Onion Creek Water Supply Reservoir

Dam:	
Location, River Mile	0.7 mile above Squaw Creek
Legal	NE1/4, Sec. 32, T84N, R24W, Story County
Watershed Area, Sq. Mi.	19
Earthen Embankment	
Height, Ft.	65
Length, Ft.	700
Top-of-Dam, NGVD	970
Spillway, saddle type, uncontrolled broad-crested weir, grass lined	
Width, Ft.	200
Crest Elevation, NGVD	957
Service Spillway, fixed-crest box inlet, concrete chute	
Width, Ft.	10
Crest Elevation, NGVD	950
Low-Level Outlet	30" RCP
Reservoir:	
Conservation Pool, NGVD	950
Capacity, Ac-Ft.	3,100
, Inches	3.1
, MGallons	1,010
Area, Acres	200
100-Year Flood Pool, NGVD	956.9
Maximum Flood Pool, NGVD	967.5
100-Year RPP Sediment Pool, NGVD	928.0

provide beneficial low-flow augmentation for a minimum of 12 months. This allows a 6-month lag for the existing aquifer to become stressed in before emergency water supply releases are commenced. Neither of the two sites provide for this recommended minimum 12-month capacity. Consequently, the Bear and Onion Creek water supply sites do not appear to be viable alternatives for ensuring a reliable supply of water to the city of Ames. Construction costs and environmental and social concerns also severely diminish the potential of the Onion Creek site.

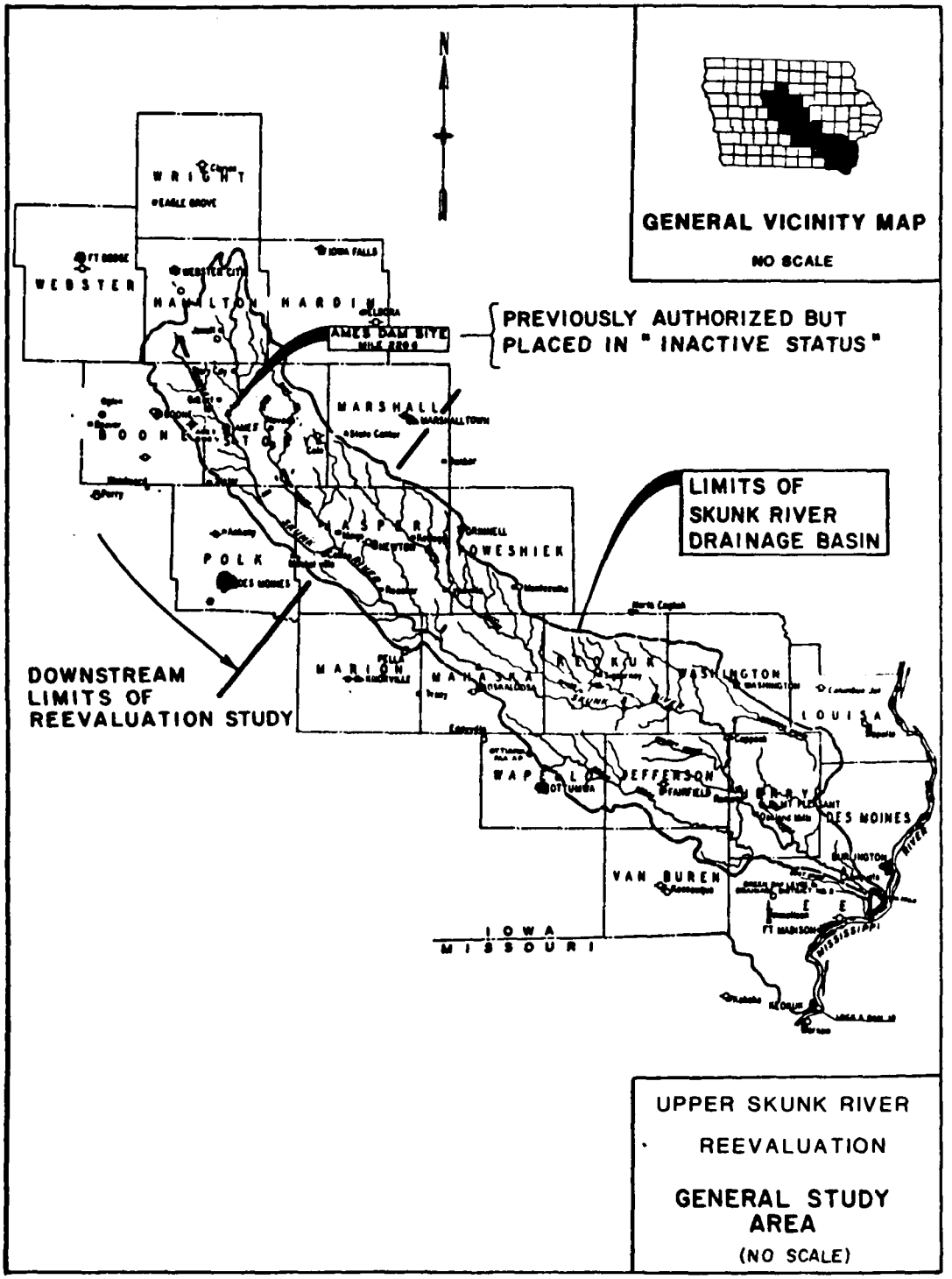
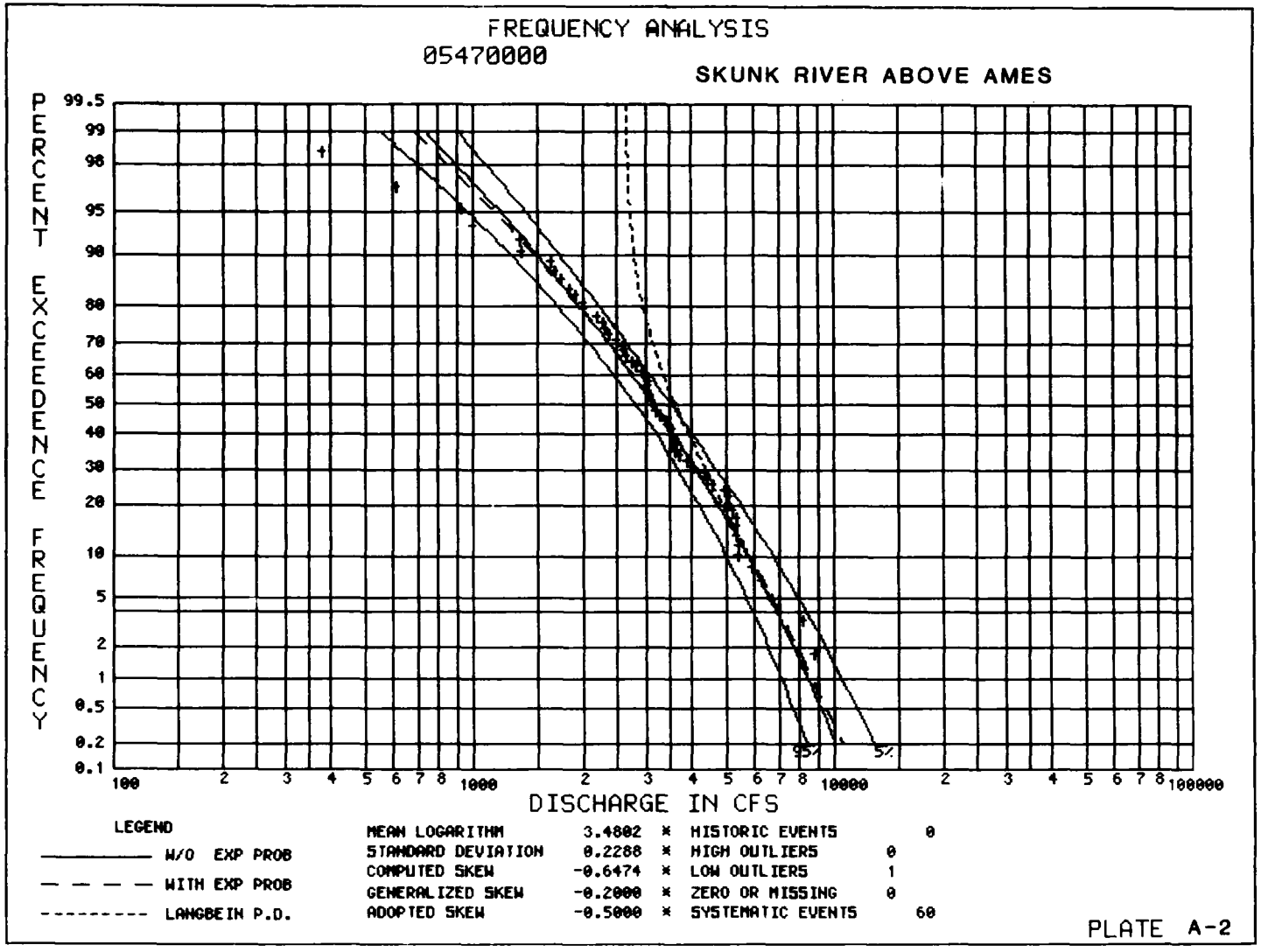

N
GENERAL VICINITY MAP
NO SCALE
PREVIOUSLY AUTHORIZED BUT PLACED IN " INACTIVE STATUS "
AMES DAM SITE
LIMITS OF SKUNK RIVER DRAINAGE BASIN
DOWNSTREAM LIMITS OF REEVALUATION STUDY
WRIGHT
WEBSTER
HAMILTON
HARDIN
MARSHALL
BOONE
STORY
POLK
JASPER
POWESHIEK
MARION
MAHASKA
KEOKUK
WASHINGTON
LOUISA
JEFFERSON
DES MOINES
VAN BUREN
IOWA
MISSOURI
MISSISSIPPI
UPPER SKUNK RIVER
REEVALUATION
GENERAL STUDY AREA
(NO SCALE)

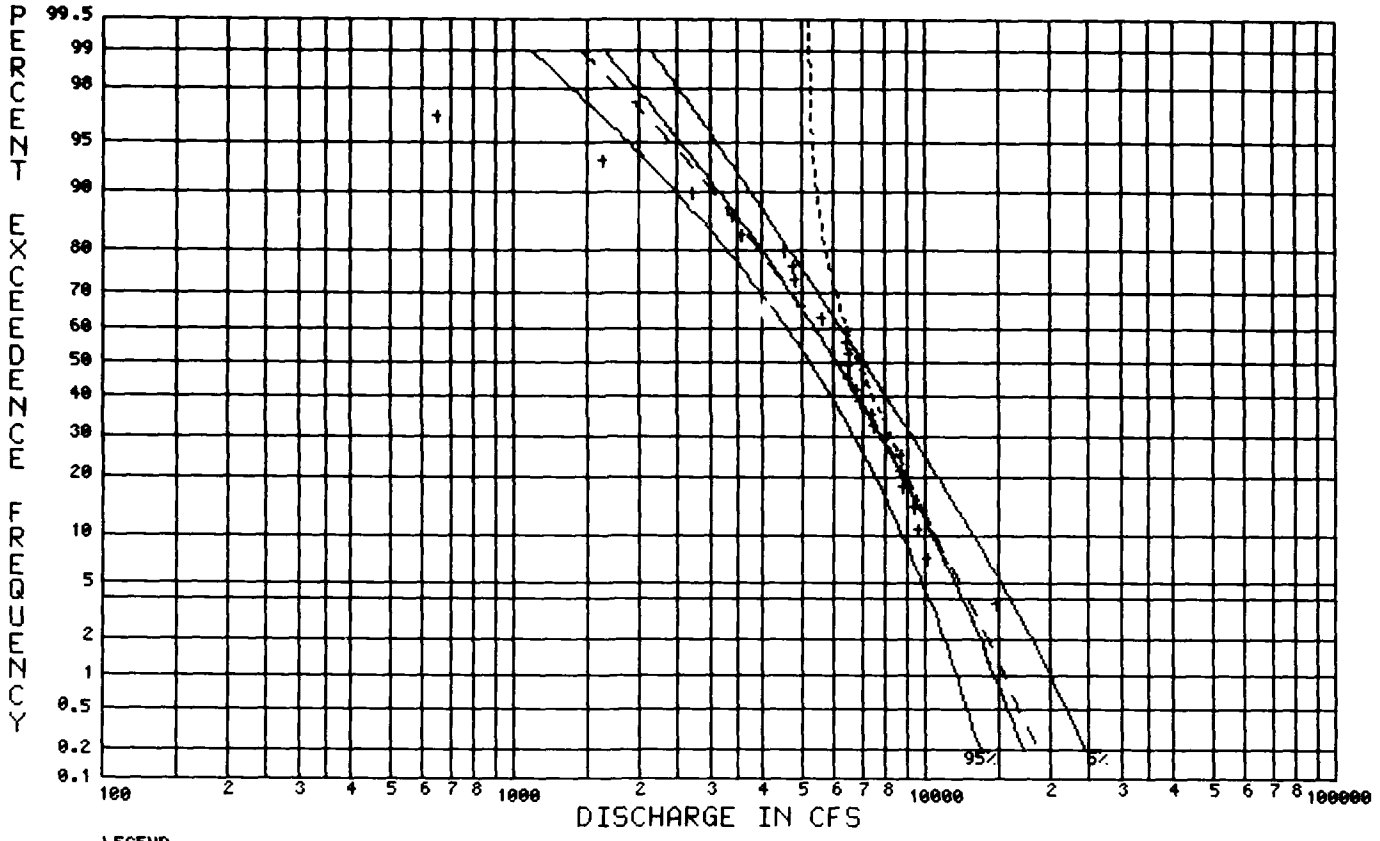
PLATE A-1


FREQUENCY ANALYSIS
05470000
SKUNK RIVER ABOVE AMES
PERCENT EXCEEDENCE FREQUENCY
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
100
1000
10000
100000
DISCHARGE IN CFS
LEGEND
W/O EXP PROB
WITH EXP PROB
LANGBEIN P.D.
MEAN LOGARITHM 3.4802
STANDARD DEVIATION 0.2288
COMPUTED SKEW -0.6474
GENERALIZED SKEW -0.2000
ADOPTED SKEW -0.5000
HISTORIC EVENTS 0
HIGH OUTLIERS 0
LOW OUTLIERS 1
ZERO OR MISSING 0
SYSTEMATIC EVENTS 60
PLATE A-2

FREQUENCY ANALYSIS

05471000

SKUNK RIVER BELOW SQUAW CREEK



LEGEND

——————— W/O EXP PROB

— — — — WITH EXP PROB

--------- LANGBEIN P.D.

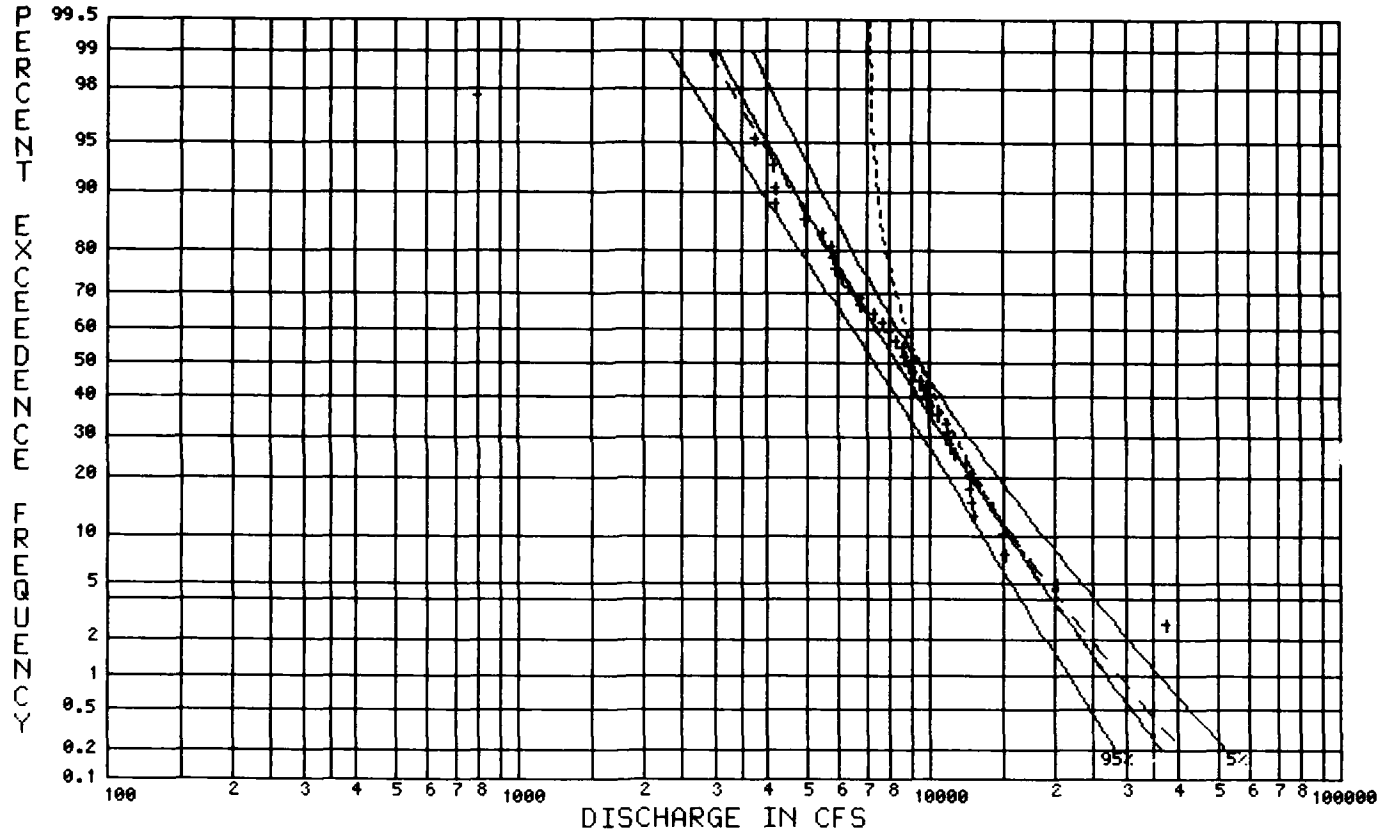
MEAN LOGARITHM	3.7688	*	HISTORIC EVENTS	0
STANDARD DEVIATION	0.2046	*	HIGH OUTLIERS	0
COMPUTED SKEW	-0.9408	*	LOW OUTLIERS	1
GENERALIZED SKEW	-0.2000	*	ZERO OR MISSING	0
ADOPTED SKEW	-0.5000	*	SYSTEMATIC EVENTS	28

PLATE A-3

FREQUENCY ANALYSIS

05471500

SKUNK RIVER NEAR OSKALOOSA



LEGEND

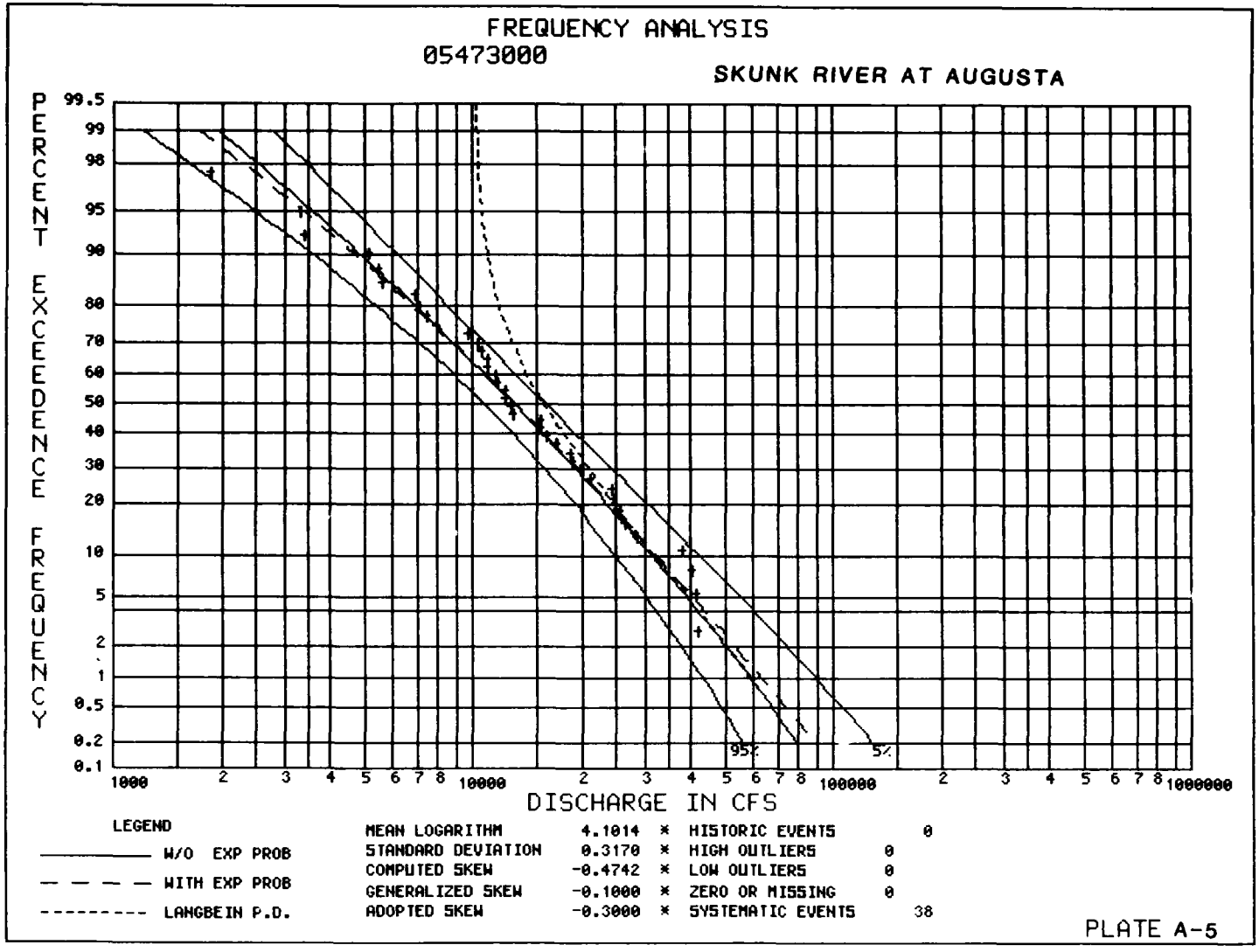
———— W/O EXP PROB

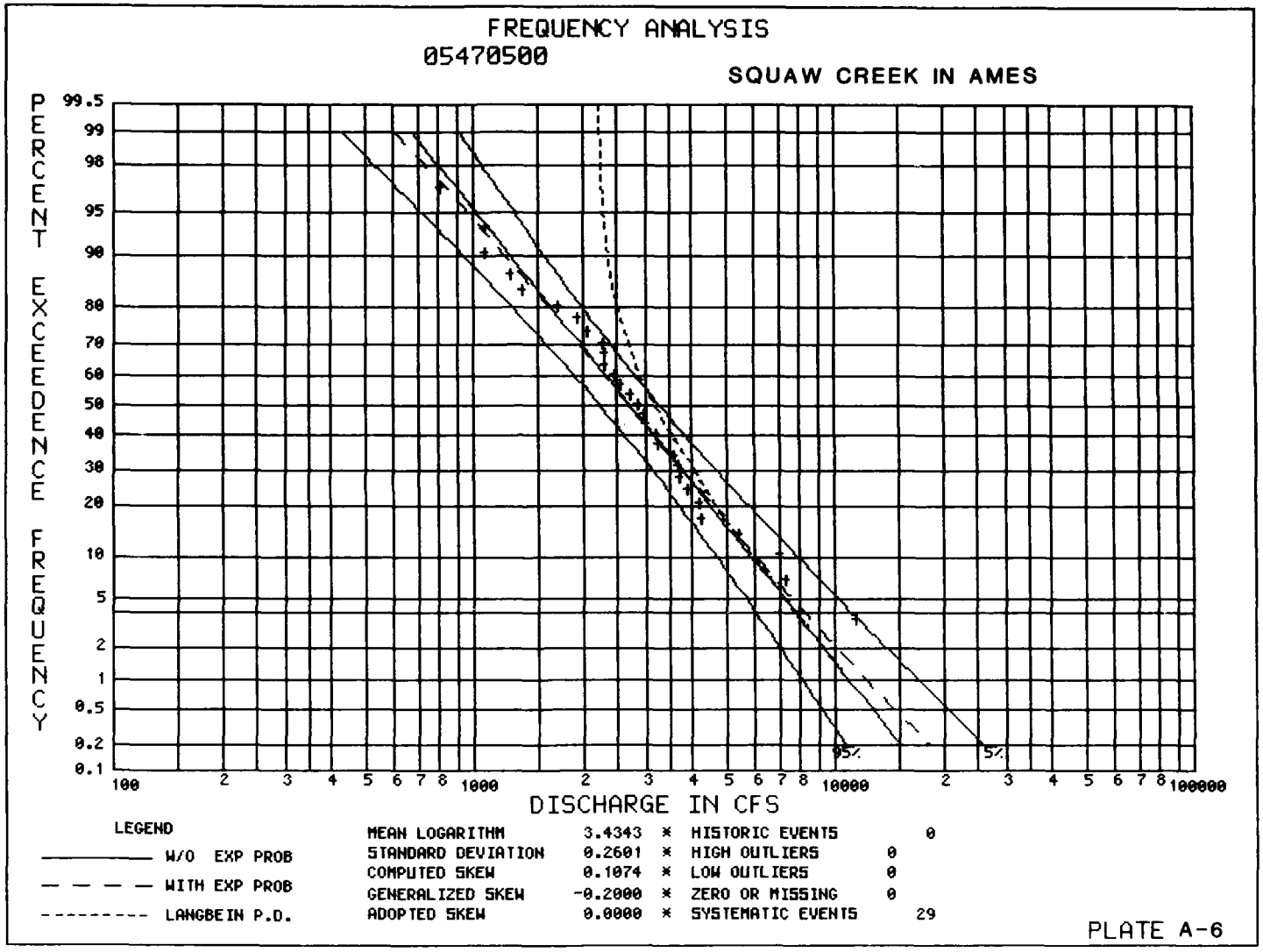
— — — — WITH EXP PROB

--------- LANGBEIN P.D.

MEAN LOGARITHM	3.9276	*	HISTORIC EVENTS	0
STANDARD DEVIATION	0.2034	*	HIGH OUTLIERS	0
COMPUTED SKEW	0.5432	*	LOW OUTLIERS	1
GENERALIZED SKEW	-0.2000	*	ZERO OR MISSING	0
ADOPTED SKEW	0.2000	*	SYSTEMATIC EVENTS	40

PLATE A-4


FREQUENCY ANALYSIS
05473000
SKUNK RIVER AT AUGUSTA
PERCENT EXCEEDENCE FREQUENCY
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
95%
5%
1000
2
3
4
5
6
7
8
10000
100000
1000000
DISCHARGE IN CFS
LEGEND
W/O EXP PROB
WITH EXP PROB
LANGBEIN P.D.
MEAN LOGARITHM 4.1014 * HISTORIC EVENTS 0
STANDARD DEVIATION 0.3170 * HIGH OUTLIERS 0
COMPUTED SKEW -0.4742 * LOW OUTLIERS 0
GENERALIZED SKEW -0.1000 * ZERO OR MISSING 0
ADOPTED SKEW -0.3000 * SYSTEMATIC EVENTS 38
PLATE A-5


FREQUENCY ANALYSIS
05470500
SQUAW CREEK IN AMES
PERCENT EXCEEDENCE FREQUENCY
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
95%
5%
100
2
3
4
5
6
7
8
1000
2
3
4
5
6
7
8
10000
2
3
4
5
6
7
8
100000
DISCHARGE IN CFS
LEGEND
W/O EXP PROB
WITH EXP PROB
LANGBEIN P.D.
MEAN LOGARITHM 3.4343 * HISTORIC EVENTS 0
STANDARD DEVIATION 0.2601 * HIGH OUTLIERS 0
COMPUTED SKEW 0.1074 * LOW OUTLIERS 0
GENERALIZED SKEW -0.2000 * ZERO OR MISSING 0
ADOPTED SKEW 0.0000 * SYSTEMATIC EVENTS 29
PLATE A-6

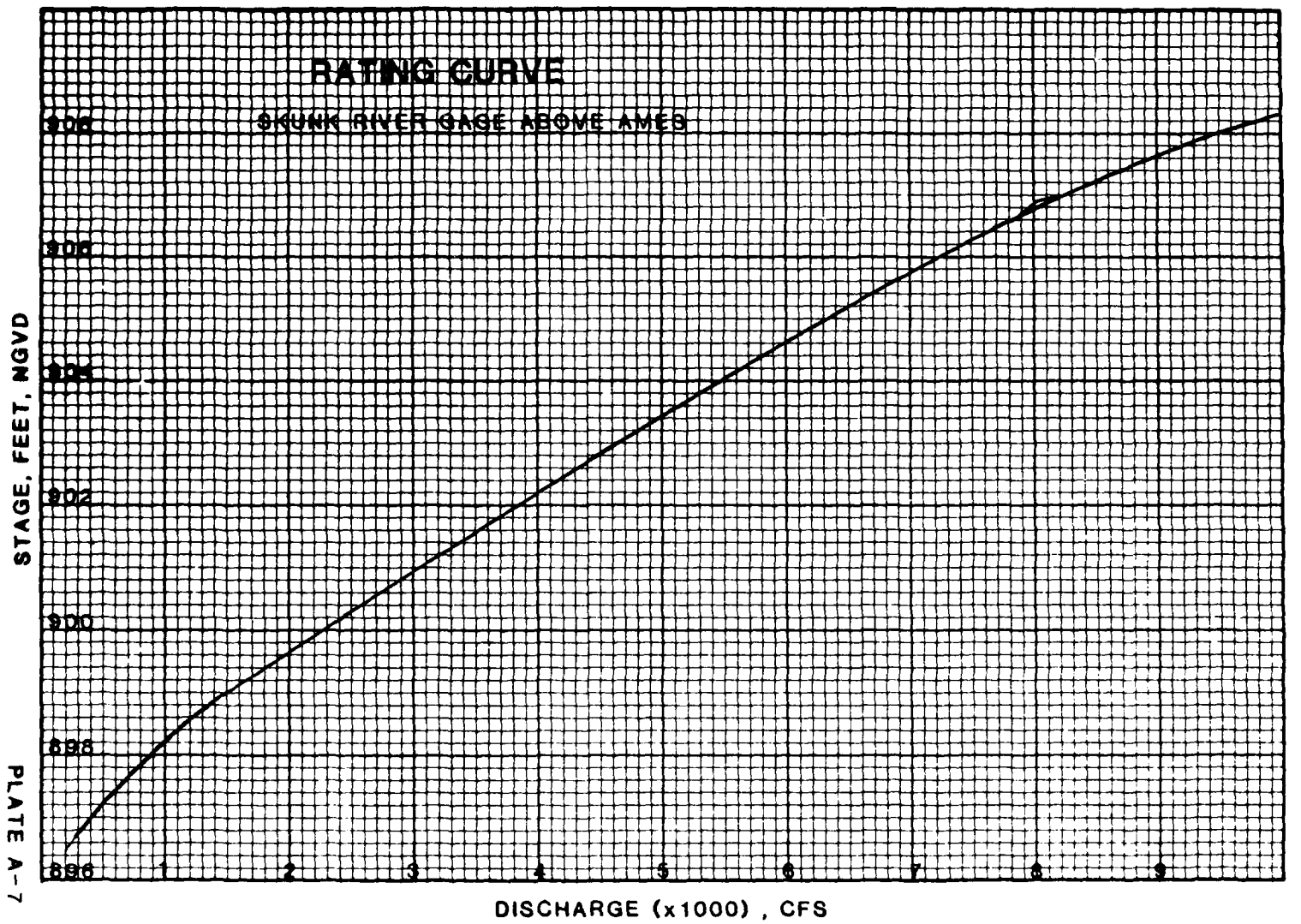

RATING CURVE
SKUNK RIVER GAGE ABOVE AMES
STAGE, FEET, NGVD
904
902
900
898
896
1
2
3
4
5
6
7
8
9
DISCHARGE (x1000) , CFS

PLATE A-7

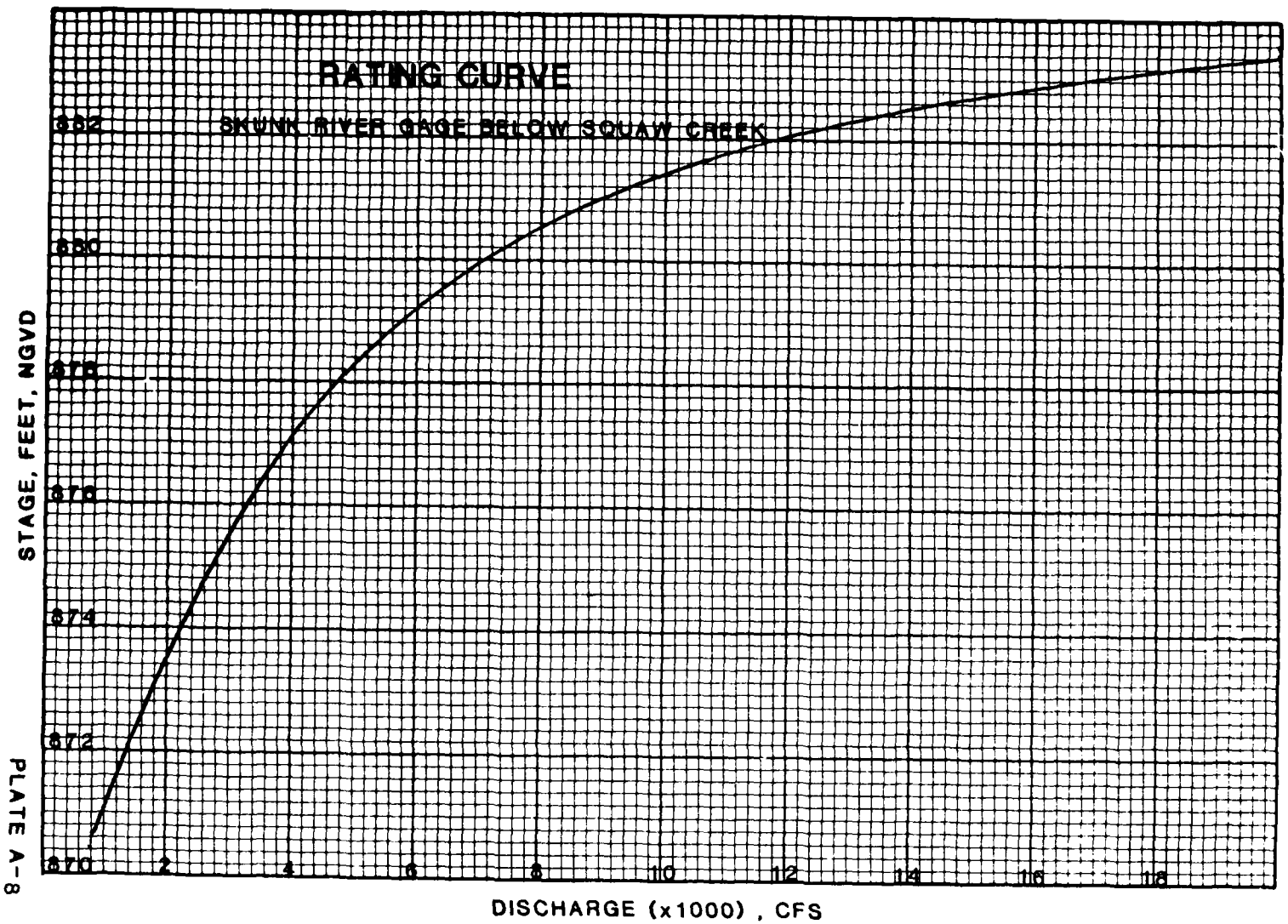

RATING CURVE
SKUNK RIVER GAGE BELOW SQUAW CREEK
STAGE, FEET, NGVD
682
680
678
676
674
672
670
2
4
6
8
10
12
14
16
18
DISCHARGE (x1000) , CFS

PLATE A-8

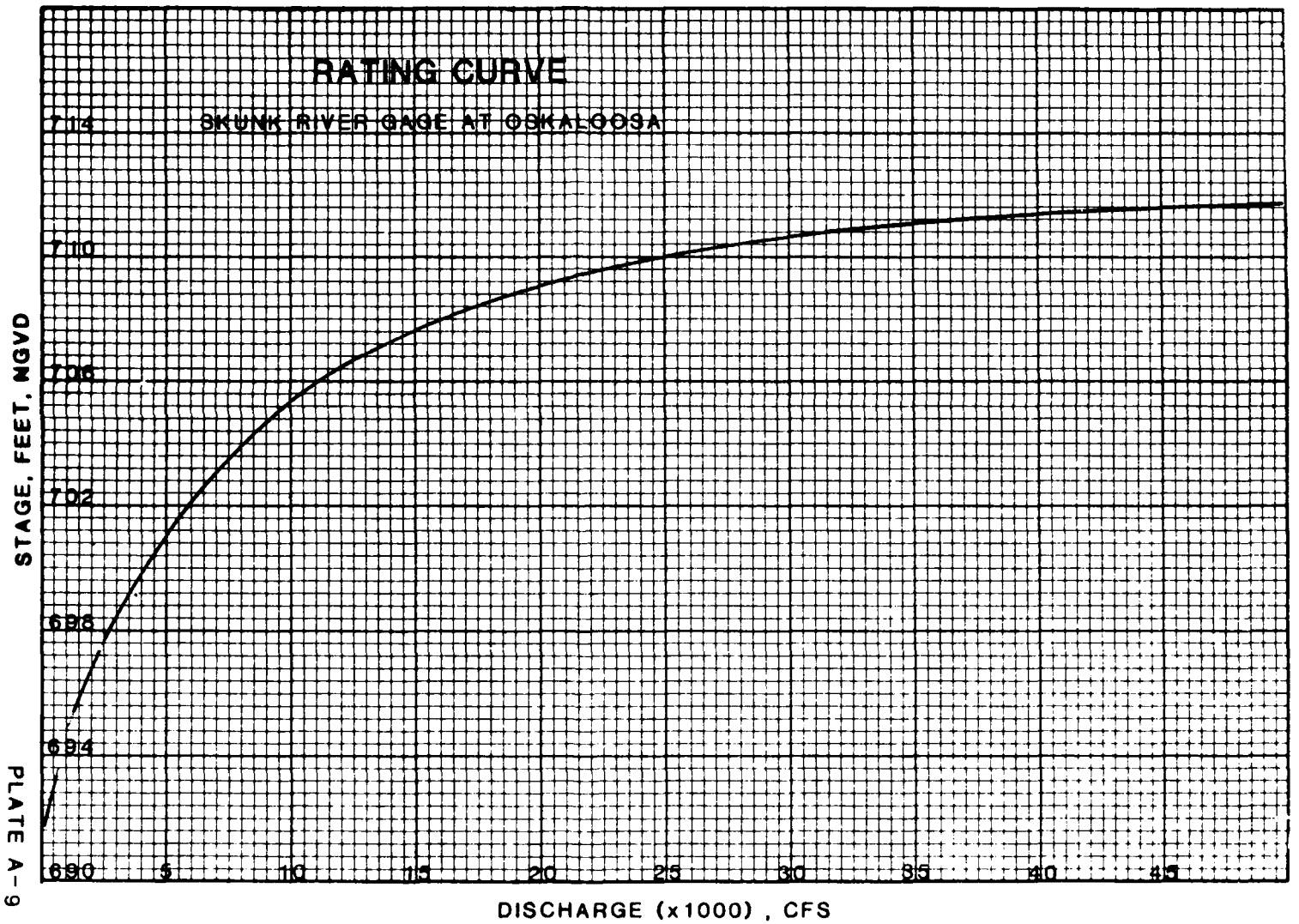

RATING CURVE
SKUNK RIVER GAGE AT OSKALOOSA
STAGE, FEET, NGVD
714
710
706
702
698
694
690
5
10
15
20
25
30
35
40
45
DISCHARGE (x1000), CFS

PLATE A-9

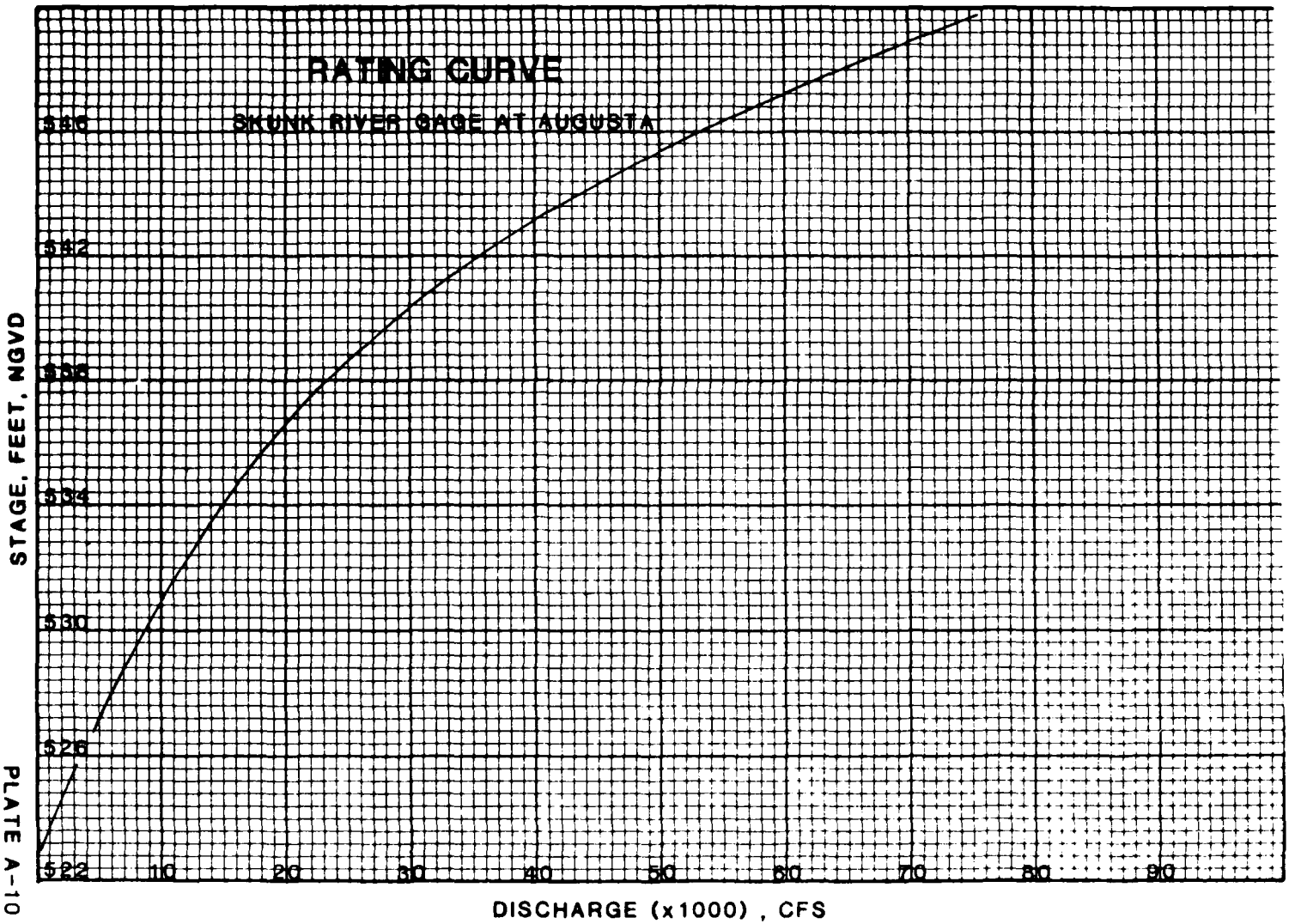

RATING CURVE
SKUNK RIVER GAGE AT AUGUSTA
STAGE, FEET, NGVD
$26
$30
$34
$22
10
20
30
40
50
60
70
80
90
DISCHARGE (x1000) , CFS

PLATE A-10

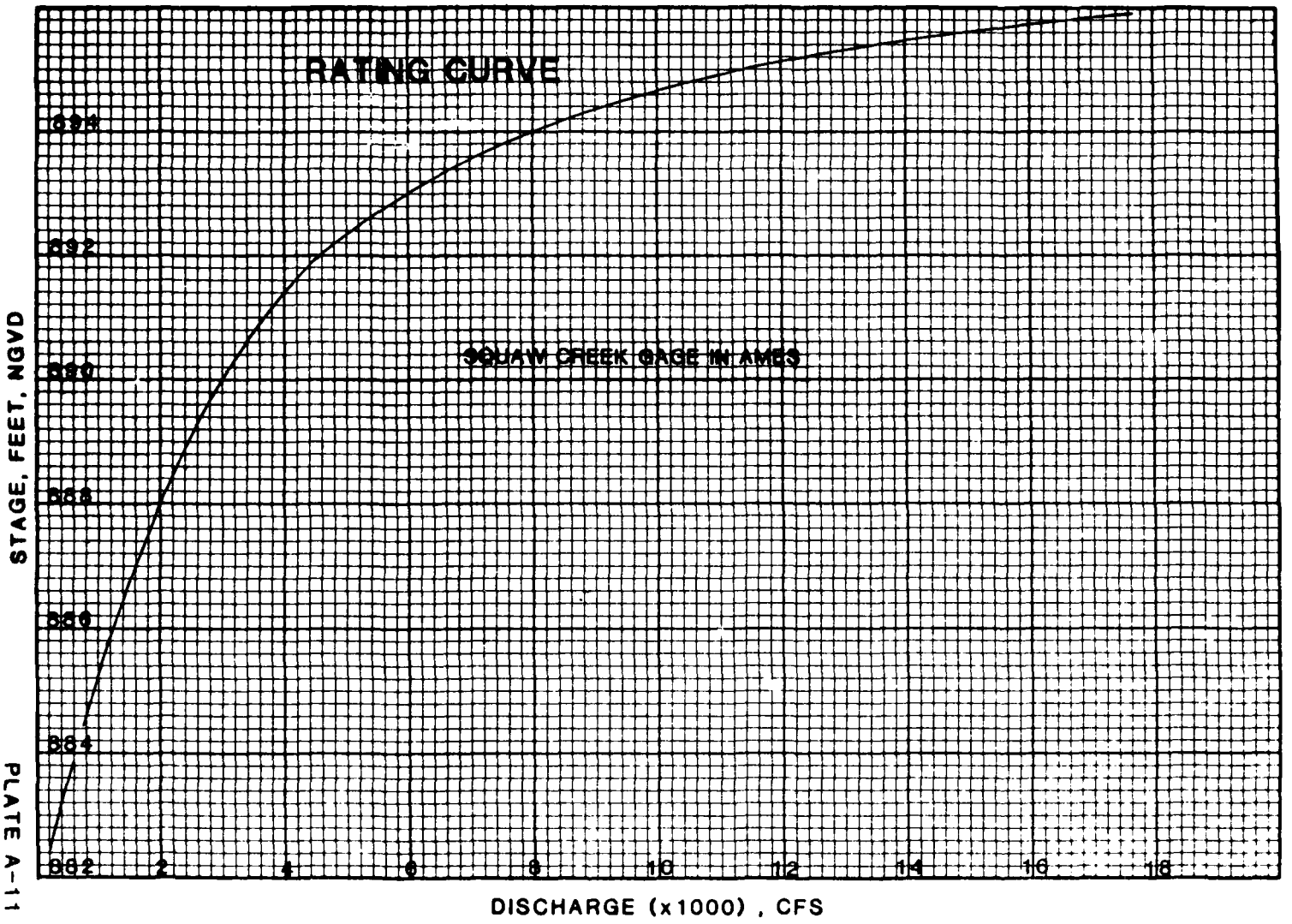

RATING CURVE
SQUAW CREEK GAGE IN AMES
STAGE, FEET, NGVD
DISCHARGE (x1000) , CFS
2
4
6
8
10
12
14
16
18

PLATE A-11

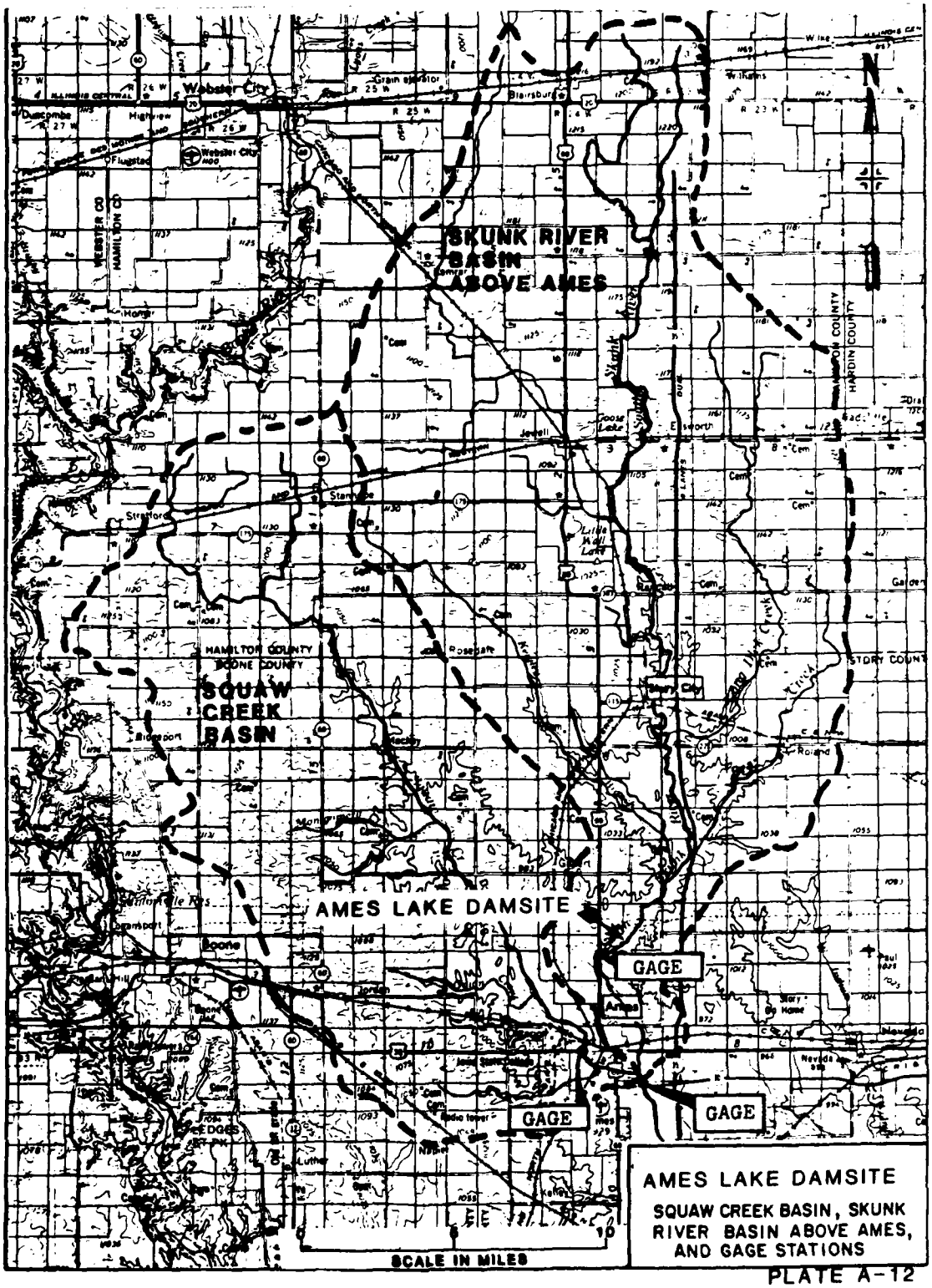

SKUNK RIVER BASIN ABOVE AMES
SQUAW CREEK BASIN
AMES LAKE DAMSITE
GAGE
GAGE
GAGE
HAMILTON COUNTY
BOONE COUNTY
HARDIN COUNTY
STORY COUNTY
Webster City
Boone
Ames
SCALE IN MILES
AMES LAKE DAMSITE
SQUAW CREEK BASIN, SKUNK RIVER BASIN ABOVE AMES, AND GAGE STATIONS

PLATE A-12

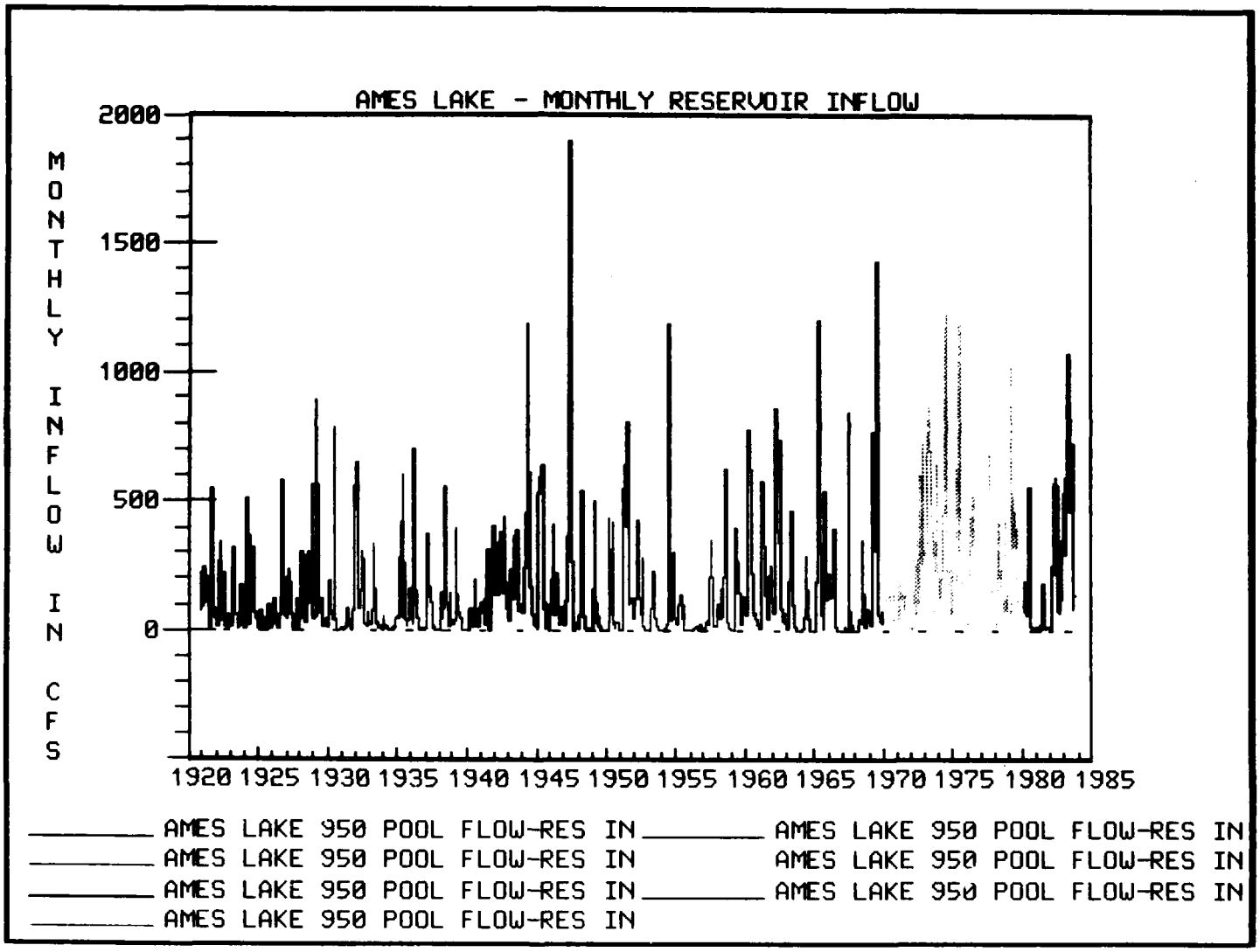

AMES LAKE - MONTHLY RESERVOIR INFLOW
MONTHLY INFLOW IN CFS
2000
1500
1000
500
0
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN

PLATE A-13

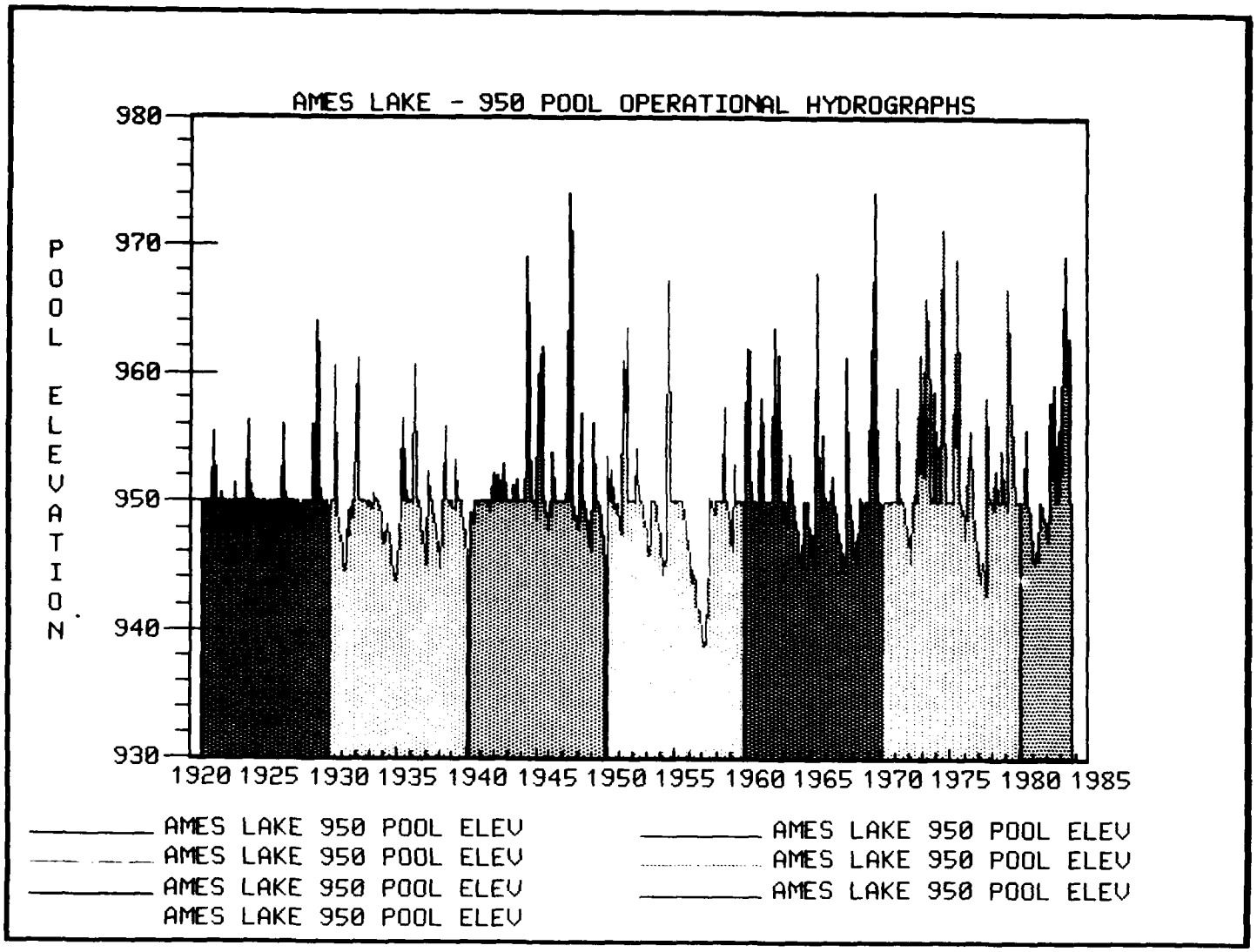

AMES LAKE - 950 POOL OPERATIONAL HYDROGRAPHS
POOL ELEVATION
980
970
960
950
940
930
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985
AMES LAKE 950 POOL ELEV
AMES LAKE 950 POOL ELEV
AMES LAKE 950 POOL ELEV
AMES LAKE 950 POOL ELEV
AMES LAKE 950 POOL ELEV
AMES LAKE 950 POOL ELEV
AMES LAKE 950 POOL ELEV

PLATE A-14

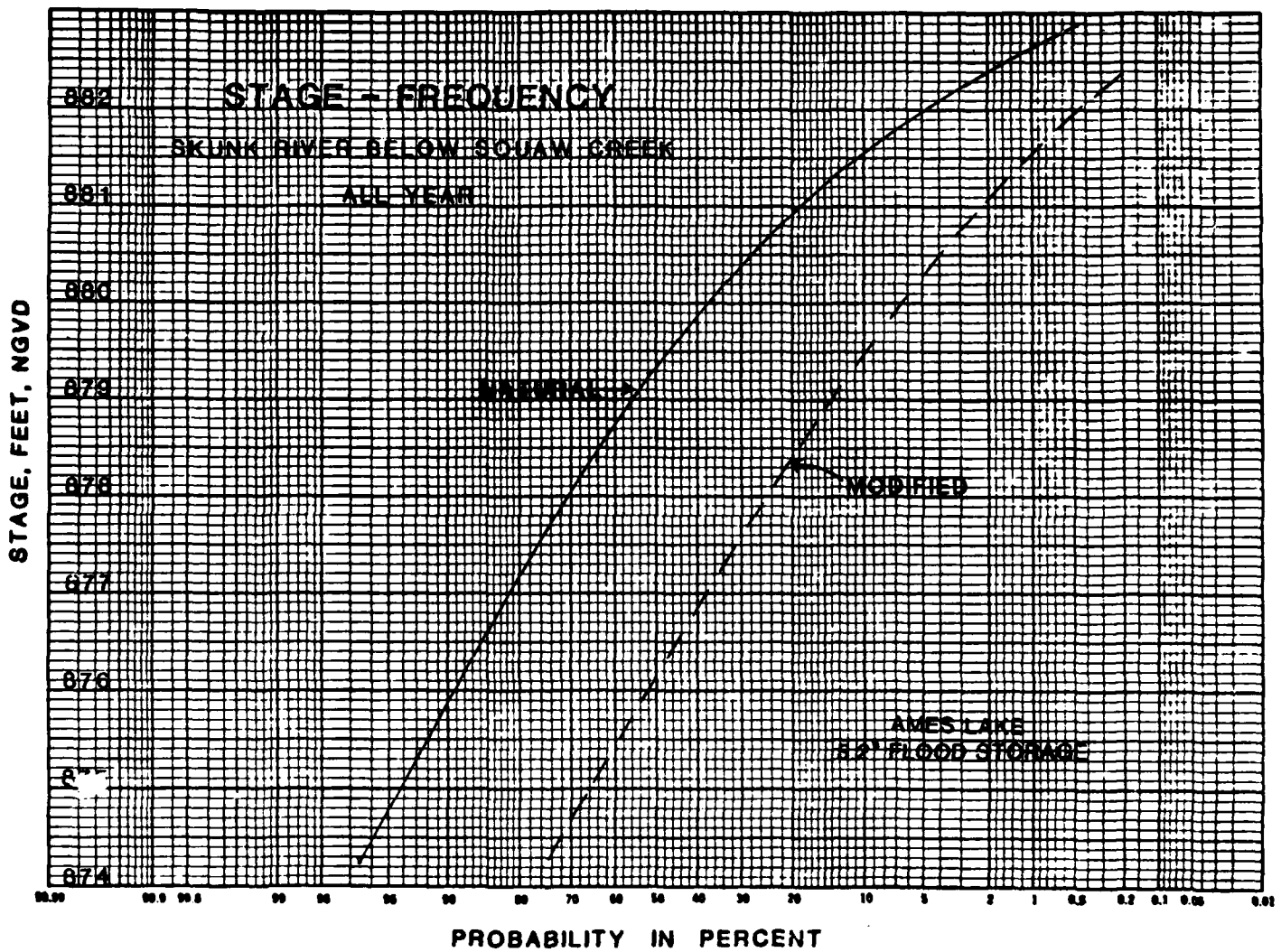

STAGE - FREQUENCY
SKUNK RIVER BELOW SQUAW CREEK
ALL YEAR
682
681
680
679
678
677
676
675
674
MODIFIED
AMES LAKE
5.2' FLOOD STORAGE
STAGE, FEET, NGVD
PROBABILITY IN PERCENT

PLATE A-15

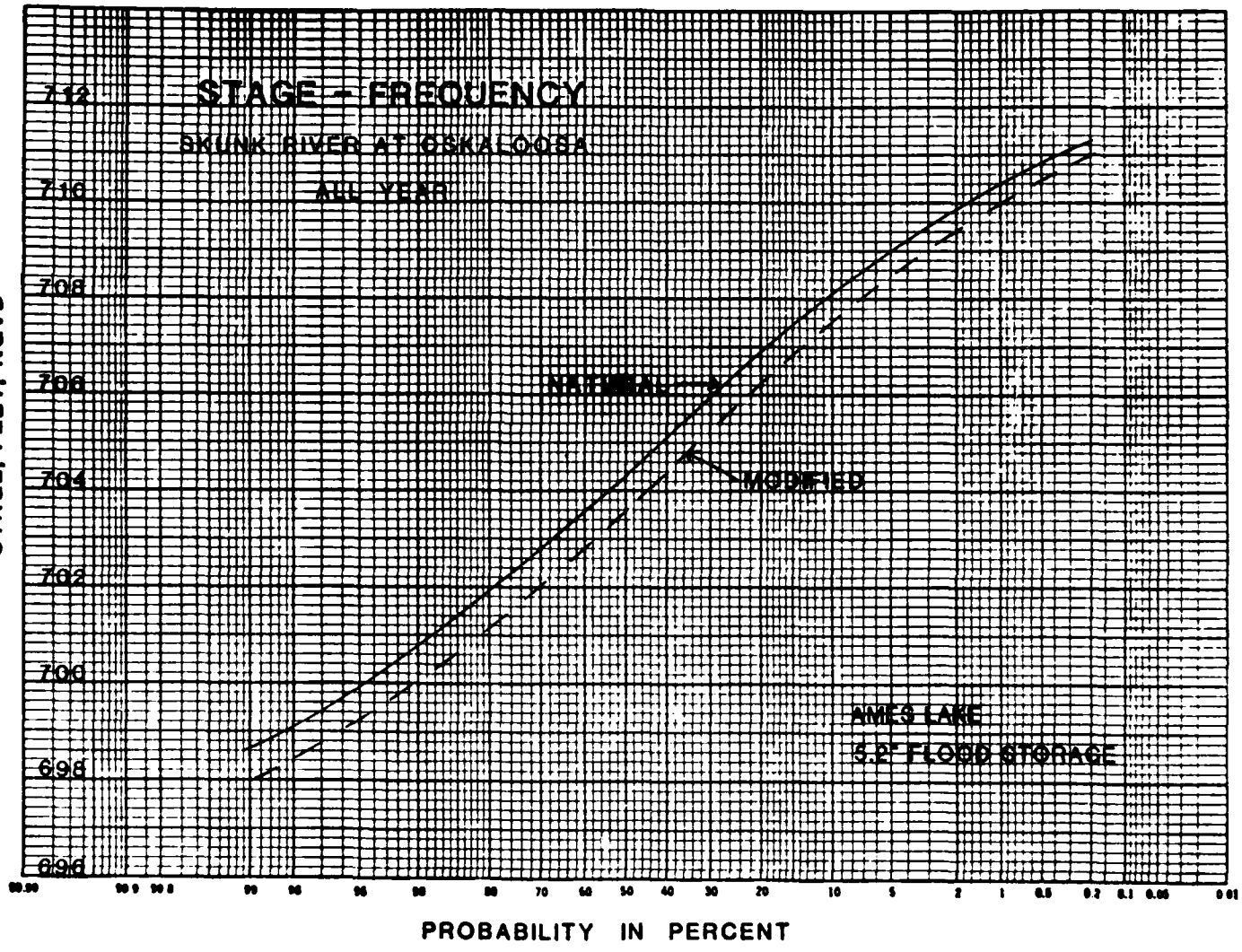

STAGE - FREQUENCY
SKUNK RIVER AT OSKALOOSA
ALL YEAR
STAGE, FEET, NGVD
712
710
708
706
704
702
700
698
696
NATURAL
MODIFIED
AMES LAKE
5.2' FLOOD STORAGE
99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
PROBABILITY IN PERCENT

PLATE A-16

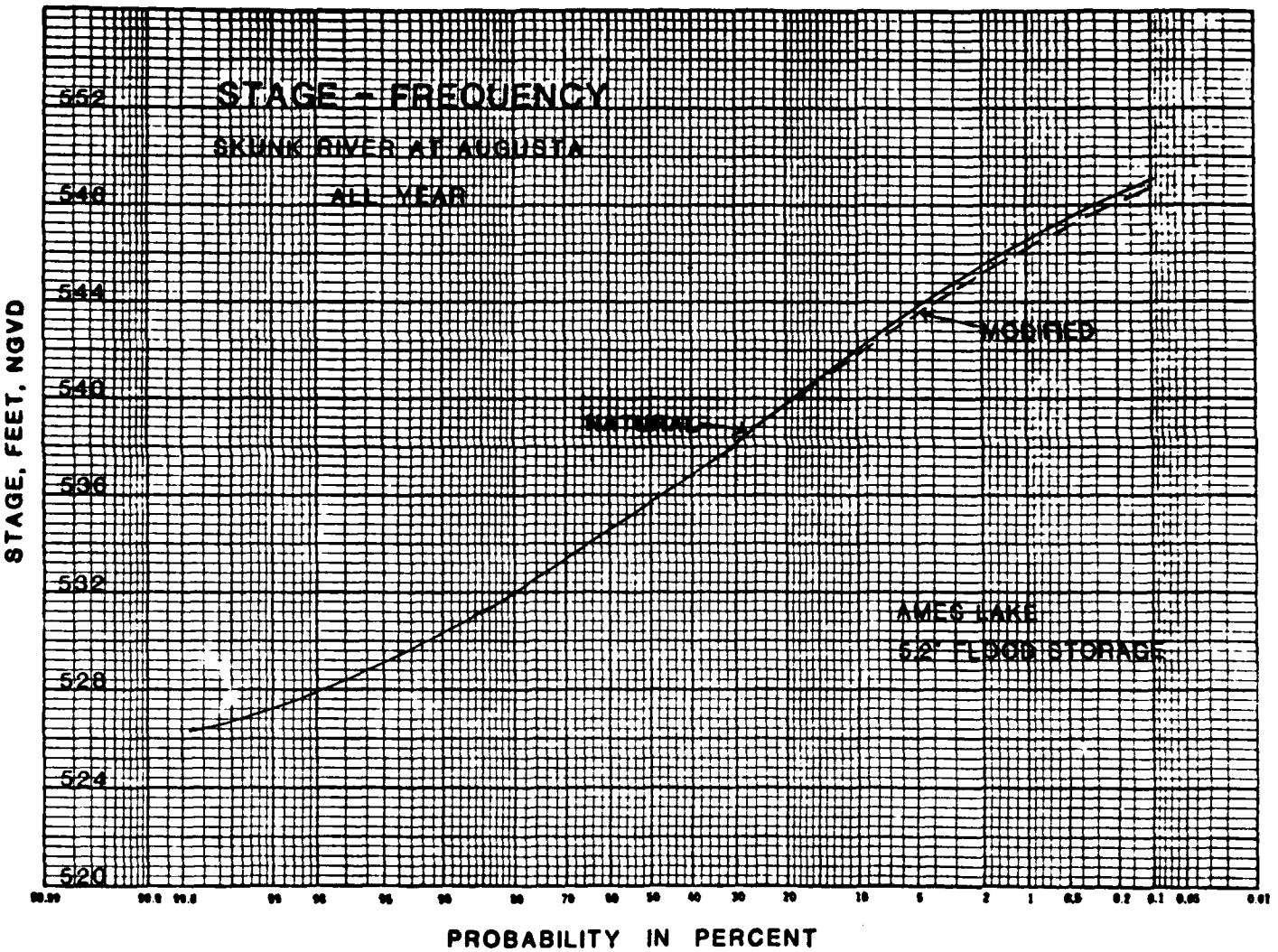

STAGE - FREQUENCY
SKUNK RIVER AT AUGUSTA
ALL YEAR
552
548
544
540
536
532
528
524
520
STAGE, FEET, NGVD
MODIFIED
NATURAL
AMES LAKE
5.2' FLOOD STORAGE
PROBABILITY IN PERCENT

PLATE A-17

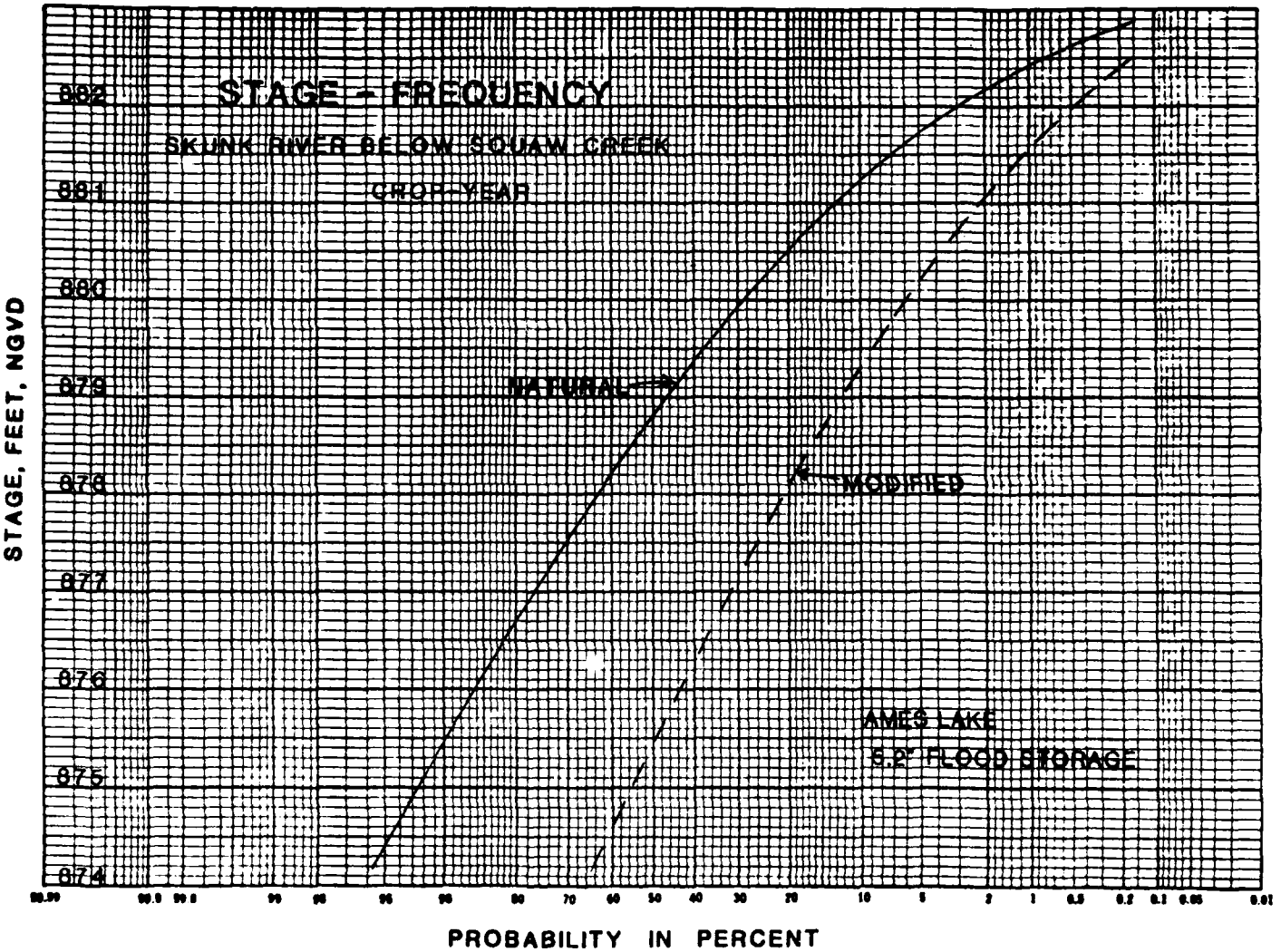

STAGE - FREQUENCY
SKUNK RIVER BELOW SQUAW CREEK
CROP-YEAR
NATURAL
MODIFIED
AMES LAKE
5.2' FLOOD STORAGE
STAGE, FEET, NGVD
882
881
880
879
878
877
876
875
874
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
PROBABILITY IN PERCENT

PLATE A-18

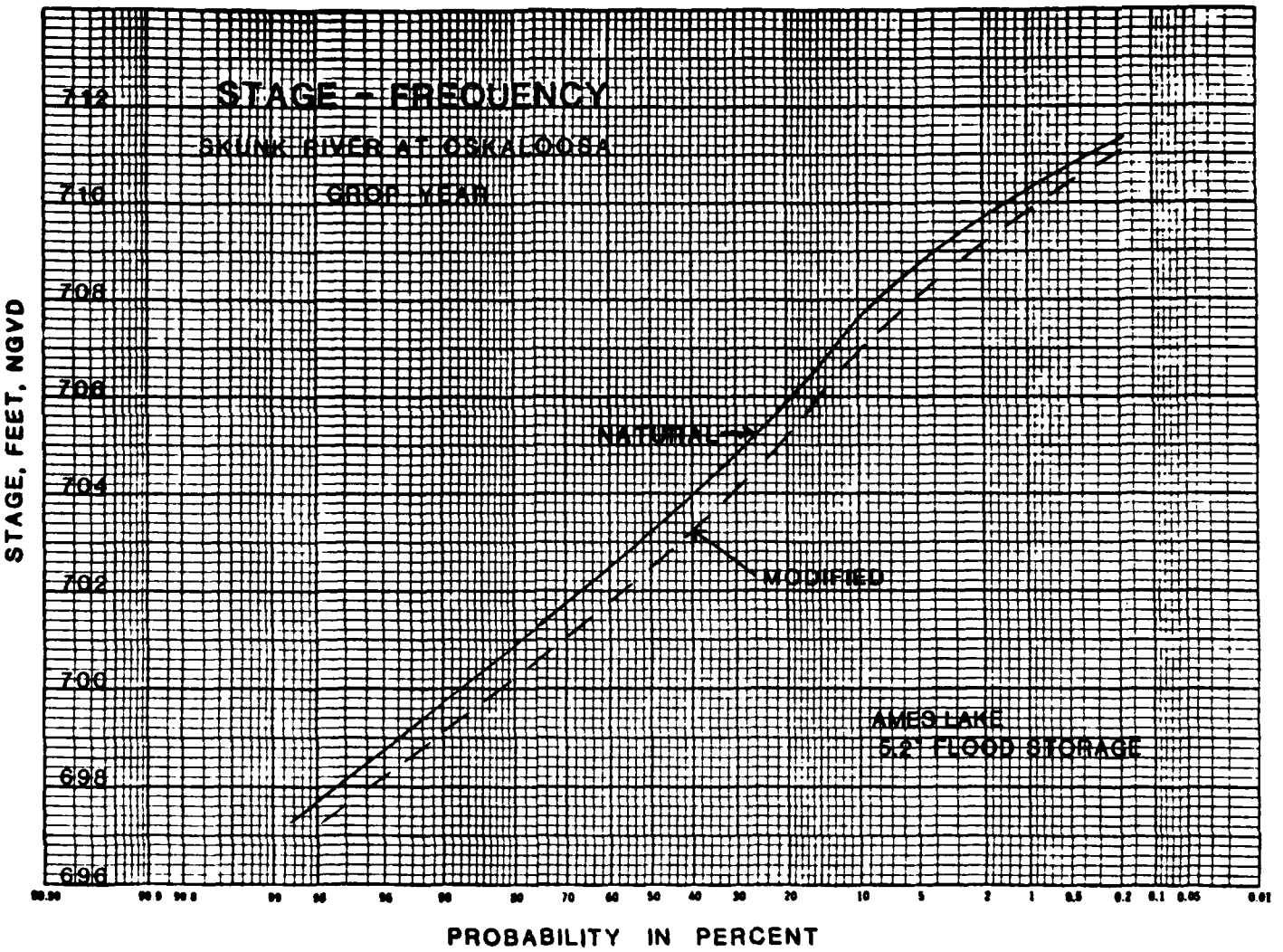

STAGE - FREQUENCY
SKUNK RIVER AT OSKALOOSA
CROP YEAR
712
710
708
706
704
702
700
698
696
STAGE, FEET, NGVD
NATURAL
MODIFIED
AMES LAKE
5.2' FLOOD STORAGE
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
PROBABILITY IN PERCENT

PLATE A-19

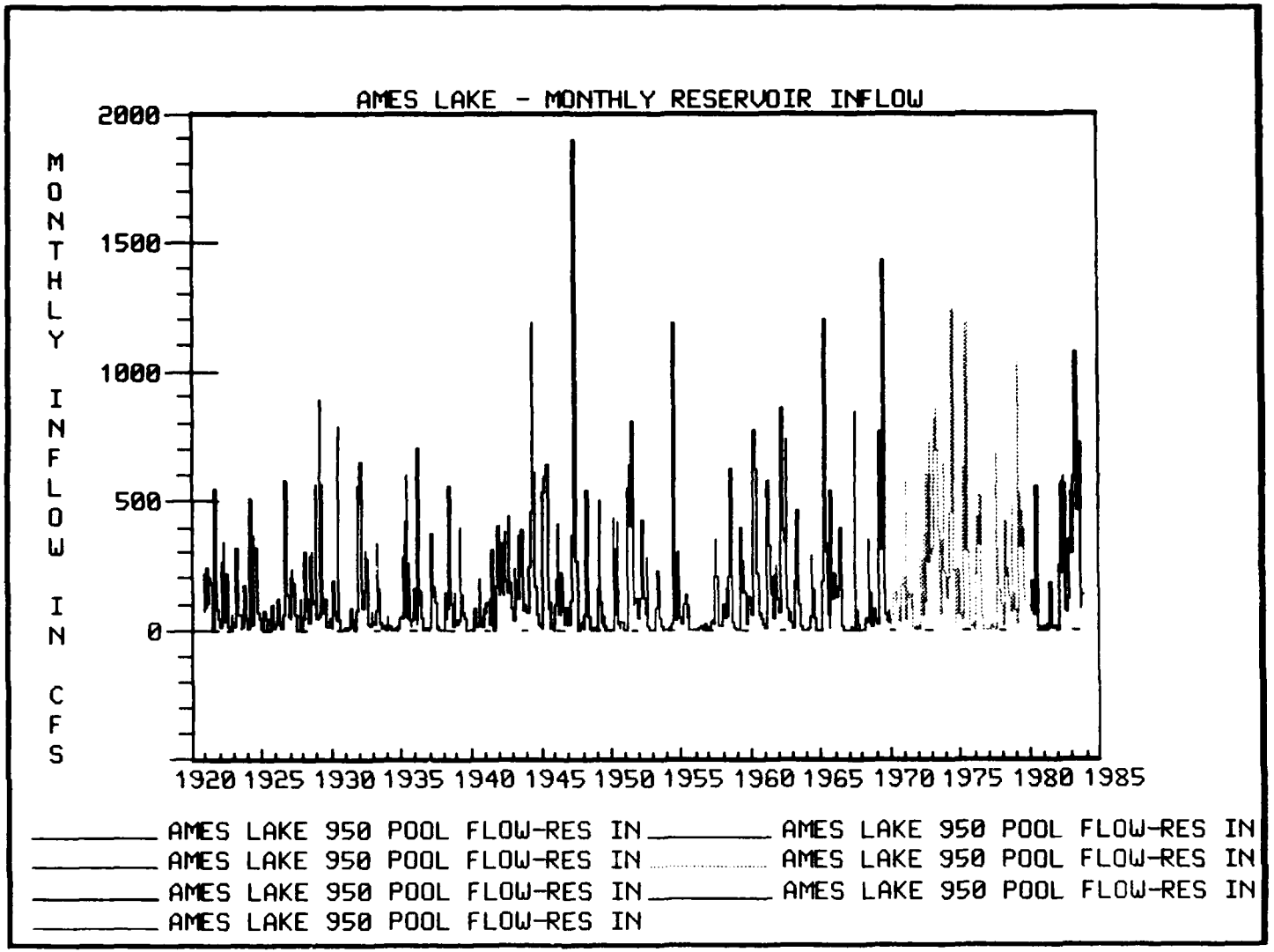

AMES LAKE - MONTHLY RESERVOIR INFLOW
MONTHLY INFLOW IN CFS
2000
1500
1000
500
0
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN
AMES LAKE 950 POOL FLOW-RES IN

PLATE A-20

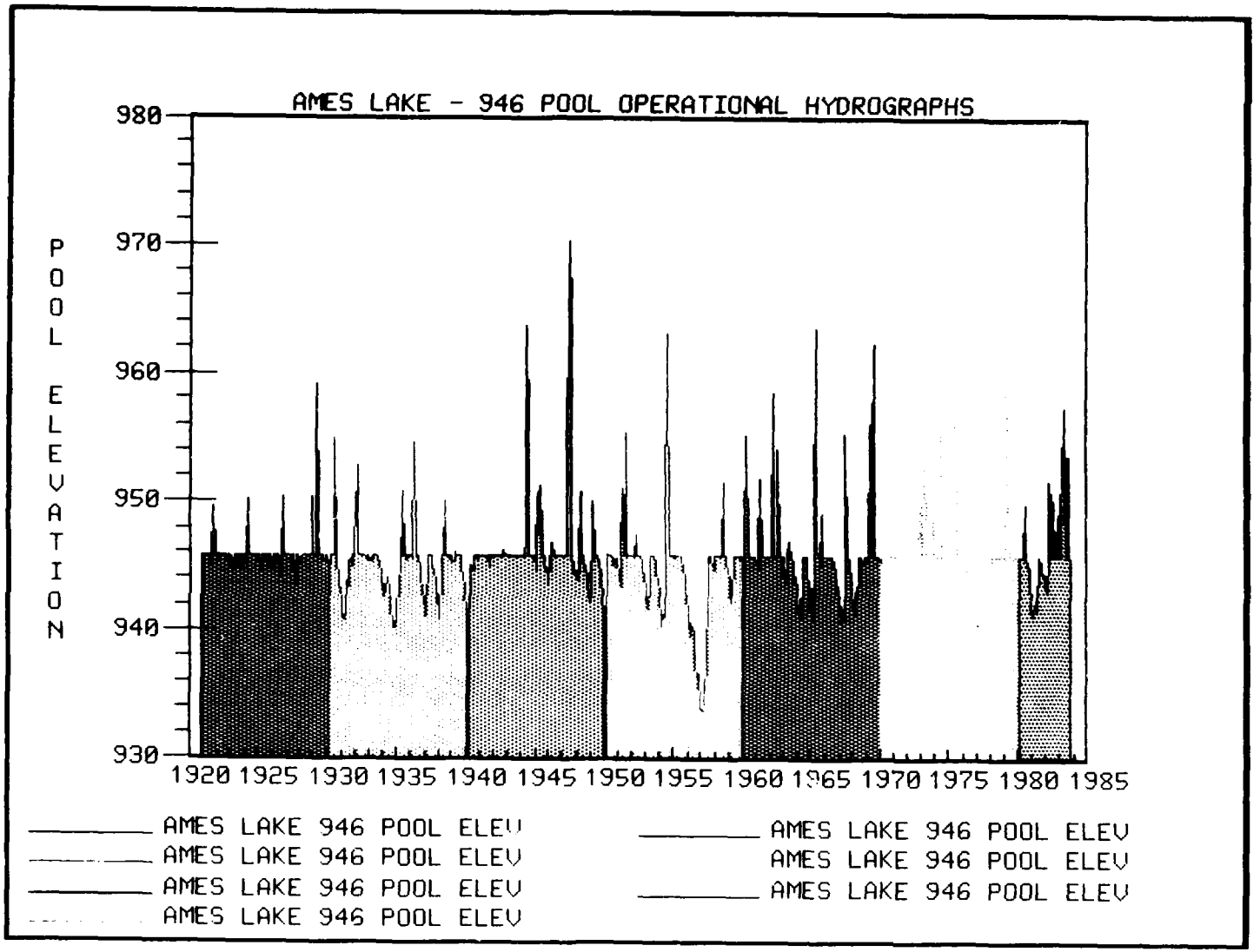

AMES LAKE - 946 POOL OPERATIONAL HYDROGRAPHS
POOL ELEVATION
980
970
960
950
940
930
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985
AMES LAKE 946 POOL ELEV
AMES LAKE 946 POOL ELEV
AMES LAKE 946 POOL ELEV
AMES LAKE 946 POOL ELEV
AMES LAKE 946 POOL ELEV
AMES LAKE 946 POOL ELEV
AMES LAKE 946 POOL ELEV

PLATE A-21

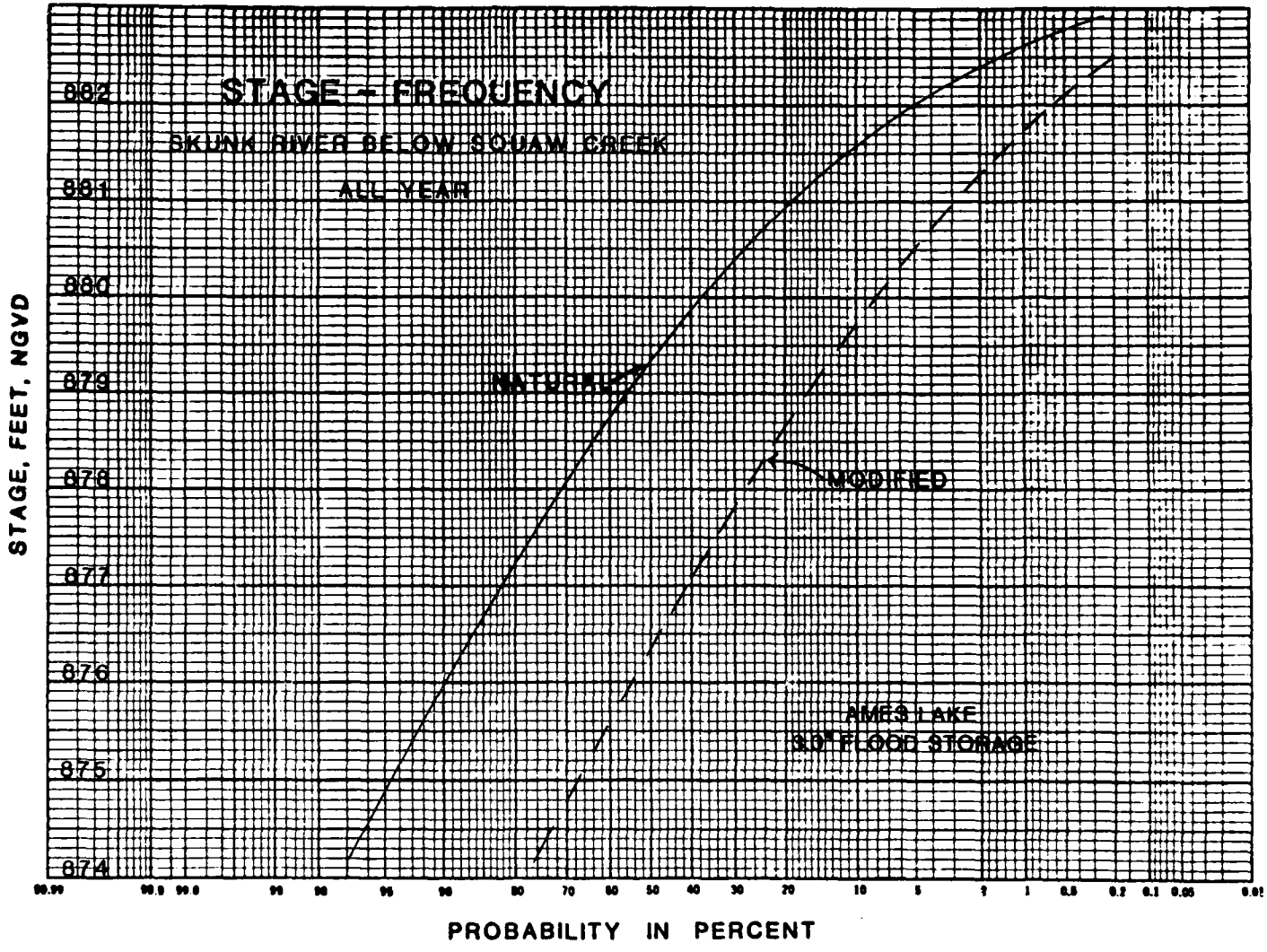

STAGE - FREQUENCY
SKUNK RIVER BELOW SQUAW CREEK
ALL YEAR
NATURAL
MODIFIED
AMES LAKE
3.0" FLOOD STORAGE
STAGE, FEET, NGVD
PROBABILITY IN PERCENT

PLATE A-22

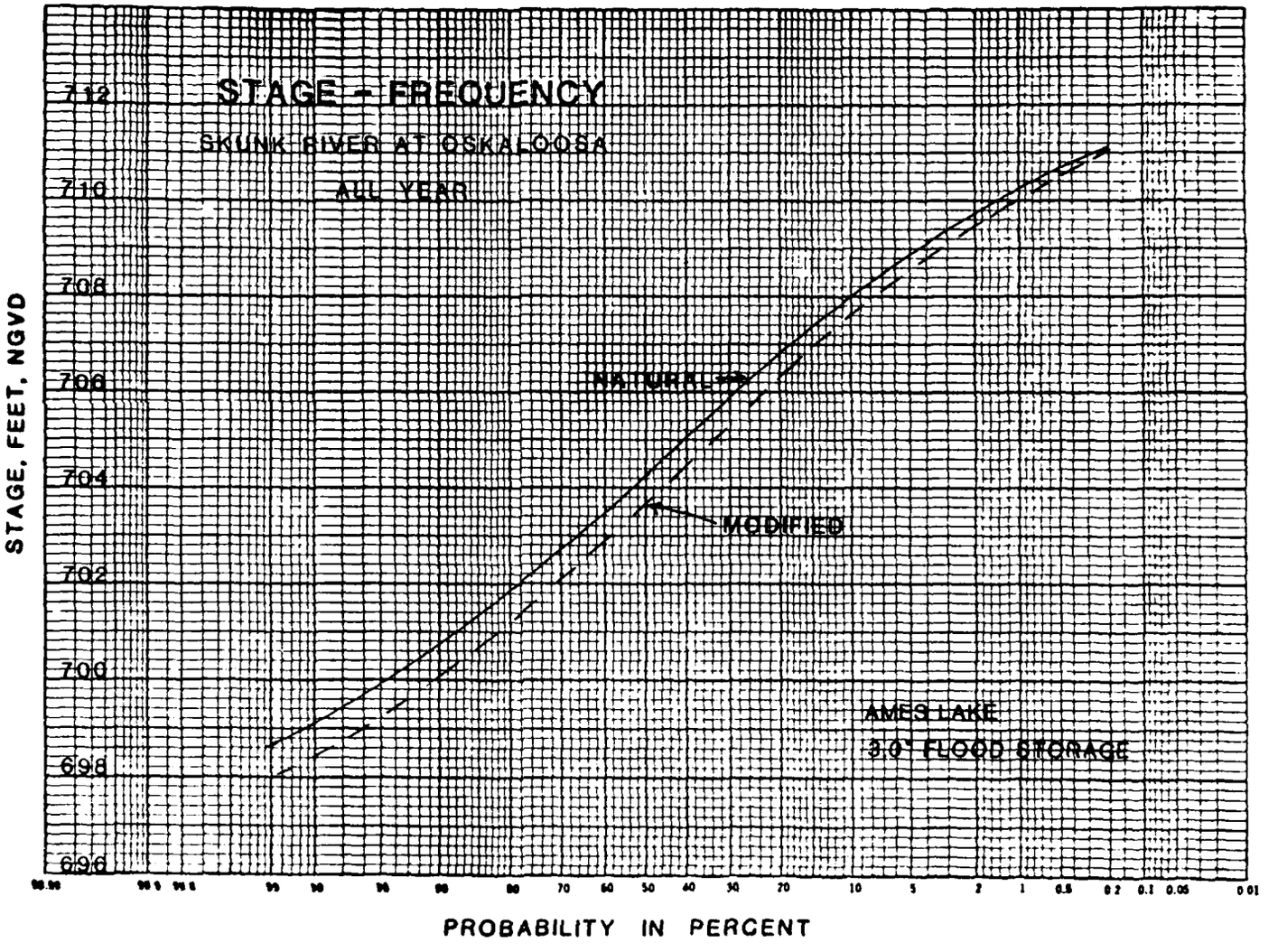

STAGE - FREQUENCY
SKUNK RIVER AT OSKALOOSA
ALL YEAR
712
710
708
706
704
702
700
698
696
NATURAL
MODIFIED
AMES LAKE
3.0" FLOOD STORAGE
STAGE, FEET, NGVD
99.99
99.9
99.8
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
PROBABILITY IN PERCENT

PLATE A-23

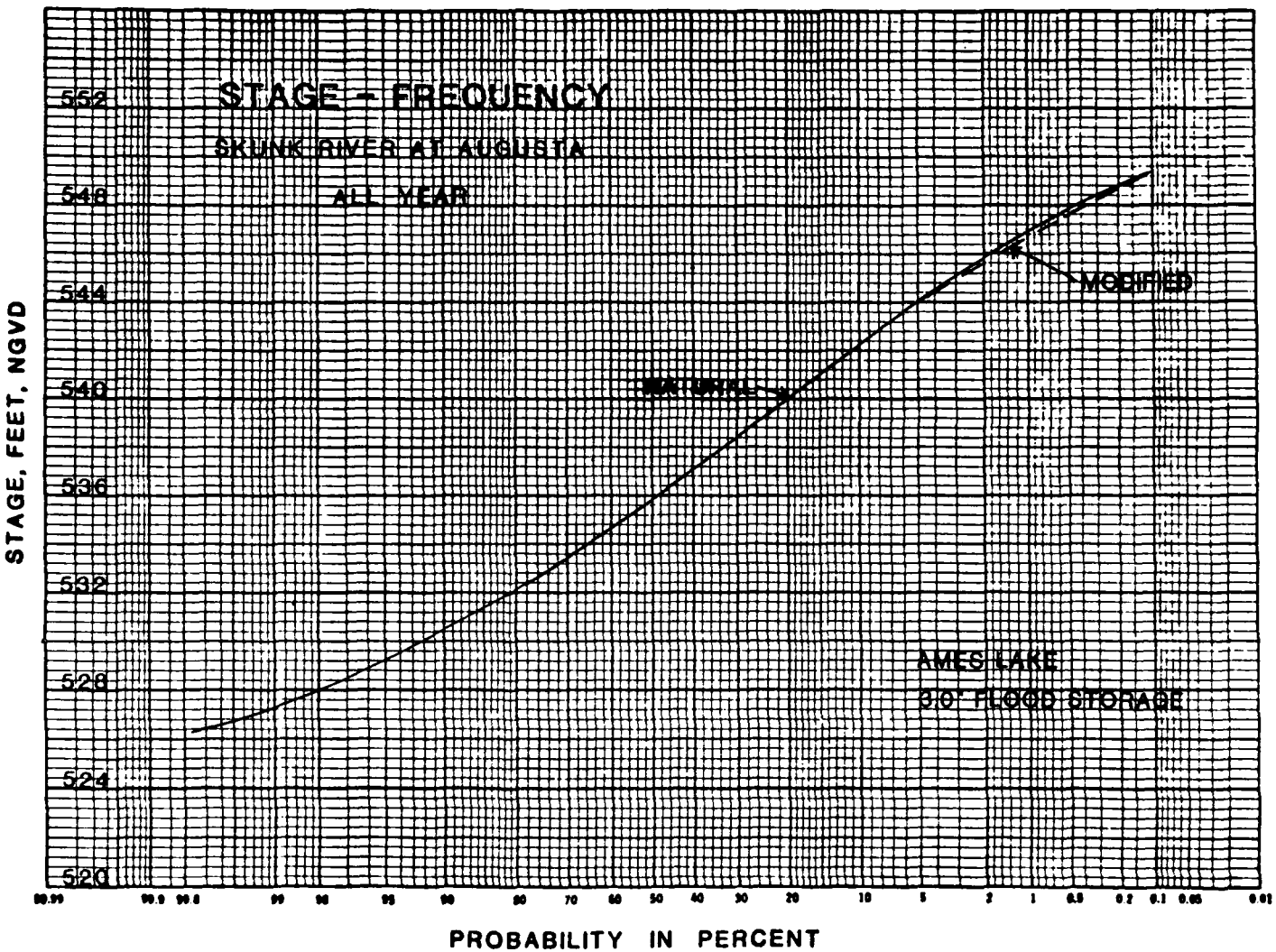

STAGE - FREQUENCY
SKUNK RIVER AT AUGUSTA
ALL YEAR
MODIFIED
AMES LAKE
3.0" FLOOD STORAGE
STAGE, FEET, NGVD
552
548
544
540
536
532
528
524
520
PROBABILITY IN PERCENT

PLATE A-24

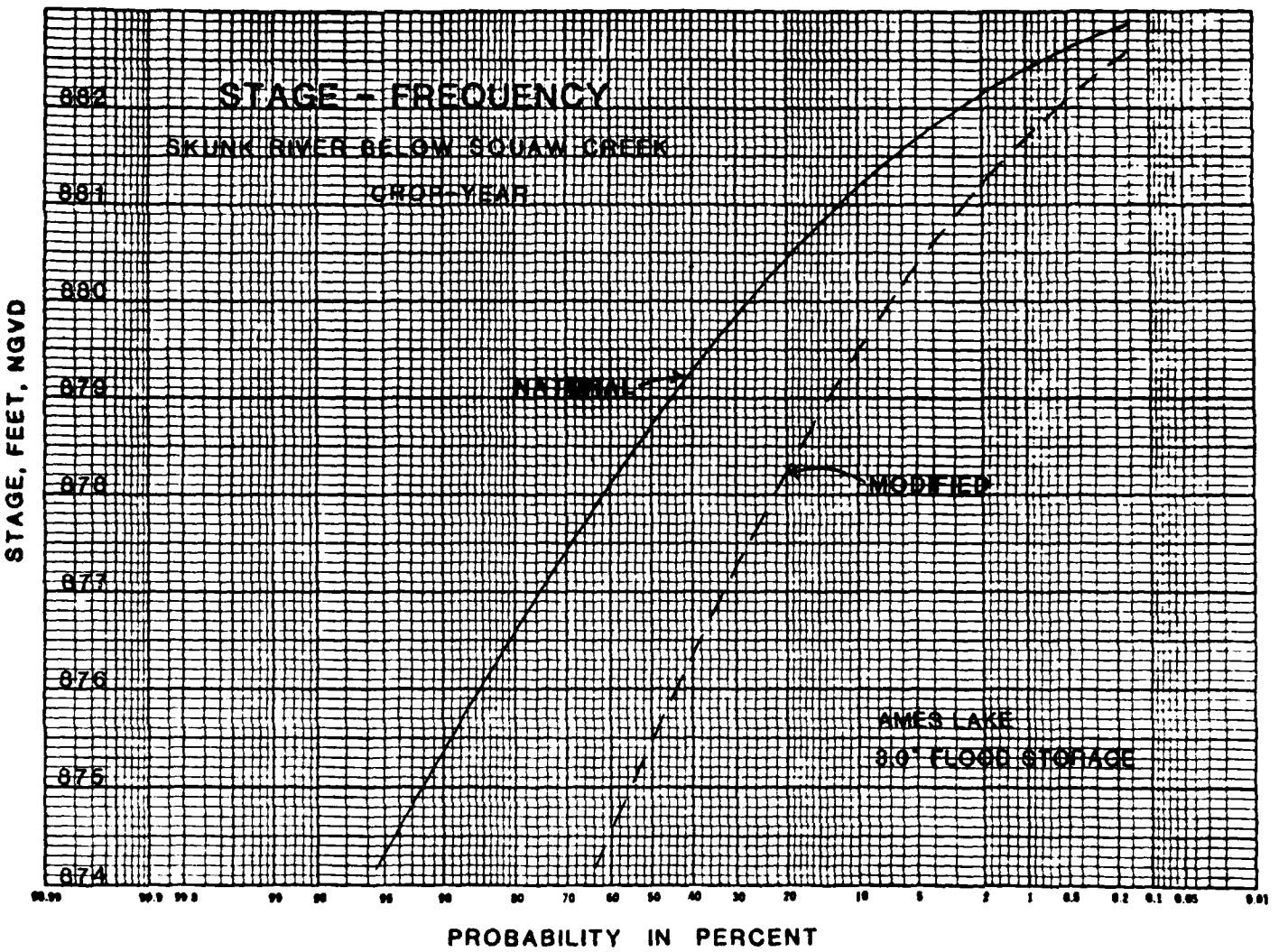

STAGE - FREQUENCY
SKUNK RIVER BELOW SQUAW CREEK
CROP-YEAR
NATURAL
MODIFIED
AMES LAKE
3.0 FLOOD STORAGE
STAGE, FEET, NGVD
PROBABILITY IN PERCENT

PLATE A-25

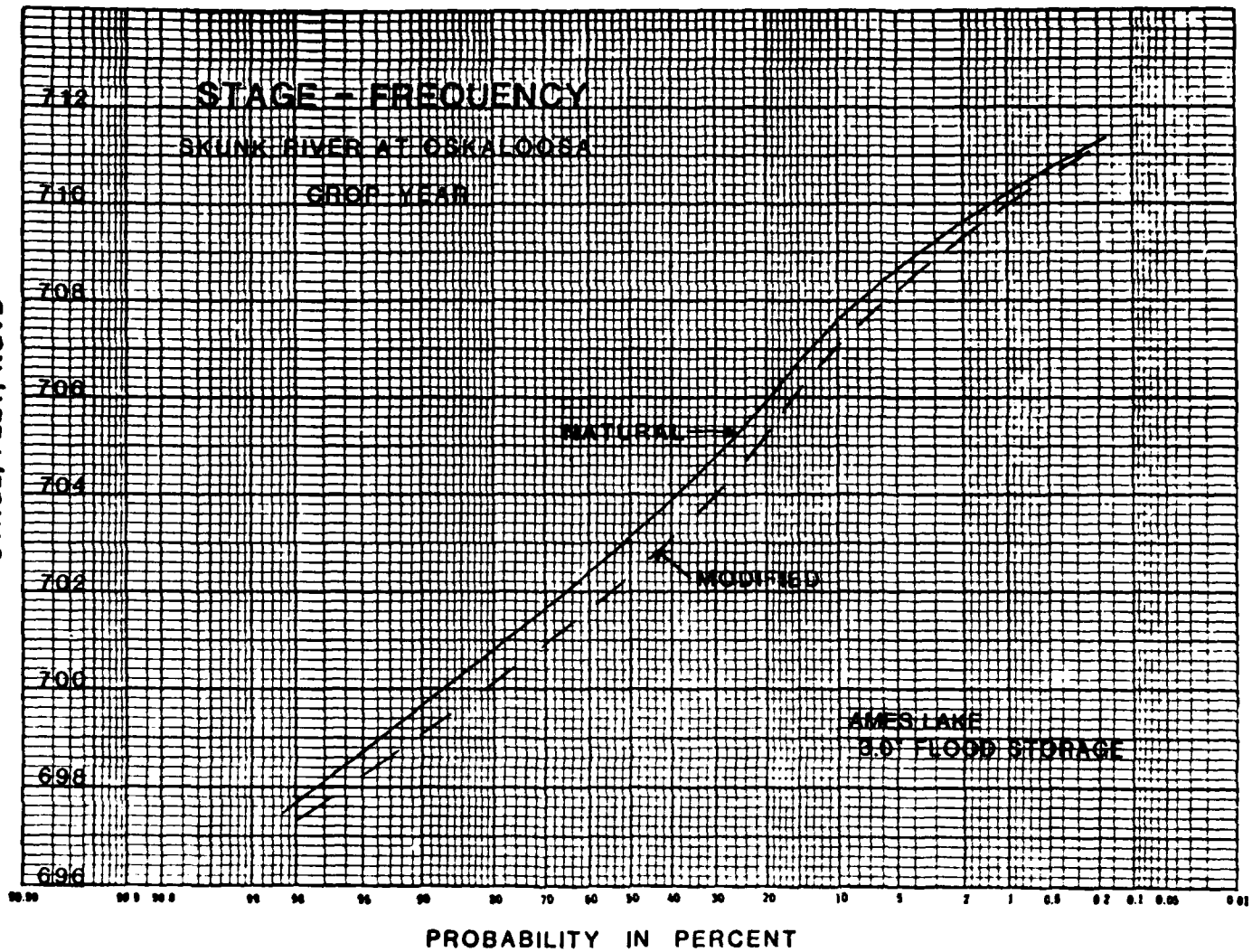
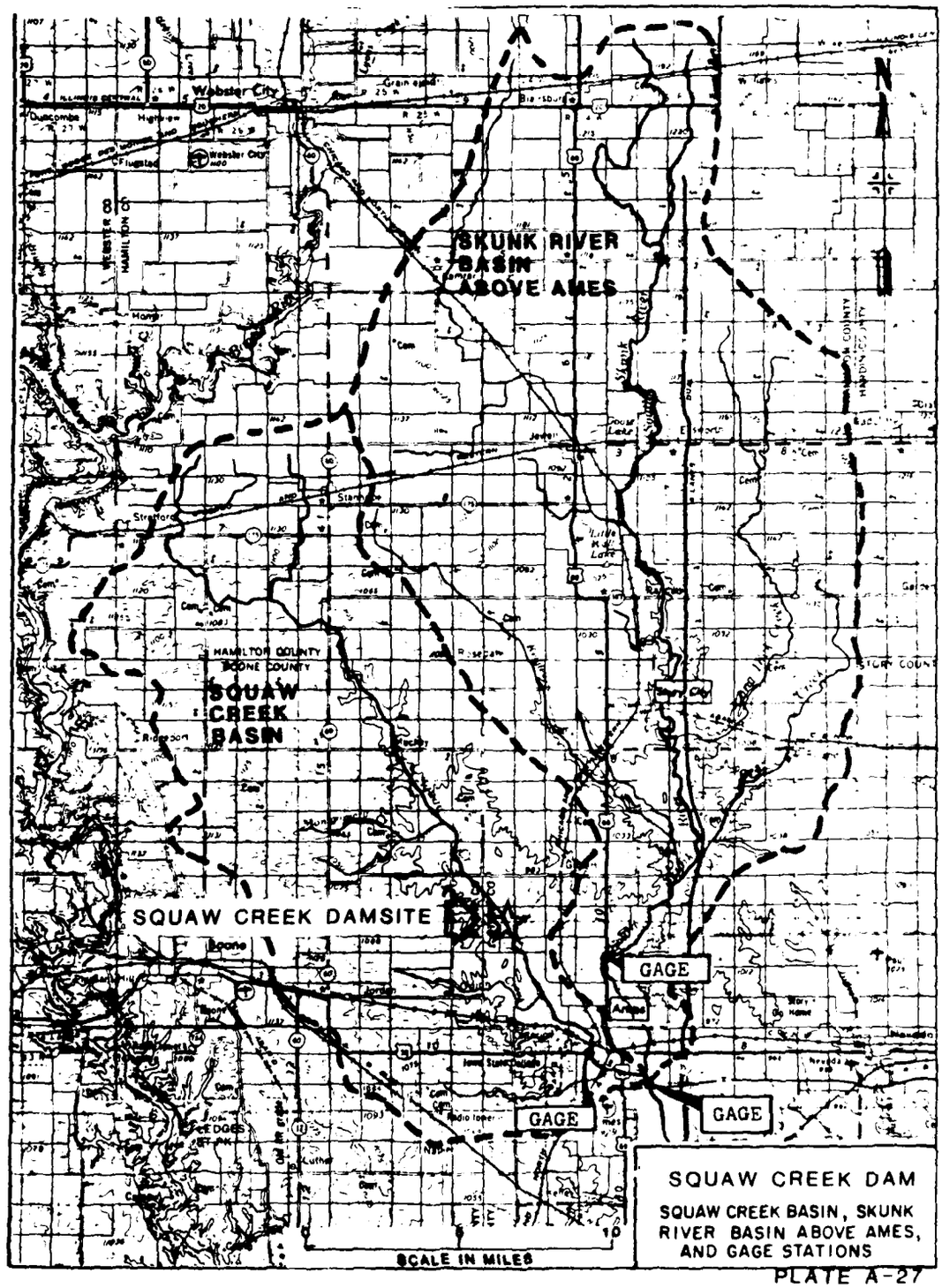

STAGE - FREQUENCY
SKUNK RIVER AT OSKALOOSA
CROP YEAR
712
716
708
706
704
702
700
698
696
STAGE, FEET, NGVD
NATURAL
MODIFIED
AMES LAKE
9.0' FLOOD STORAGE
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
PROBABILITY IN PERCENT

PLATE A-26



SQUAW CREEK DAM

SQUAW CREEK BASIN, SKUNK RIVER BASIN ABOVE AMES, AND GAGE STATIONS

PLATE A-27

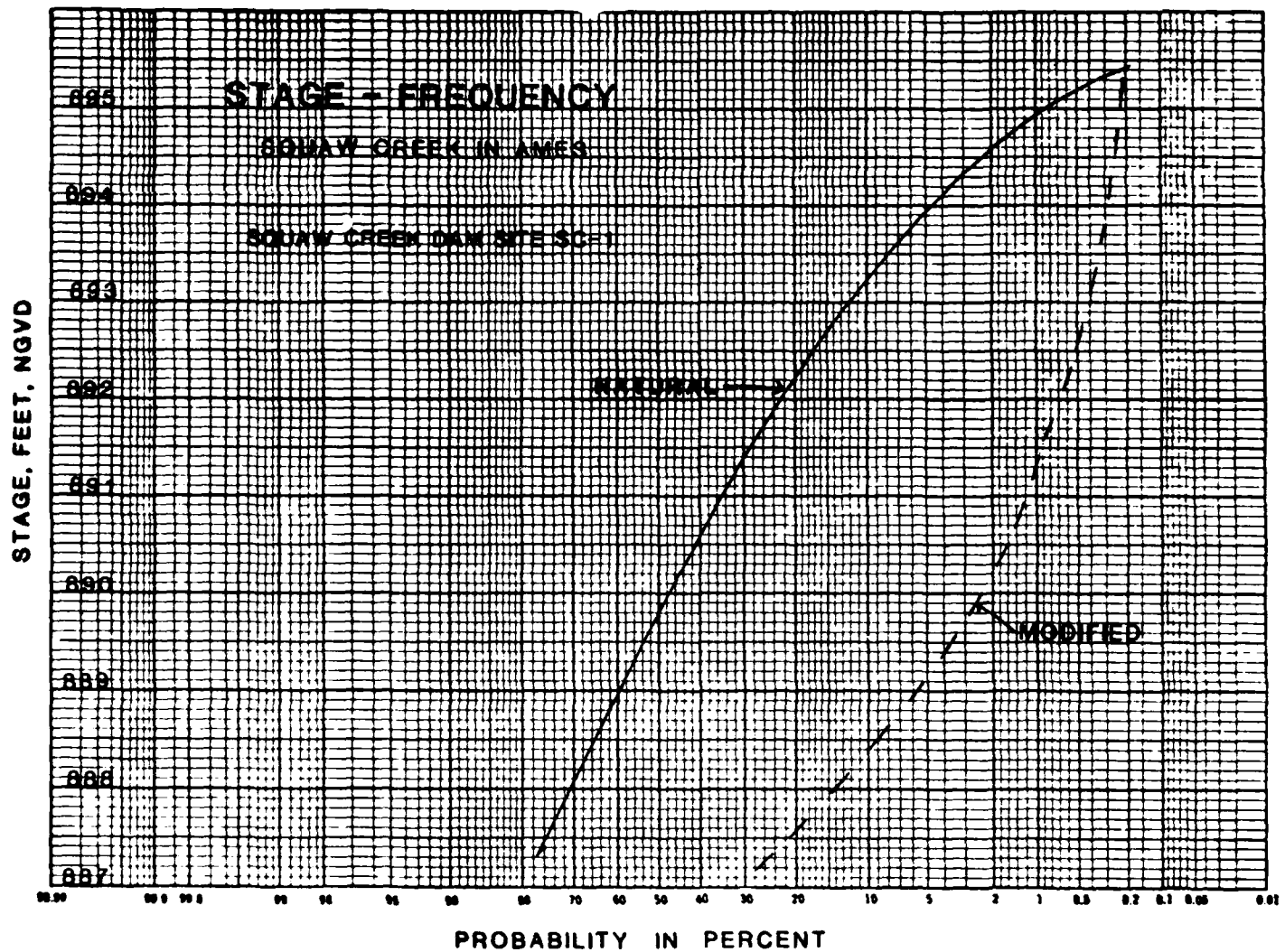

STAGE - FREQUENCY
SQUAW CREEK IN AMES
SQUAW CREEK DAM SITE SC-1
NATURAL
MODIFIED
STAGE, FEET, NGVD
PROBABILITY IN PERCENT

PLATE A-28

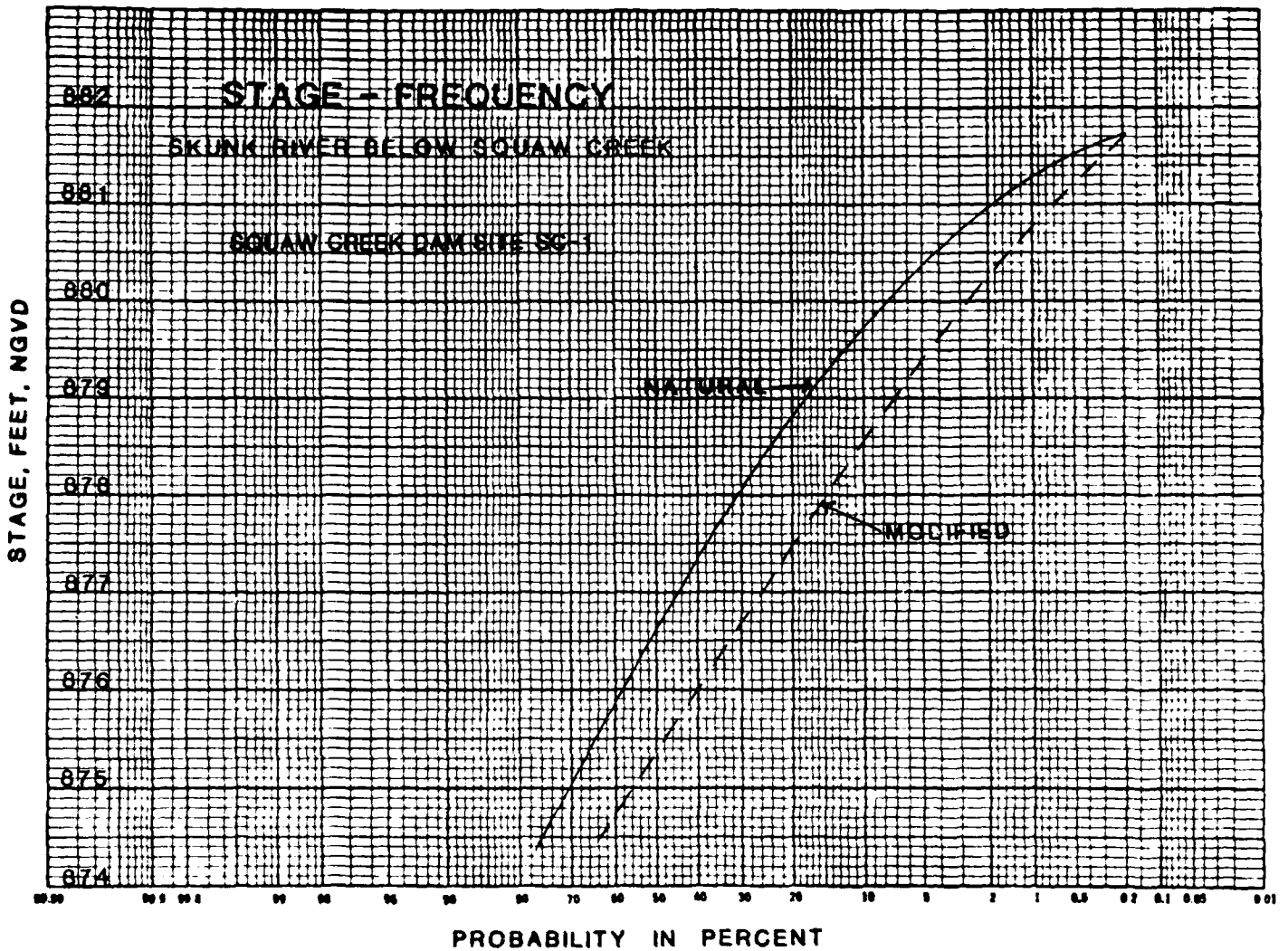

STAGE - FREQUENCY
SKUNK RIVER BELOW SQUAW CREEK
SQUAW CREEK DAM SITE SC-1
NATURAL
MODIFIED
STAGE, FEET, NGVD
882
881
880
879
878
877
876
875
874
PROBABILITY IN PERCENT

PLATE A-29

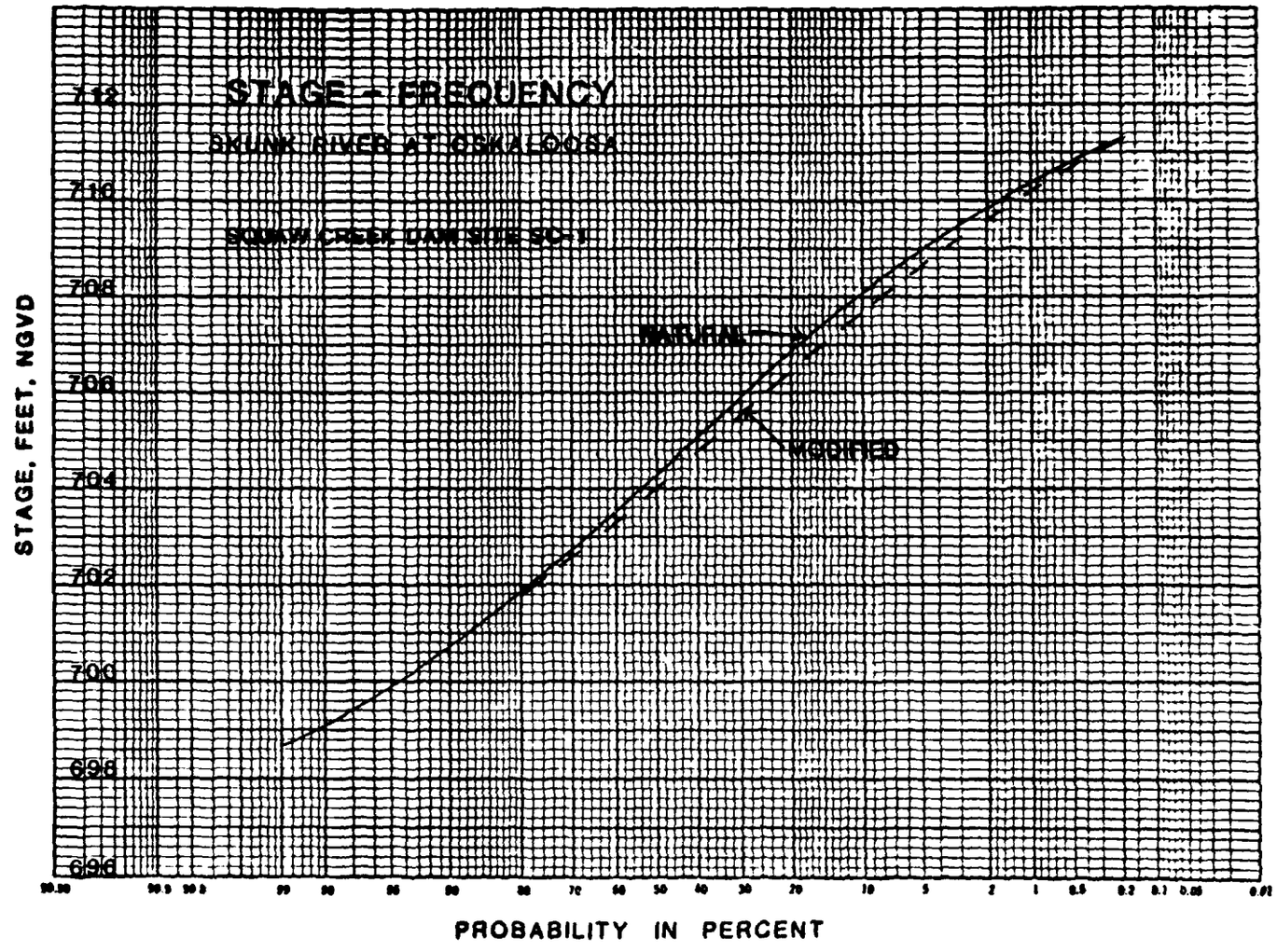

STAGE - FREQUENCY
SKUNK RIVER AT OSKALOOSA
SQUAW CREEK DAM SITE SC-1
NATURAL
MODIFIED
STAGE, FEET, NGVD
712
710
708
706
704
702
700
698
696
PROBABILITY IN PERCENT

PLATE A-30

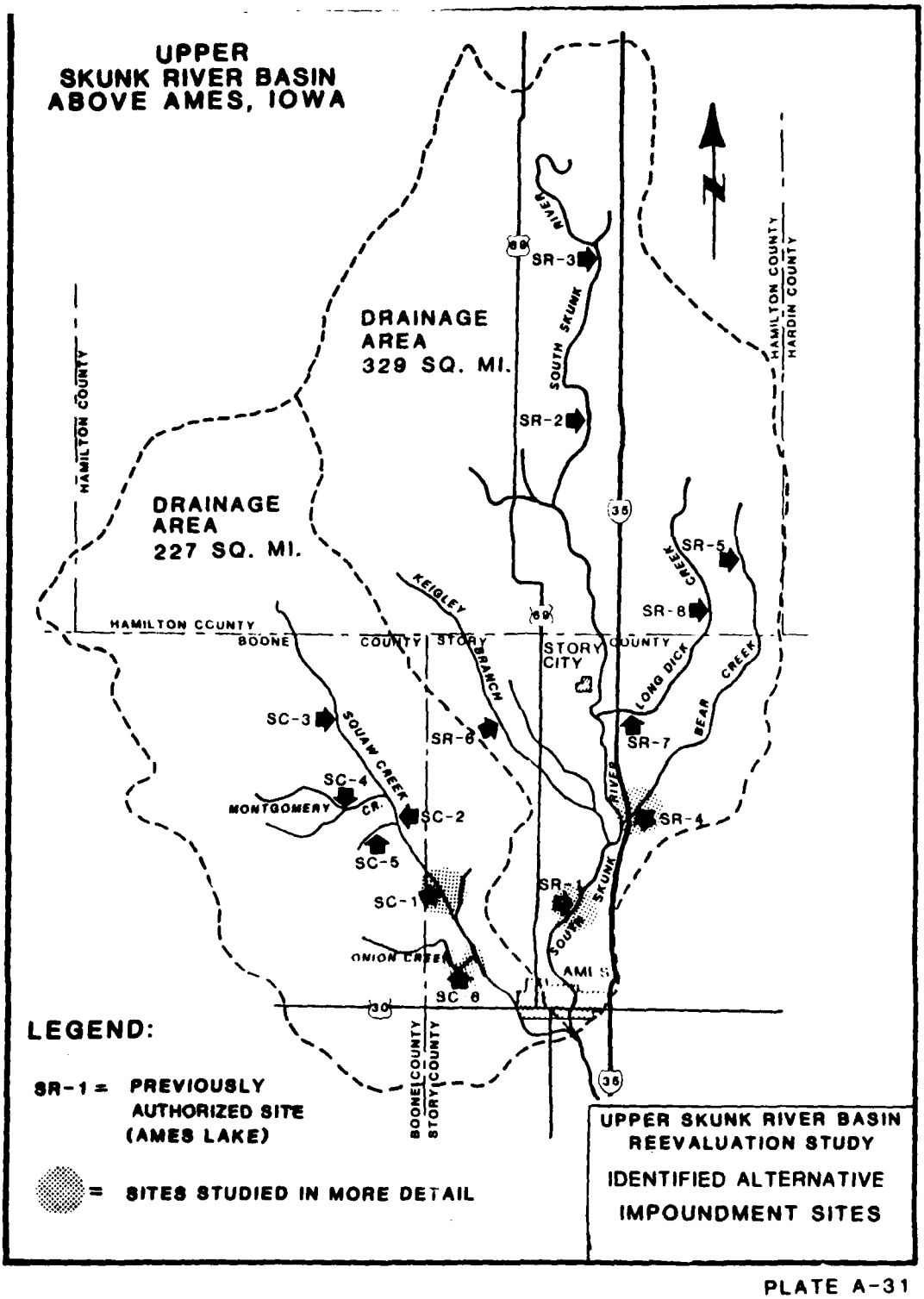

UPPER
SKUNK RIVER BASIN
ABOVE AMES, IOWA
DRAINAGE
AREA
329 SQ. MI.
DRAINAGE
AREA
227 SQ. MI.
HAMILTON COUNTY
HAMILTON COUNTY
HARDIN COUNTY
HAMILTON COUNTY
BOONE COUNTY
STORY COUNTY
STORY CITY
BOONE COUNTY
STORY COUNTY
SR-1
SR-2
SR-3
SR-4
SR-5
SR-6
SR-7
SR-8
SC-1
SC-2
SC-3
SC-4
SC-5
SC 6
SOUTH SKUMK RIVER
SOUTH SKUNK RIVER
KEIGLEY BRANCH
LONG DICK CREEK
BEAR CREEK
SQUAW CREEK
MONTGOMERY CR.
ONION CREEK
AMES
LEGEND:
SR-1 = PREVIOUSLY AUTHORIZED SITE (AMES LAKE)
= SITES STUDIED IN MORE DETAIL
UPPER SKUNK RIVER BASIN
REEVALUATION STUDY
IDENTIFIED ALTERNATIVE
IMPOUNDMENT SITES

PLATE A-31

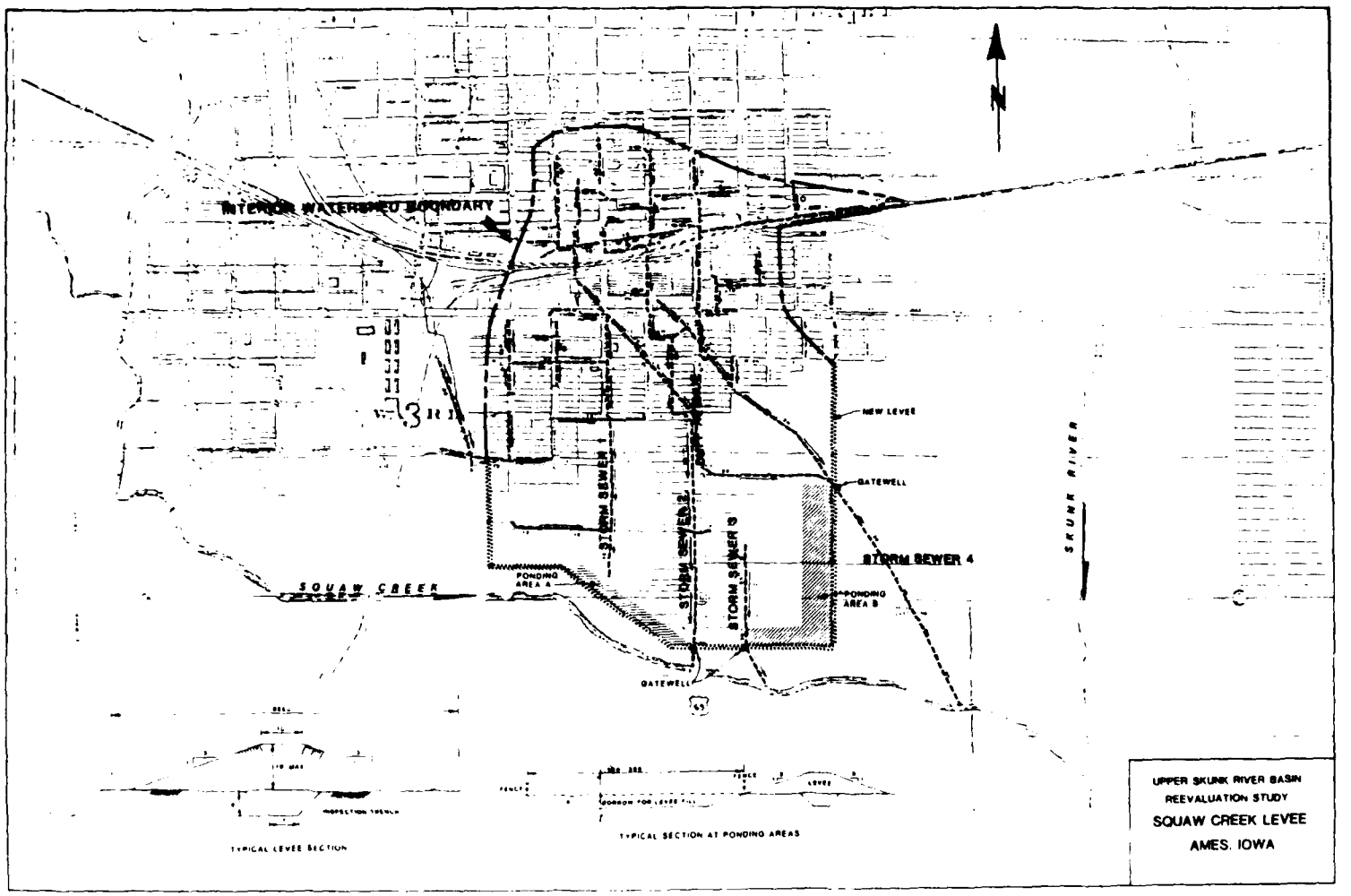

N
INTERIOR WATERSHED BOUNDARY
NEW LEVEE
GATEWELL
STORM SEWER 4
SKUNK RIVER
SQUAW CREEK
PONDING AREA A
PONDING AREA B
STORM SEWER 1
STORM SEWER 2
STORM SEWER 3
GATEWELL
TYPICAL LEVEE SECTION
TYPICAL SECTION AT PONDING AREAS
UPPER SKUNK RIVER BASIN
REEVALUATION STUDY
SQUAW CREEK LEVEE
AMES, IOWA

PLATE A-32

AMES, IOWA
(STORY COUNTY)
FLOOD PROFILES
SQUAW CREEK
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
ELEVATION IN FEET (MSL)
MILES ABOVE MOUTH
930
920
910
900
890
880
870
860
0
1
2
3
4
5

PLATE A-33

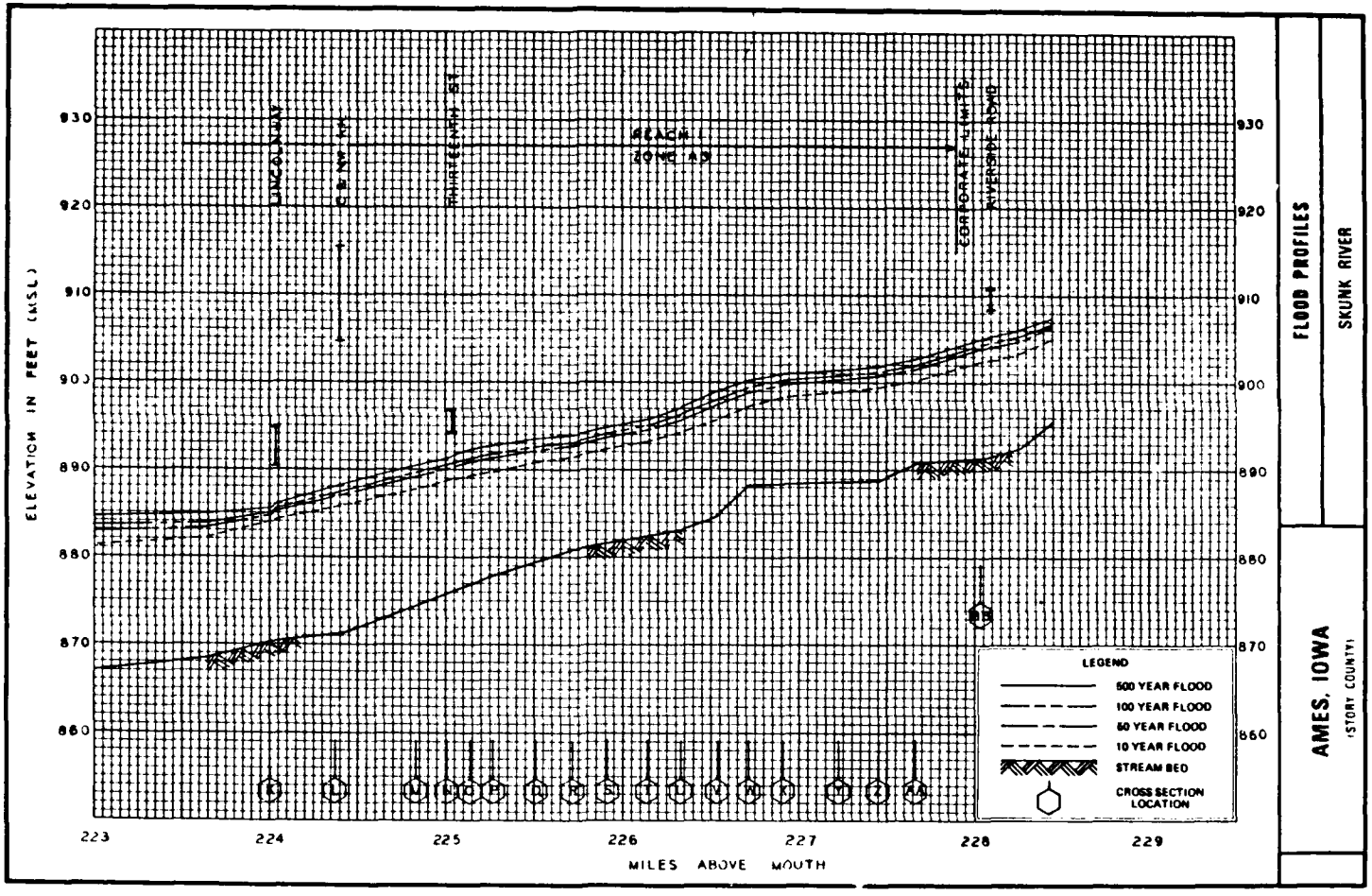

ELEVATION IN FEET (MSL)
930
920
910
900
890
880
870
860
223
224
225
226
227
228
229
MILES ABOVE MOUTH
LINCOLNWAY
C & NW R.R.
THIRTEENTH ST.
REACH 1
ZONE AE
CORPORATE LIMITS
RIVERSIDE ROAD
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
SKUNK RIVER
AMES, IOWA
(STORY COUNTY)

PLATE A-34

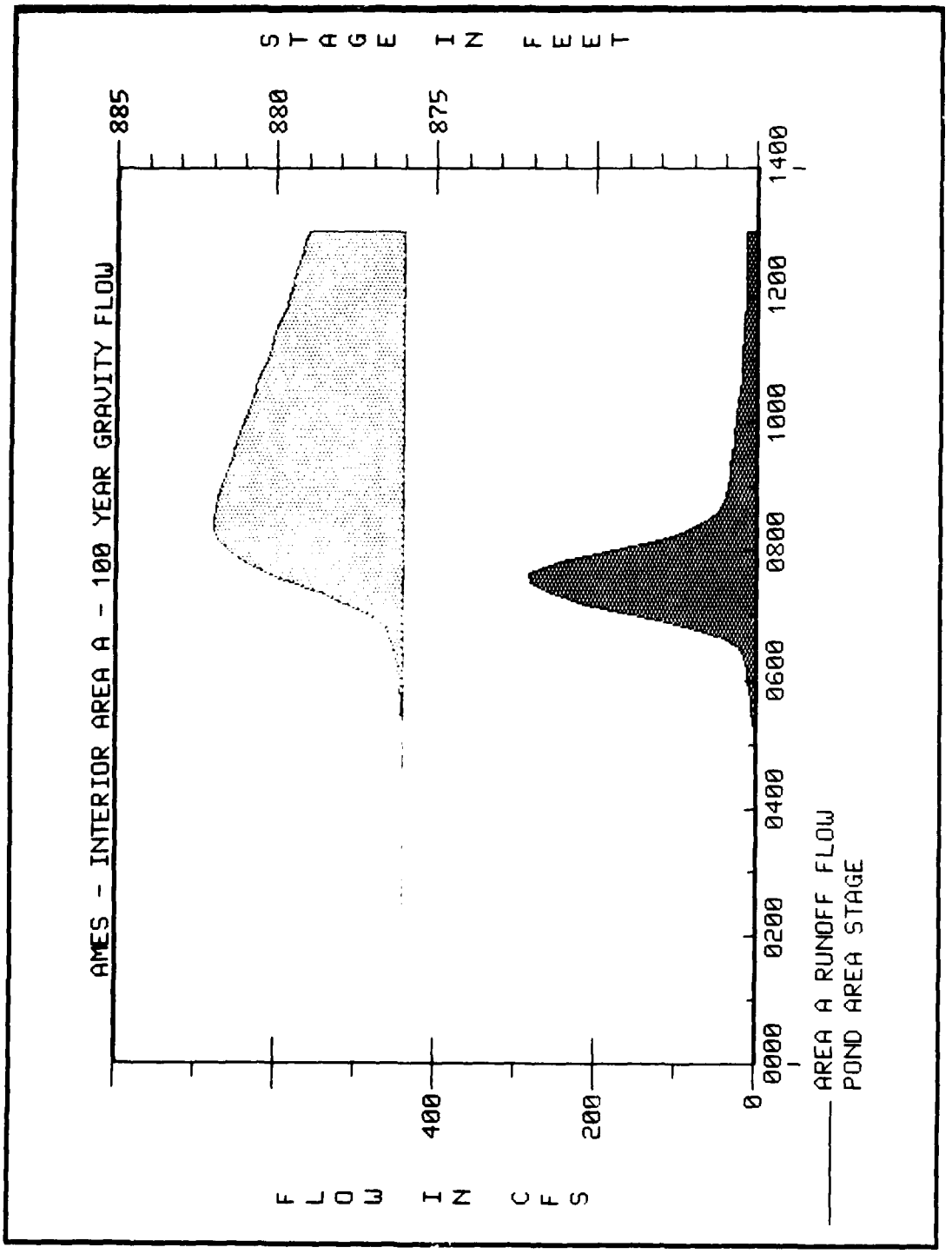

AMES - INTERIOR AREA A - 100 YEAR GRAVITY FLOW
STAGE IN FEET
885
880
875
FLOW IN CFS
400
200
0
0000
0200
0400
0600
0800
1000
1200
1400
AREA A RUNOFF FLOW
POND AREA STAGE

PLATE A-35

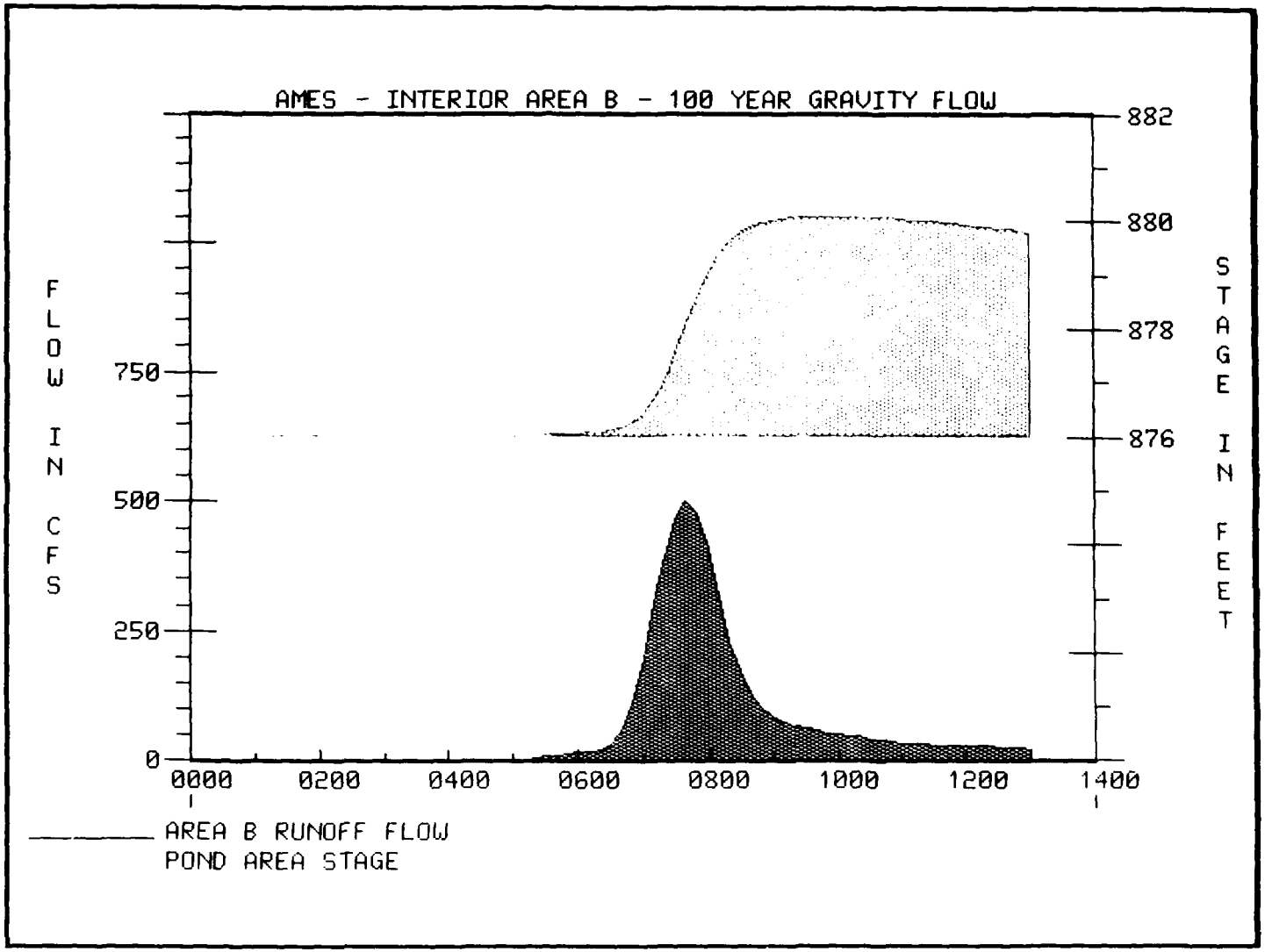

AMES - INTERIOR AREA B - 100 YEAR GRAVITY FLOW
FLOW IN CFS
STAGE IN FEET
882
880
878
876
750
500
250
0
0000
0200
0400
0600
0800
1000
1200
1400
AREA B RUNOFF FLOW
POND AREA STAGE

PLATE A-36

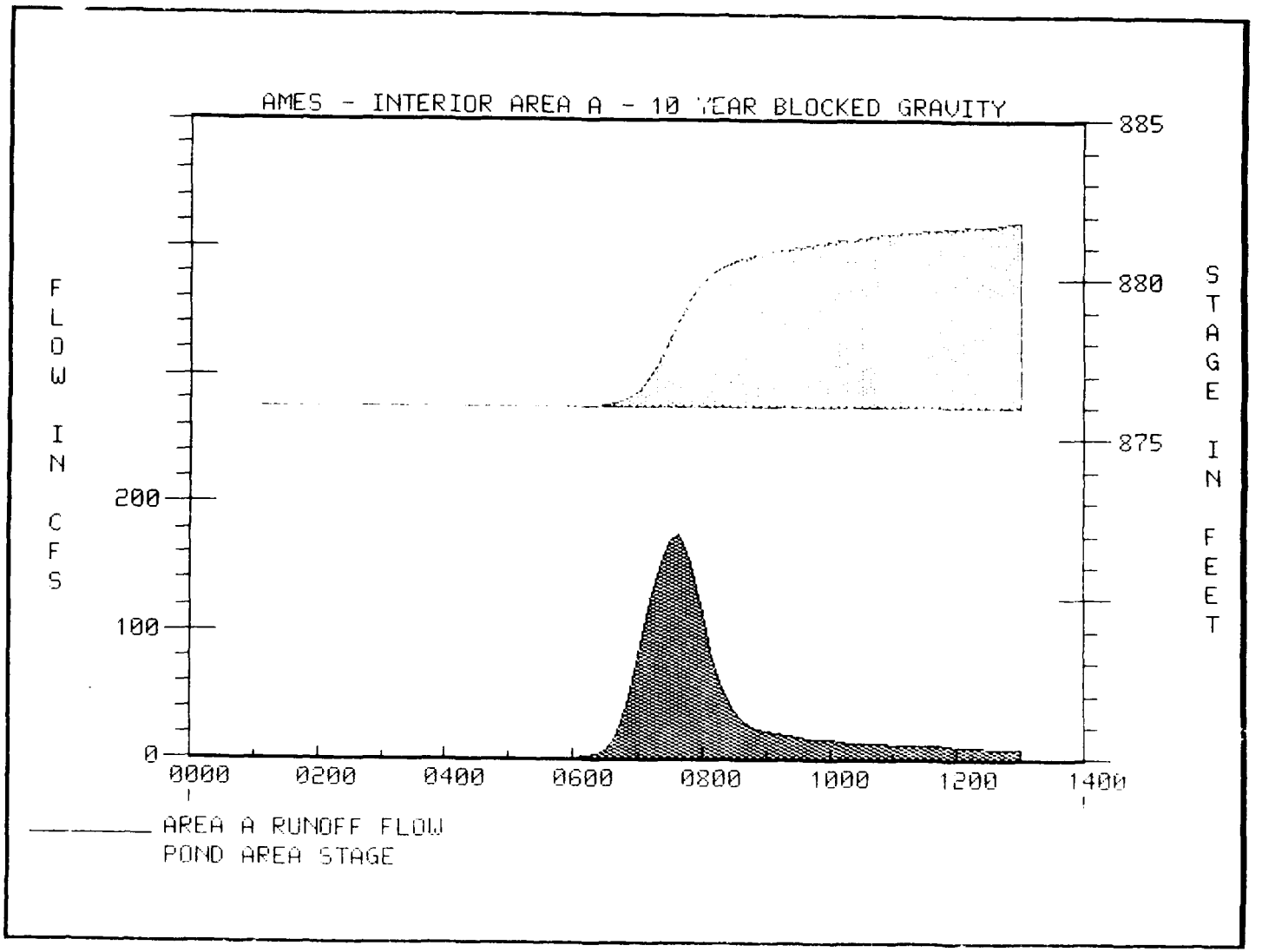

AMES - INTERIOR AREA A - 10 YEAR BLOCKED GRAVITY
FLOW IN CFS
STAGE IN FEET
885
880
875
200
100
0
0000
0200
0400
0600
0800
1000
1200
1400
AREA A RUNOFF FLOW
POND AREA STAGE

PLATE A-37

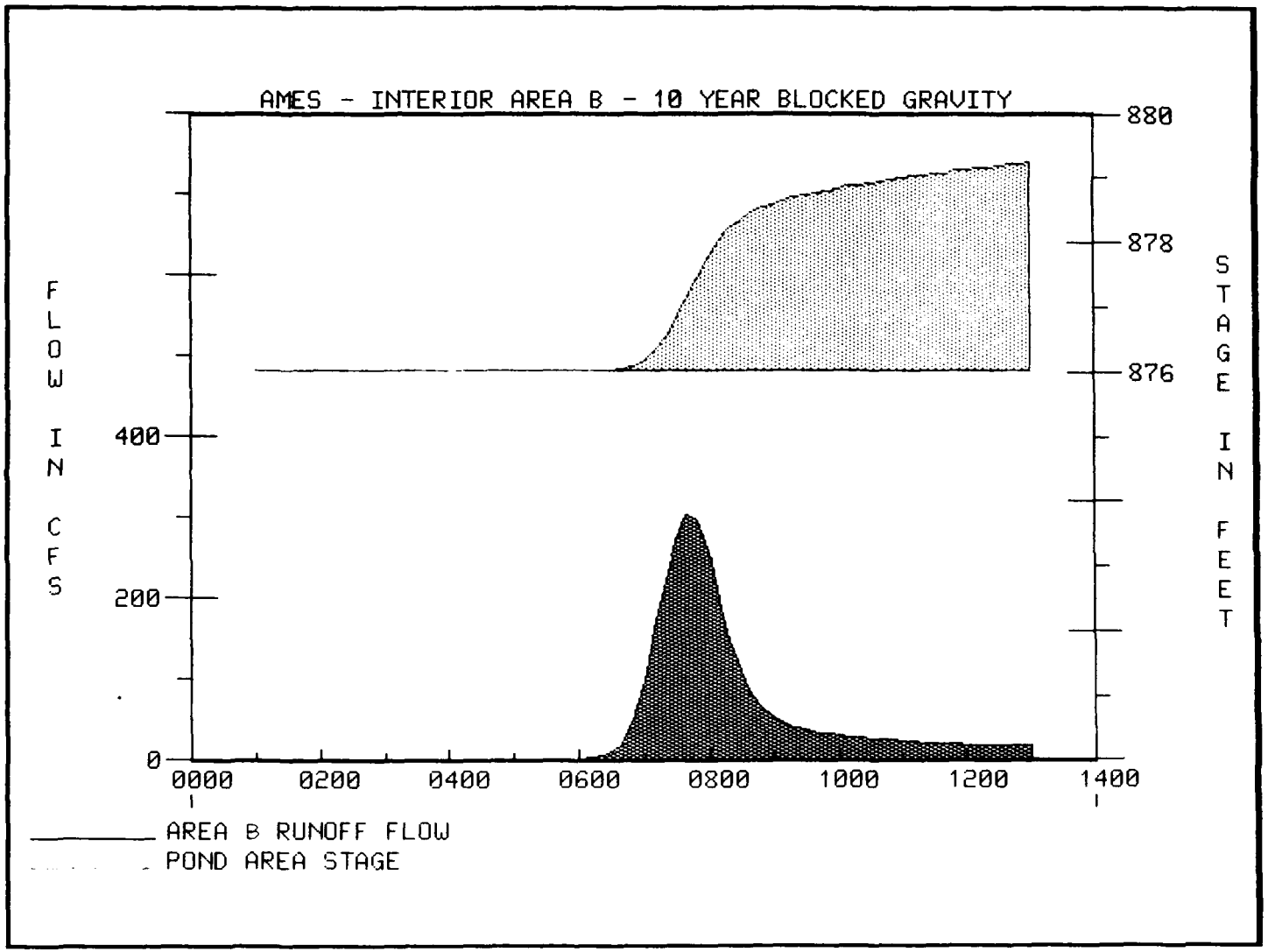

AMES - INTERIOR AREA B - 10 YEAR BLOCKED GRAVITY
FLOW IN CFS
STAGE IN FEET
400
200
0
880
878
876
0000
0200
0400
0600
0800
1000
1200
1400
AREA B RUNOFF FLOW
POND AREA STAGE

PLATE A-38

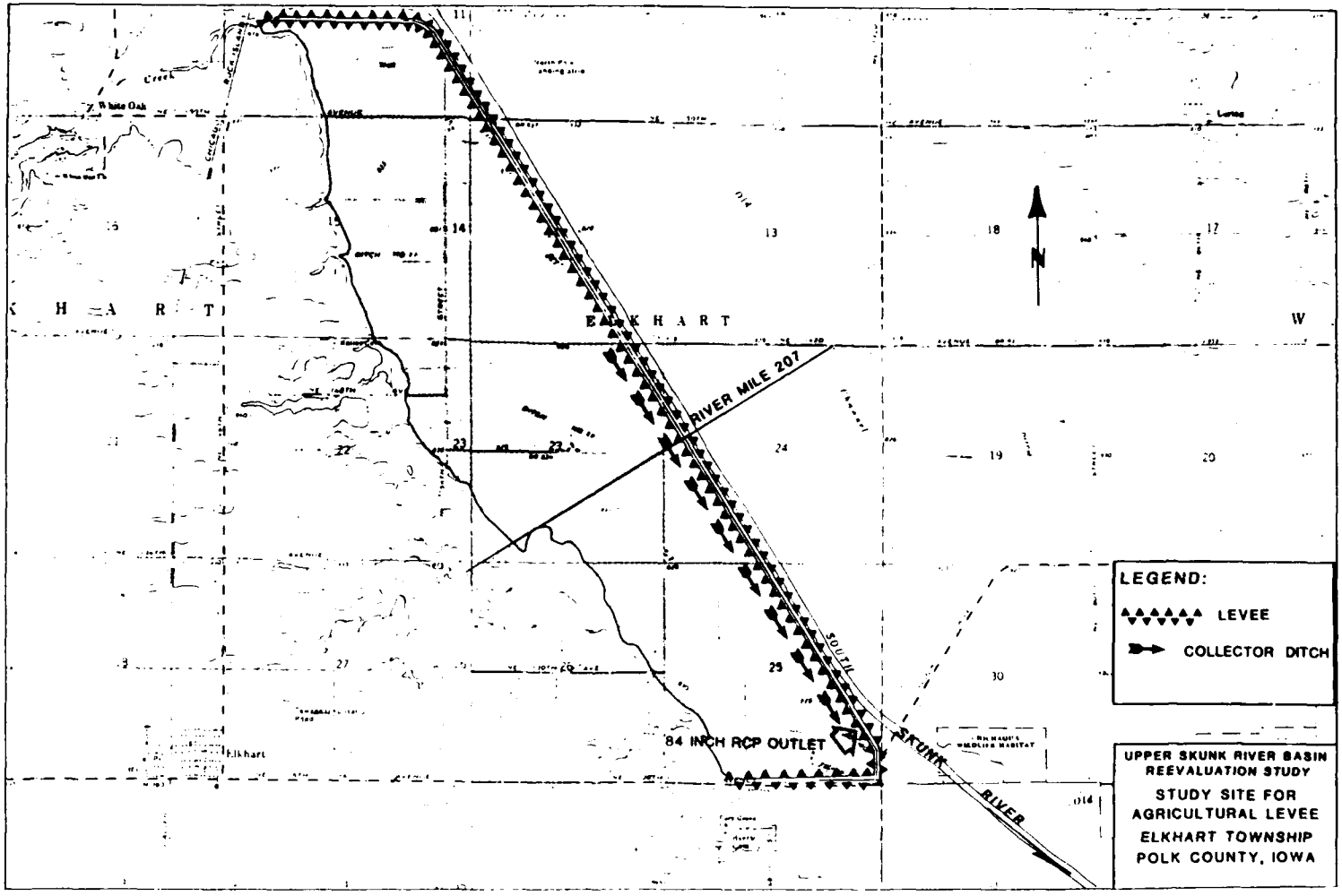

RIVER MILE 207
84 INCH RCP OUTLET
SOUTH SKUNK RIVER
N
LEGEND:
LEVEE
COLLECTOR DITCH
UPPER SKUNK RIVER BASIN
REEVALUATION STUDY
STUDY SITE FOR
AGRICULTURAL LEVEE
ELKHART TOWNSHIP
POLK COUNTY, IOWA

PLATE A-39

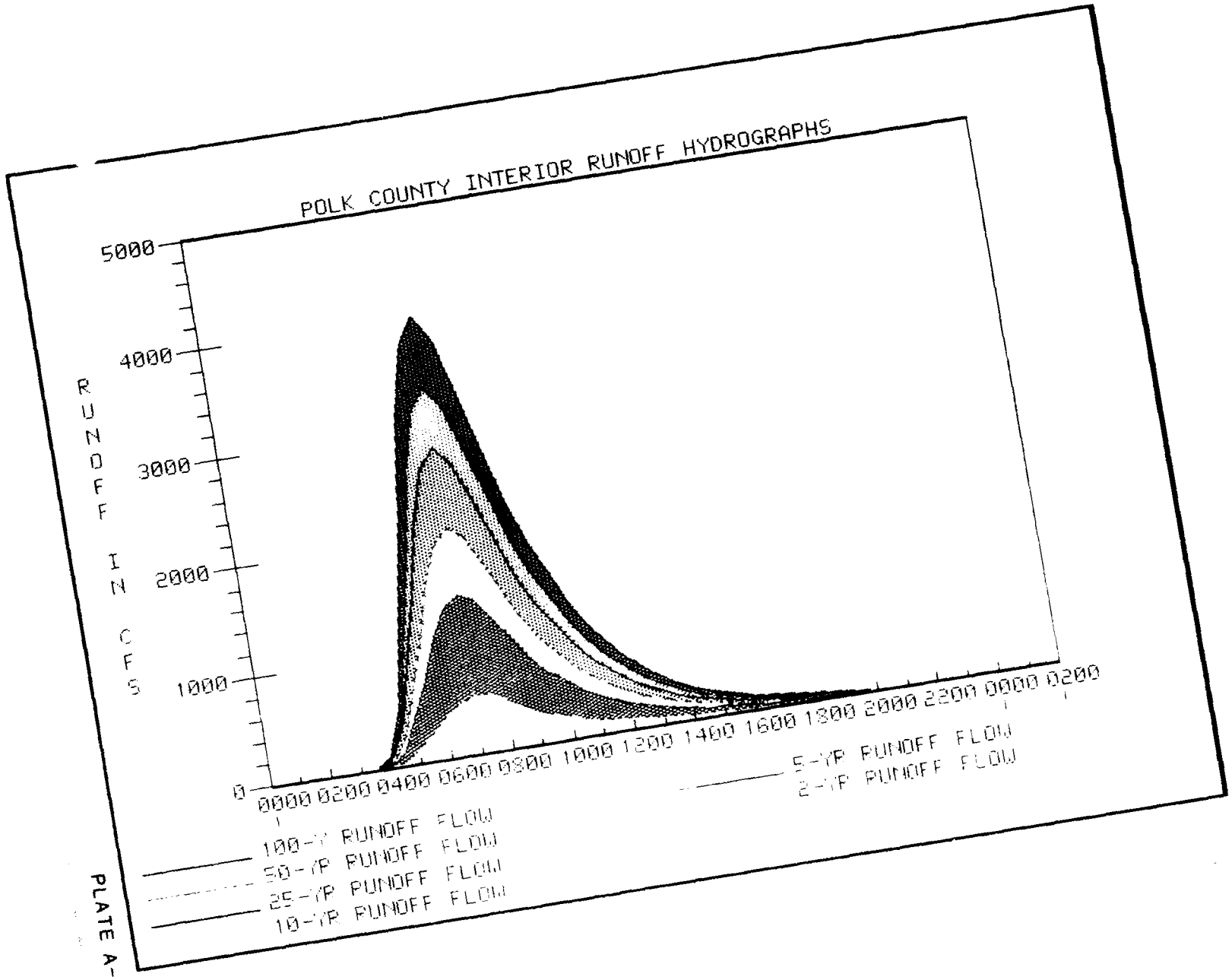

POLK COUNTY INTERIOR RUNOFF HYDROGRAPHS
RUNOFF IN CFS
5000
4000
3000
2000
1000
0
0000 0200 0400 0600 0800 1000 1200 1400 1600 1800 2000 2200 0000 0200
100-YR RUNOFF FLOW
50-YR RUNOFF FLOW
25-YR RUNOFF FLOW
10-YR RUNOFF FLOW
5-YR RUNOFF FLOW
2-YR RUNOFF FLOW

PLATE A-40

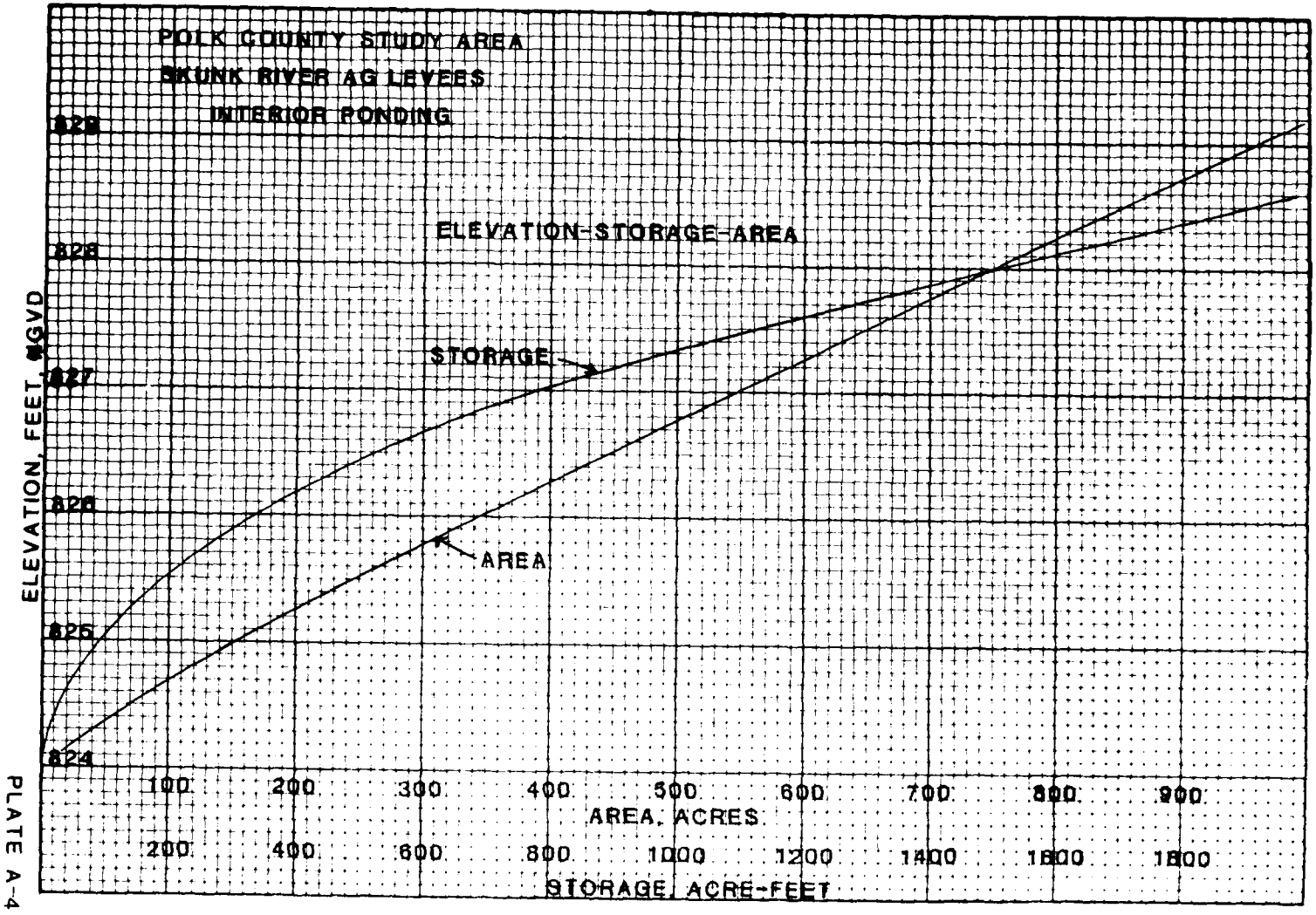

POLK COUNTY STUDY AREA
SKUNK RIVER AG LEVEES
INTERIOR PONDING
ELEVATION-STORAGE-AREA
STORAGE
AREA
ELEVATION, FEET, NGVD
828
827
826
825
824
100
200
300
400
500
600
700
800
900
AREA, ACRES
200
400
600
800
1000
1200
1400
1600
1800
STORAGE, ACRE-FEET

PLATE A-41

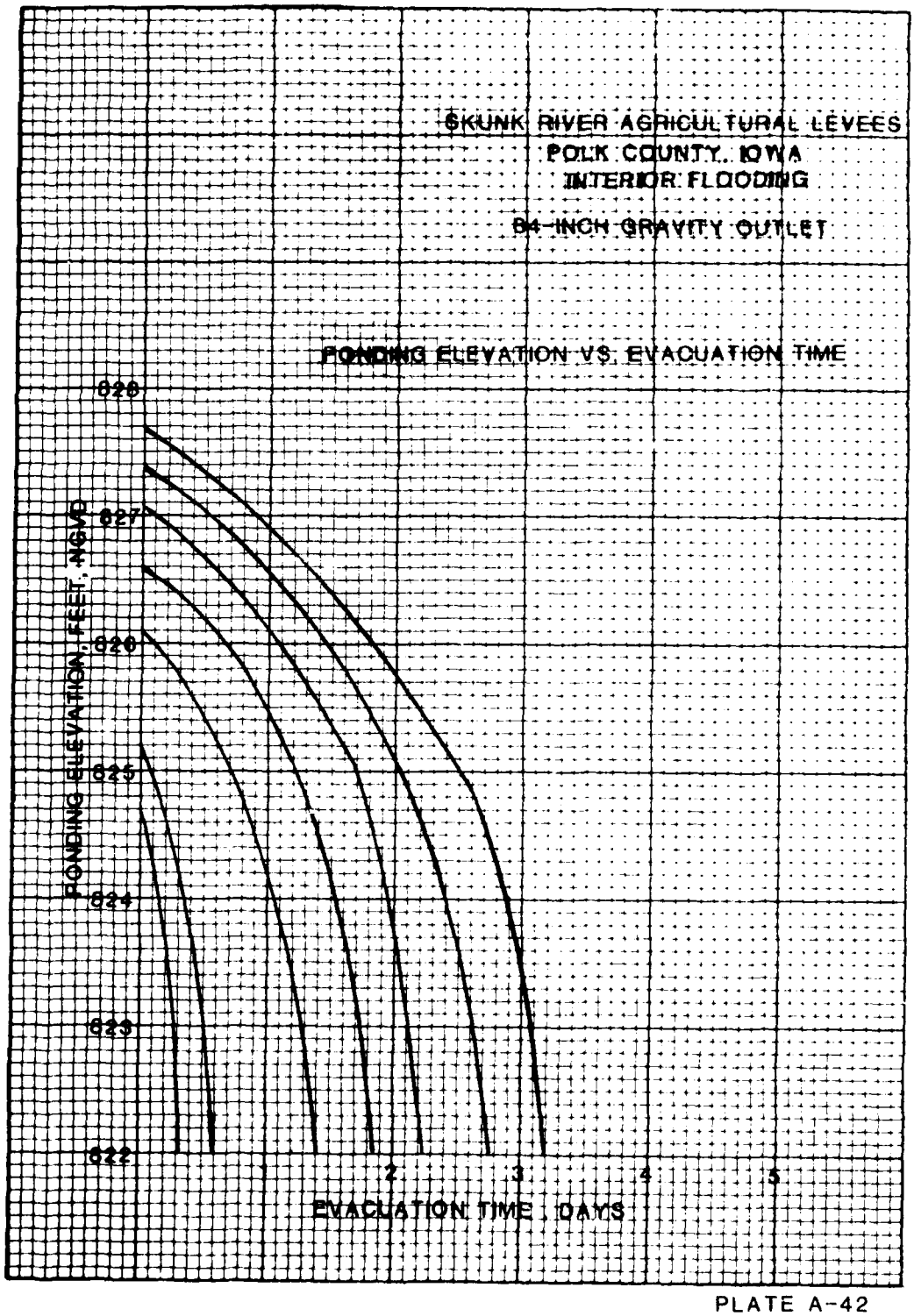

SKUNK RIVER AGRICULTURAL LEVEES
POLK COUNTY, IOWA
INTERIOR FLOODING
84-INCH GRAVITY OUTLET
PONDING ELEVATION VS. EVACUATION TIME
PONDING ELEVATION, FEET, NGVD
628
627
626
625
624
623
622
1
2
3
4
5
EVACUATION TIME, DAYS

PLATE A-42

LOSS OF VALLEY STORAGE IMPACTS

SKUNK MAINSTEM
DISCHARGE VS. DRAINAGE AREA

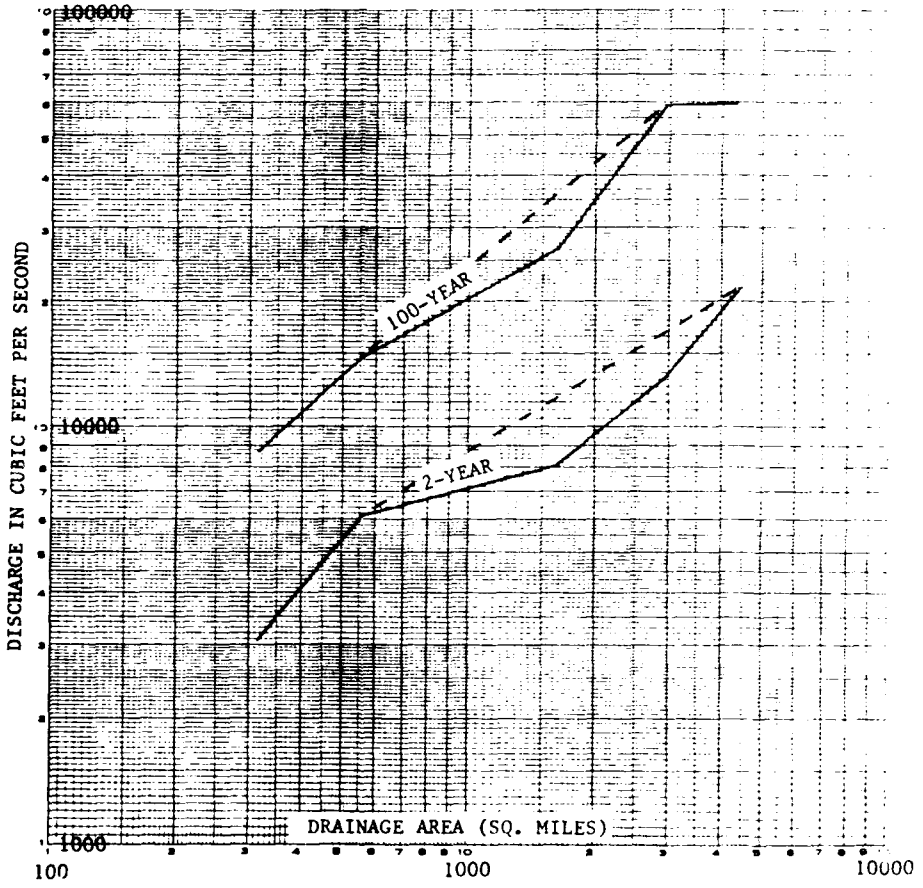
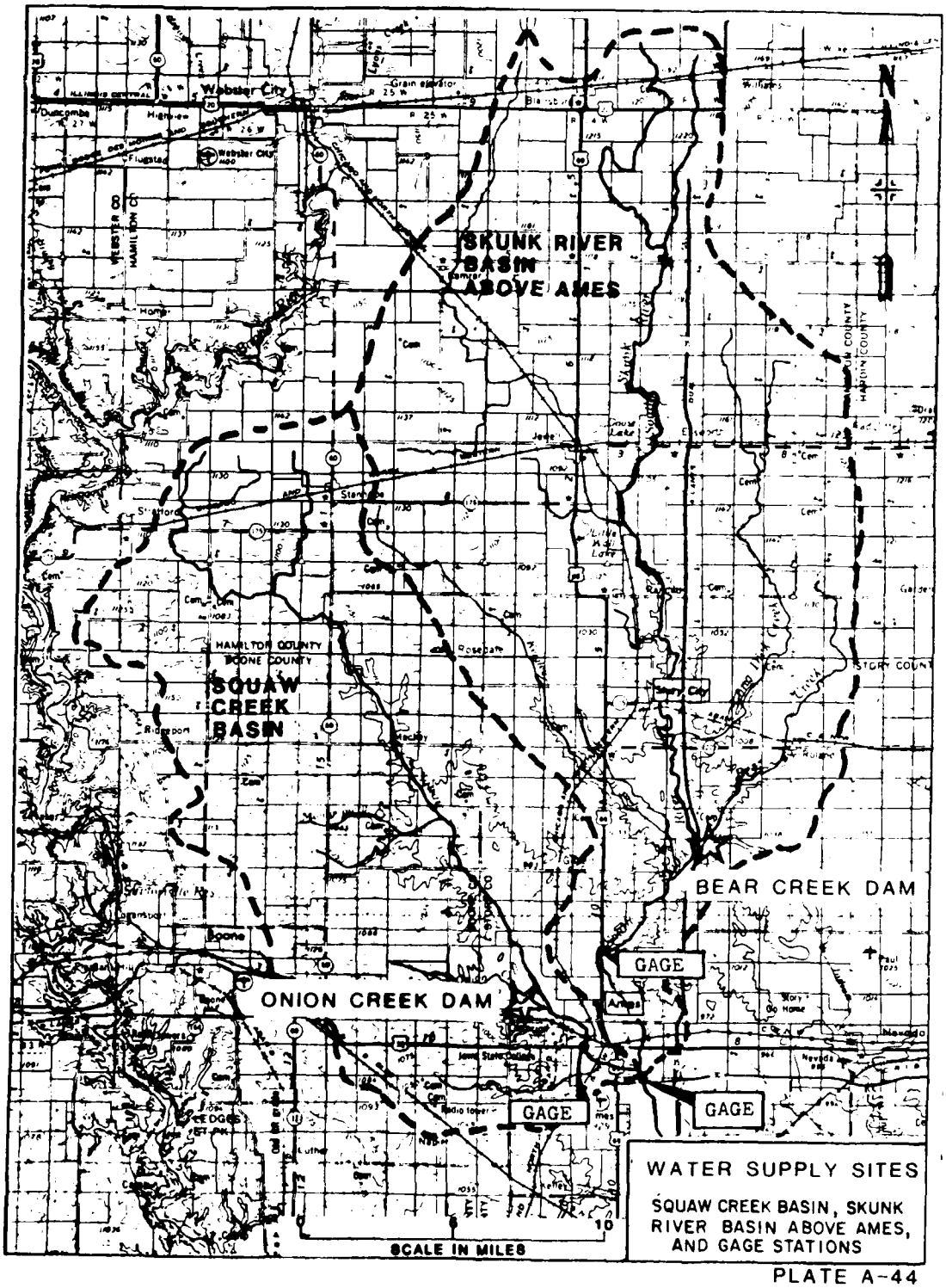


PLATE A-43



WATER SUPPLY SITES

SQUAW CREEK BASIN, SKUNK RIVER BASIN ABOVE AMES, AND GAGE STATIONS

PLATE A-44

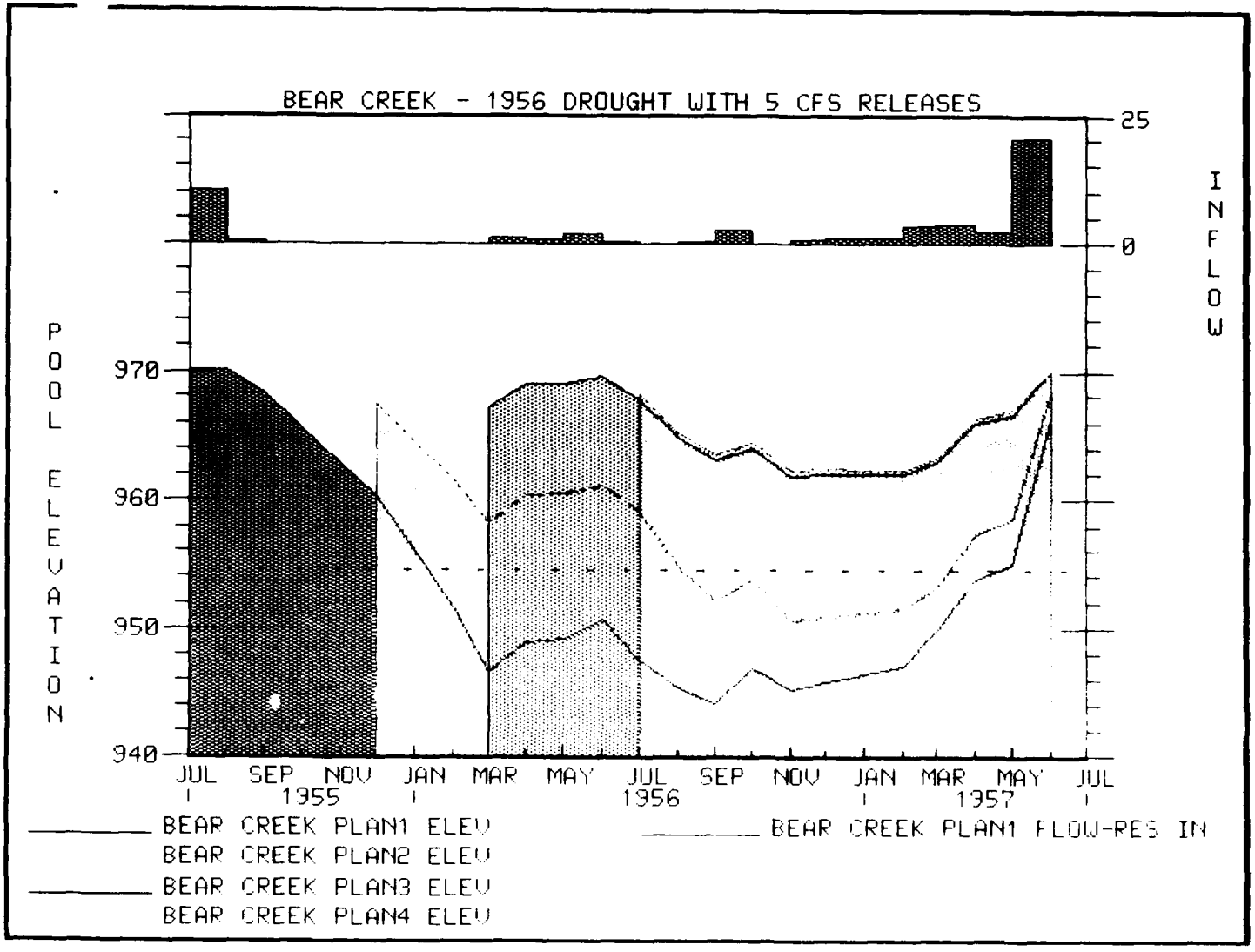

BEAR CREEK - 1956 DROUGHT WITH 5 CFS RELEASES
25
0
INFLOW
POOL ELEVATION
970
960
950
940
JUL
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
JAN
MAR
MAY
JUL
1955
1956
1957
BEAR CREEK PLAN1 ELEV
BEAR CREEK PLAN2 ELEV
BEAR CREEK PLAN3 ELEV
BEAR CREEK PLAN4 ELEV
BEAR CREEK PLAN1 FLOW-RES IN

PLATE A-45

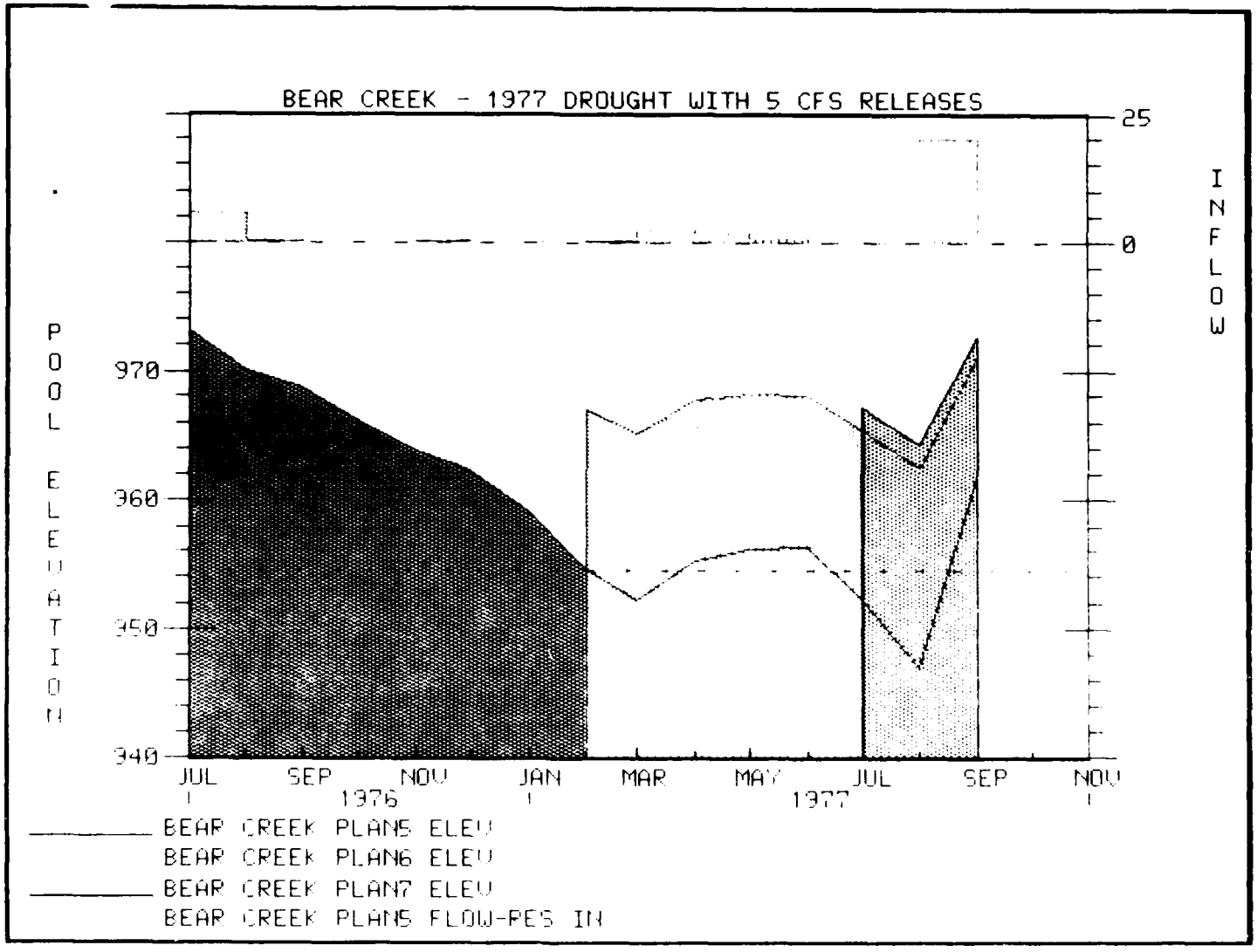

BEAR CREEK - 1977 DROUGHT WITH 5 CFS RELEASES
POOL ELEVATION
INFLOW
970
960
950
940
25
0
JUL
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
1976
1977
BEAR CREEK PLAN5 ELEV
BEAR CREEK PLAN6 ELEV
BEAR CREEK PLAN7 ELEV
BEAR CREEK PLAN5 FLOW-PES IN

PLATE A-46

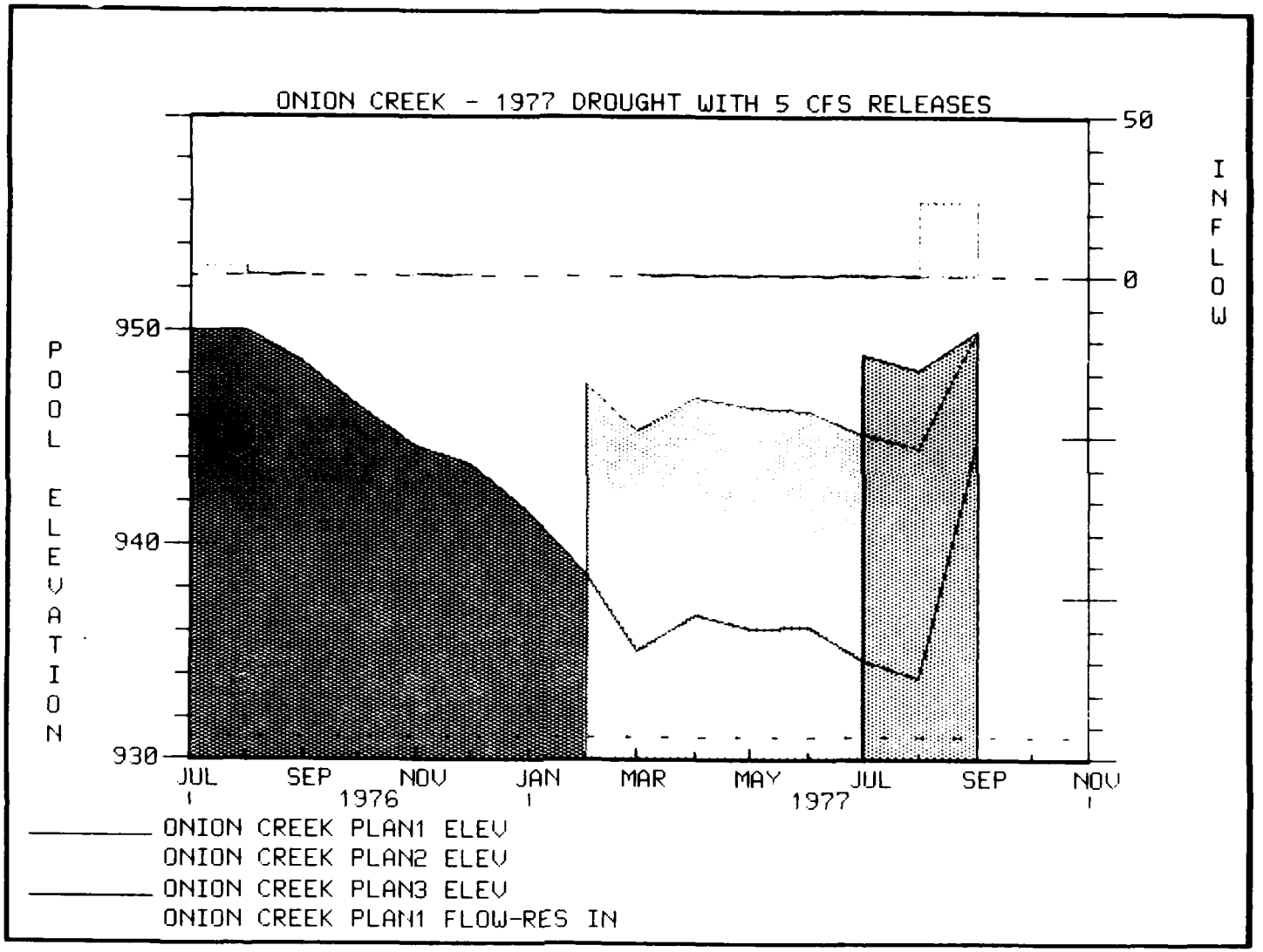

ONION CREEK - 1977 DROUGHT WITH 5 CFS RELEASES
50
0
INFLOW
POOL ELEVATION
950
940
930
JUL
SEP
NOV
JAN
MAR
MAY
JUL
SEP
NOV
1976
1977
ONION CREEK PLAN1 ELEV
ONION CREEK PLAN2 ELEV
ONION CREEK PLAN3 ELEV
ONION CREEK PLAN1 FLOW-RES IN

PLATE A-47

ECONOMIC ANALYSIS

APPENDIX B

GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

APPENDIX B
ECONOMIC ANALYSIS

TABLE OF CONTENTS

Subject	Page
SECTION 1 - INTRODUCTION	
Purpose	B-1
Background	B-1
Historical Flooding	B-1
SECTION 2 - ECONOMIC ANALYSIS	
Purpose	B-2
Methodology	B-2
SECTION 3 - TYPES OF BENEFITS	
Existing Benefits	B-3
Emergency Operation Benefits	B-3
Flood Insurance Benefits	B-3
Future Growth Benefits	B-3
SECTION 4 - PRELIMINARY SCREENING	
Background	B-4
Squaw Creek Reservoir Project	B-4
Ames Local Protection Project	B-5
Downstream Agricultural Levees	B-5
Methodology	B-5
Squaw Creek Reservoir Project	B-6
Ames Local Protection Project	B-6
Downstream Agricultural Levees	B-6
Computations	B-6
SECTION 5 - THE AMES LAKE PROJECTS	
Background	B-7
Lake Purposes	B-8

TABLE OF CONTENTS (Cont'd)

Subject	Page
SECTION 6 - THE 1968 AMES LAKE PROJECT	
Benefits	B-9
Construction Costs	B-9
Annual Costs and Benefit-Cost Ratio	B-10
SECTION 7 - THE 5.2-INCH AMES LAKE PROJECT	
Storage Requirements	B-11
Damage Reaches	B-11
Methodology	B-12
Flood Control	B-12
Water Supply	B-13
Water Quality	B-16
Fish and Wildlife	B-16
Recreation	B-18
Total Benefits	B-20
Benefits Versus Costs	B-21
SECTION 8 - THE 3.6-INCH AMES LAKE PROJECT	
Background	B-21
Benefits and Costs	B-22
SECTION 9 - THE 3.0-INCH AMES LAKE PROJECT	
Benefits for Various Purposes	B-23
Recreation Purpose	B-23
Benefits Versus Costs	B-24
SECTION 10 - COST-SHARING	
Introduction	B-25
Allocation Studies	B-25
Elements of the Allocation	B-26
Alternative Single-Purpose Costs	B-26
Separable Costs	B-27

List of Tables

No.	Title	Page
B-1	Infeasible Projects	B-4
B-2	Results Indicating Degree of Infeasibility	B-7
B-3	Storage Allocation for the 1968 GDM Report	B-8
B-4	Benefit Update, 1968 Ames Lake Project	B-9

TABLE OF CONTENTS (Cont'd)

List of Tables (Cont'd)

No.	Title	Page
B-5	Interest During Construction for the 1968 Ames Lake Project Update	B-10
B-6	Annual Costs for the 1968 Ames Lake Project Update	B-10
B-7	Yield Versus Storage Required for the 5.2-Inch Project	B-11
B-8	Damage Reaches for the 1968 Ames Lake Project on the Skunk River	B-12
B-9	Flood Control Benefits for the 5.2-Inch Ames Lake Project	B-13
B-10	Computation of Water Treatment Costs	B-14
B-11	Total Cost Estimate for Proposed Deep Well Water Supply	B-15
B-12	Annual Costs for Deep Well Least Cost Alternative	B-15
B-13	Annual Costs for Single-Purpose Lake for Water Quality Storage	B-16
B-14	Computation of Fish and Wildlife Benefits	B-17
B-15	Recreational Use for 1986, Ames Lake Project (5.2" Capacity), 100-Year Period of Analysis at 8-5/8 Percent	B-19
B-16	Recreational Use for the Greenbelt Development, 100-Year Period of Analysis at 8-5/8 Percent	B-20
B-17	A Benefit Summary for the 1986 5.2-Inch Ames Lake Project	B-21
B-18	Construction Cost Estimated by Year and Interest During Construction	B-22
B-19	Annual Costs for the 3.6-Inch Ames Lake Project	B-22
B-20	Benefit of Recreational Use for the 3.0-Inch Ames Lake Project for 100-Year Period of Analysis, Conservation Pool Elevation 940	B-23
B-21	Summary of Benefits for Various Purposes of the 3.0-Inch Project	B-24
B-22	Benefits Versus Costs Summarized Using Two Interest Rates	B-25
B-23	Single-Purpose Dam Costs for Designated Purposes	B-26
B-24	Ames Reservoir: Multiple-Purpose and Single-Purpose	B-27
B-25	3.0-Inch Ames Lake Cost Allocation Studies	B-29
B-26	Ames Reservoir - Cost Allocation by Separable Cost-Remaining Benefits Allocation of Costs to Project Purposes	B-30

List of Plates

No.	Title
B-1	Skunk River, Iowa, Topographic, Hydrologic, and Flood Damage Data
B-2	Costs Curve, Ames Lake Site

GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

APPENDIX B
ECONOMIC ANALYSIS

SECTION 1 - INTRODUCTION

PURPOSE

The purpose of this appendix is to reevaluate previous studies of the Upper Skunk River Basin and to respond to expressed concerns that have appeared because of changing needs and conditions of the basin.

BACKGROUND

The Ames Lake project near the city of Ames, Iowa, was recommended for construction by a 1968 General Design Memorandum (GDM). Further action was not taken because of lack of public support.

Documents reviewed for this appendix are listed as follows: (1) the U.S. Army Corps of Engineers' Interior Review of Reports for Flood Control and Other Purposes - Ames Reservoir, dated 10 December 1964; (2) the U.S. Army Corps of Engineers' General Design Memorandum No. 1, dated 30 September 1968; (3) the Iowa State Water Resources Research Institute - Iowa State University's Ames Reservoir Environmental Study, five volumes dated 1973; and (4) the U.S. Army Corps of Engineers' Review of Reports for Flood Control and Major Drainage, dated 1971.

All sites studied for flood control in the above reports were indicated to be infeasible, with the exception of the Gilbert Reservoir (Lake) on Squaw Creek and the Ames Reservoir (Lake) on the Skunk River.

HISTORICAL FLOODING

The flood of 1947 was the most damaging flood of the Skunk River. The flood of 1975 was the most damaging of the Squaw Creek, most of the damage occurring to the city of Ames, Iowa.

Damage surveys made for a number of past floods of the Skunk River furnished a basis of economic analysis for referenced reports. Persons whose properties were located in the floodplain of each flood were interviewed to determine the type and extent of damage. The floodplain area was divided into reaches as shown on plate B-1.

SECTION 2 - ECONOMIC ANALYSIS

PURPOSE

The purpose of this economic analysis is to compute benefits and costs of reducing flood damage for projects of various types and location throughout the basin. Projects selected for study were:

a. a Squaw Creek detention reservoir, i.e., no conservation pool

b. an Ames local protection project

c. three alternative sizes of the Ames Lake project

d. a downstream agricultural levee project

METHODOLOGY

For the purpose of preliminary analysis, information updated from past reports was used where possible without introducing excessive error. Recent preliminary survey procedures were used for collecting data involving the city of Ames, Iowa. This was needed because of the new floodplain development that has occurred since the latest flood survey recorded for the area.

For a project appearing to be a candidate for further study, two interest rates, 8-5/8 percent and 8-7/8 percent, were used for discounting purposes during the process of computing benefits and also in converting project construction costs to annual costs. The purpose of using two rates was to show a change in benefit-cost ratio (BCR) with a change in interest rate.

Computed benefits represent Average Annual Damage (AAD) reductions that a project plan is expected to produce. Backwater profiles and corresponding frequencies of occurrence needed for AAD computations were developed to provide a basis for deriving damage frequency curves to be used in the analysis.

For projects with a clear preliminary indication of infeasibility, existing and future growth benefits were the only benefits developed. For those indicating project feasibility, other benefits were considered, as needed.

SECTION 3 - TYPES OF BENEFITS

EXISTING BENEFITS

Existing benefits are those resulting from a consideration of damageable properties existing at present time. The benefits result from decreased inundation of properties that are damageable when brought into contact with water. This damage is equated to the cost necessary to restore these properties to their original condition. When inundation is reduced or prevented by a project, the damage is considered to be reduced or eliminated, and benefits are credited to the project.

EMERGENCY OPERATION BENEFITS

Emergency operation benefits are based upon emergency costs incurred during flooding. These costs are equivalent to damage, and, when correlated to frequency of occurrence, can be used to derive annual benefits.

FLOOD INSURANCE BENEFITS

These benefits occur when protection eliminates the administrative costs of the National Flood Insurance Program. The present method is to count the number of houses in the 100-year floodplain under existing conditions compared to those under project conditions. The difference in number, or the number of houses removed from floodplain status, multiplied by the annual administrative cost per house, represents the amount of flood insurance benefits provided by the project.

FUTURE GROWTH BENEFITS

Increased damage from future flood events is expected when properties experience an increase in value of damageable properties during future years. In addition to increased damage to the structure and contents of existing establishments, there may be damage to new structures that will occupy currently unoccupied land. If this future change occurs as a result of existing development trends, then an analysis of increased flood damage is used. If the change is induced as a result of the project reducing the flood hazard, then the beneficial effects of land enhancement are analyzed as location benefits.

Computations of the effects of future growth as related to residential and commercial properties were based upon OBERS projections. Because OBERS

projections include areas outside of the floodplain, results may be larger than normally expected for the floodplain. However, if infeasibility is clearly indicated, refinement of the analysis may not be necessary. For agricultural crops, future growth computations were based upon an assumption of annual growth in yields consistent with those realized for other similar agricultural areas and with historical growth rates.

SECTION 4 - PRELIMINARY SCREENING

Table B-1 lists the projects found to be infeasible through procedures used for preliminary screening. Project location is shown on plates 2 and 3 of the main report.

TABLE B-1

Infeasible Projects

Name of Project	Project Purpose
Squaw Creek Reservoir Project	Single purpose flood control; no conservation pool
Ames Local Protection Project	Flood protection of a part of the city of Ames floodplain
Downstream Agricultural Levees	Flood protection of a sample agricultural floodplain

BACKGROUND

Background information for each project listed in table B-1 is given in the following paragraphs.

SQUAW CREEK RESERVOIR PROJECT

Eight downstream reaches of Squaw Creek and four downstream reaches of the Skunk River were studied for flood control benefits derived from the reduced height of peak flows that would result from a proposed Squaw Creek Reservoir project. Possible benefits would occur for residential, commercial, public, and agricultural properties along the Squaw Creek, and for agricultural properties along the Skunk River.

AMES LOCAL PROTECTION PROJECT

Four reaches of Squaw Creek within the city of Ames, Iowa, were studied for flood control benefits resulting from urban lands being protected from Squaw Creek floods by proposed use of levees and floodwalls. Properties that would be protected include many that were damaged by the 1975 Squaw Creek flood.

DOWNSTREAM AGRICULTURAL LEVEES

A trial project site involving 25,000 feet of agricultural levee was studied to obtain information regarding two types of damage reduction: (1) a reduction of agricultural damage along the Skunk River and (2) a supplement to the damage reduction given by a proposed upstream lake project.

The selected trial project location was along the Skunk River near river mile 207, and including sections 10, 11, 14, 23, 24 and 25, Township 81 North, Range 23 West, Polk County, Iowa. The location was selected because it appeared to involve the widest floodplain in Polk County and the greatest number of acres protected per mile of levee. Therefore, it represents the best potential for a positive project.

METHODOLOGY

The methodology used for analyzing each project listed in table B-1 is given in the following paragraphs.

SQUAW CREEK RESERVOIR PROJECT

The analysis for the Squaw Creek Reservoir project used certain assumptions that were made to reduce the amounts of study time used for preliminary screening of projects. These assumptions are described as follows:

a. It was assumed that the project would remove all damage for the downstream floodplain of Squaw Creek. Complete damage removal would be unlikely. However, the assumption would overstate damage reduction and offset other preliminary computations that would understate or omit other benefits.

b. It was assumed that the project would reduce damage for the downstream floodplain of the Skunk River. Damage curves for these downstream reaches were computed by combining county crop production data with current normalized crop prices to derive damage per acre value for each reach. The damage per acre value was combined with elevation-acre

curves from the 1968 GDM report to derive damage curves for each reach. Damage curves were integrated with elevation frequency curves to produce AAD relationships needed to compute benefits.

c. Computations of the effects of future growth as related to residential and commercial properties were based upon OBERS projections for area BEA 104. For agricultural crops, future growth computations were based upon the assumption of 1 percent annual growth in yields.

AMES LOCAL PROTECTION PROJECT

Two levels of protection were computed for the Ames Local Protection project to provide some indication of benefit change with changes of protection level. Computation of "other benefits" was not considered necessary because of the low BCR's anticipated. Usual methods of converting recorded floor elevations and property values to damage data were used to produce damage-elevation curves. These were in turn related to updated frequency curves.

DOWNSTREAM AGRICULTURAL LEVEES

An index station for use of a damage-frequency curve was designated at River Mile 207. Updated flow frequency relationships were provided by the Rock Island District's Hydraulics Branch. Damage relationships were derived by combining elevation-acre information obtained from U.S. Geological Survey topographic maps with damage per acre information obtained from previous Skunk River studies. These were updated to present time to produce damage curves. Damage curves were correlated with frequency curves to produce flood control benefits. The 1 percent assumption was used to compute future benefits.

COMPUTATIONS

Table B-2 indicates the results of the computations used to determine the degree of infeasibility.

TABLE B-2

Results Indicating Degree of Infeasibility

Name of Project	Existing Benefits ($1,000)	Future Benefits ($1,000)	Total Benefits ($1,000)	Annual Cost ($1,000)	BCR (8-5/8%) Interest Rate
Squaw Creek Reservoir Project	1,769.5	236.3	2,005.8	2,573.9	0.78
Ames Local Protection Project					
100-Year Level of Protection	8.0	2.9	10.9	166.0	0.06
500-Year Level of Protection	15.8	10.1	25.9	173.5	0.16
Downstream Agricultural Levees					
25-Year Level of Protection					
Natural Flows	60.7	0.6	61.3	262.6	0.23
Modified Flows	55.6	0.6	56.2	239.5	0.23
100-Year Level of Protection					
Natural Flows	67.0	0.7	67.7	305.5	0.22
Modified Flows	61.7	0.6	62.3	278.0	0.22

These projects were not studied further because of the definite indication of infeasibility.

SECTION 5 - THE AMES LAKE PROJECTS

BACKGROUND

A project in the location selected by the 1968 GDM appeared to be the most logical site that could be used to satisfy BCR requirements and also help solve problems of major concern to the city of Ames, Iowa, and to downstream farmlands. Conditions such as floodplain development, construction costs, interest rates, hydraulic assumptions, etc., have changed since the 1968 study. Therefore, further benefit-cost analyses, optimization and allocation procedures resulting in new recommendations were needed in order to answer questions and needs of the concerned public.

The following study plan was adopted:

a. Update the 1968 Ames Lake project presented by the GDM to preliminarily determine a BCR and a basis to proceed with further study.

b. If item a. indicates a chance for feasibility, study various project sizes at the Ames site to help give preliminary indication of a lake capacity that would give an optimum financial return.

Three lake capacities were selected for study with the understanding that additional capacities may be studied if a more satisfactory indication of results was indicated. Capacities to accommodate 5.2, 3.6, and 3.0 inches of runoff were selected.

The study involved multipurpose lake projects. As was true for the 1968 GDM, the primary purpose for each lake project would be flood control. Other purposes available, such as water quality control, recreation, etc., would be updated to accommodate needs indicated by the interested public.

LAKE PURPOSES

Each lake purpose has storage requirements to be provided in the project design. Table B-3 indicates the storage requirements indicated by the 1968 GDM report for various purposes anticipated in 1968.

The table shows that the purposes of water quality control, fish and wildlife, and recreation can use storage from the same allocated pool without jeopardizing yield requirements.

TABLE B-3

Storage Allocation for the 1968 GDM Report
(5.2" Lake)

Type of Storage	Amount (Acre-Ft) of Storage
Flood Control	89,500
Water Quality Control Fish and Wildlife Recreation	26,100
Silt Storage	8,400
Total	124,000

The purposes anticipated for current requirements of lake design are essentially the same as those for the 1968 design, exceptions:

a. "Water Supply" has been added as a purpose.

b. The storage requirements of "Water Quality Control" have decreased.

Water supply was indicated to be a need based on studies made by the city of Ames. Present water supply is from wells tapping a shallow aquifer. Water demand projected by the city indicates that this source of water

will likely be dangerously reduced in the future. The city has suggested that the shallow water aquifer could be recharged by water infiltration from the lake bottom and release channel of a proposed Ames Lake.

Decreased requirements for "Water Quality Control" were indicated because of recent construction by the city of Ames of a waste water treatment plant giving high percentage reduction of biochemical oxygen demand. Since effluent from waste water treatment discharges into the Skunk River, the new plant substantially reduced the low-flow augmentation requirement for an Ames Lake Project.

SECTION 6 - THE 1968 AMES LAKE PROJECT

BENEFITS

Benefits of the 1968 GDM Ames Lake project were updated with appropriate indices. Results of this update are shown in table B-4.

TABLE B-4

Benefit Update
1968 Ames Lake Project

Project Purpose	1968 Benefits ($1,000)	Benefits Updated to 1986 ($1,000)
Flood Control	681.1	3,675.0
Water Quality Control	325.2	1,183.7
Fish and Wildlife	42.8	155.8
Recreation	341.0	1,159.1
Totals	1,390.1	6,173.6

CONSTRUCTION COSTS

Construction costs were computed using new unit quantities and updated unit prices. Interest during construction was computed as shown by table B-5.

TABLE B-5

Interest During Construction for
the 1968 Ames Lake Project Update
(8-5/8% Interest Rate)

Stage (Year)	Construction Cost ($1,000)	Time to Base Year and Payments	Factor for Compd. Interest Increase at 4-5/16% Per Payment	Accumulated Interest to Base Year ($1,000)
I 1988	10,784.3	4.5 (9)	.4623	4,985.6
II 1989	14,379.0	3.5 (7)	.3439	4,944.9
III 1990	17,973.7	2.5 (5)	.2350	4,223.8
IV 1991	14,379.0	1.5 (3)	.1351	1,942.6
V 1992	14,379.0	0.5 (1)	.04321	621.3
Total	71,895.0			16,718.2

ANNUAL COSTS AND BENEFIT-COST RATIO

Annual costs were computed in accordance with table B-6.

TABLE B-6

Annual Costs for the
1968 Ames Lake Project Update

Item	Cost ($1,000)	Annual Cost ($1,000)
Construction Costs	71,895.0	
Interest During Construction (at 8-5/8%)	16,718.2	
Total	88,613.2	
Interest and Amortization (.086272)		7,644.8
Annual Operation and Maintenance		694.9
Total		8,339.7

The BCR computed from the information in tables B-4, B-5, and B-6 was 0.74.

SECTION 7 - THE 5.2-INCH AMES LAKE PROJECT

STORAGE REQUIREMENTS

The safe yields and corresponding storage requirements estimated by the Rock Island District's Hydraulics Branch for the 5.2-inch lake project are indicated by table B-7.

TABLE B-7

Yield Versus Storage Required for the 5.2-Inch Project

Item	Safe Yield (ft^3/s) a/	Elevation (NGVD) b/	Storage Requirement (Sediment Pool Plus Seepage Included) (Acre-Feet)
Water Supply Purpose	5	942.0	19,600
Water Quality Control Purpose	2	937.6	13,600
Fish and Wildlife Purpose	10	946.0	26,800
Conservation Pool	18	950.0	34,500

a/ Cubic feet per second
b/ National Geodetic Vertical Datum of 1929

The Rock Island District's Hydraulics Branch indicated that all purposes listed in table B-7 can use storage from the 34,500 acre-foot conservation pool without jeopardizing yield requirements.

As was true of the 1968 5.2-inch project, a recreation purpose was included in the 1986 5.2-inch project. The recommended maximum drawdown of the recreation pool during periods of drought was 7 feet, from elevation 950 to elevation 943 NGVD. Storage represented by this drawdown would be shared with other purposes between elevations 946 and 943 NGVD.

The assumptions regarding the use of the conservation pool to provide storage requirements of the various secondary purposes was considered to be adequate for preliminary analysis.

Flood control, the primary purpose of the lake, requires 89,500 acre-feet between the conservation pool elevation of 950 feet NGVD and the maximum flood pool elevation of 976 feet NGVD.

DAMAGE REACHES

A description of the damage reaches used by the 1968 GDM and adopted for this 1986 Ames Lake analysis are listed in table B-8.

TABLE B-8

Damage Reaches for the 1968
Ames Lake Project on the Skunk River

Reach	Mile From	Mile To	Description
1	0.0	93.1	Mouth of Skunk River to Mouth of North Skunk River
2	93.1	179.5	Mouth of North Skunk River to Mouth of Indian Creek
3A	179.5	187.5	Mouth of Indian Creek to Jasper-Polk County Line
3B	187.5	202.1	Jasper-Polk County Line to Polk-Story County Line
4	202.1	215.0	Polk-Story County Line to Ames Damsite

METHODOLOGY

Benefits were estimated for each purpose as explained in paragraphs that follow.

FLOOD CONTROL

Damage curves for agricultural damage were determined by using elevation-acre curves derived in the 1968 Ames Reservoir (Lake) analysis and combining them with current elevation-frequency curves to derive Average Annual Acres (AAA) for each crop for each reach. AAA were multiplied by an updated dollar loss per acre to derive AAD. The AAD with the project in operation was subtracted from the AAD without the project to obtain flood control benefits.

The loss per acre used to derive AAD for crops was determined by using current normalized crop prices and yields and production costs provided by the agricultural extension services of the involved counties.

Rural property benefits were computed by updating benefits used in the 1968 GDM, using NCD recommendations for updating factors.

Commercial and residential development has been added to the Skunk River floodplain during years following the 1968 GDM report. The following method was used to identify the development, its size, and approximate data:

a. Recent topographic maps furnished by the city of Ames were used to identify new development and to estimate the ground elevations near each establishment and the approximate size of the buildings.

b. Values of buildings and contents were estimated from approximated building size and floor elevations by comparing dimensions with values calculated for similar facilities.

The above data collected for the various land-use categories were used to develop damage curves for each reach, which, when combined with current frequency curves, provided the basis for computing AAD reductions representing flood control benefits under existing conditions of development.

Flood control benefits under future conditions of development were not computed for residential land use because of the small amount of existing benefit. Similar to methods used for the Squaw Creek Reservoir analysis, computation of future growth benefits for commercial properties was based upon the OBERS projections, and future growth for agricultural crops was based upon 1 percent annual growth. Flood control benefits are summarized in table B-9.

TABLE B-9

Flood Control Benefits for
the 5.2-Inch Ames Lake Project

Benefit Type	Amount ($1,000) at 8-5/8% Interest Rate
Existing	3,286.2
Base Year Increase	191.6
Future Growth Increase	197.2
Total	3,675.0

WATER SUPPLY

The Ames Reservoir Environmental Study made in 1973 by the Iowa State Water Resources Research Institute (ISWRRI), Iowa State University, projected a need to augment the existing shallow well system by year 2000. The city of Ames is in the process of investigating a number of methods that can be used to increase the source of water for the city. One method is to allow recharging of the shallow water aquifer from the lake bottom and release channel. The lake project would be sized to satisfy the infiltration required to provide the recharge water needed.

There are a number of difficulties in the process of determining the storage pool necessary to provide the needed recharge of the aquifer: (1) There have been changes in water use trends since the 1973 report; and (2) without extensive soil studies, detailed computation of the amounts of infiltration to be expected is not possible.

The 5 cubic feet per second (ft^3/s) safe yield and corresponding 19,600 acre-feet of storage indicated by table B-7 may be low for future projections, but is assumed adequate for present time.

Water supply benefits can be represented by the least cost alternative. The city of Ames has estimated that two deep wells into the Jordan Sandstone Aquifer at a cost of $2.5 million would serve their water supply needs. The cost includes maintenance, operation, and water treatment costs for a 45-year pump life. Converted to 100-year life for comparison purposes, the cost would be approximately $3.1 million. A single-purpose lake of capacity to provide 19,600 acre-feet of storage would cost approximately $6.4 million, including annual maintenance and operation over a 100-year project life. The deep well alternative is clearly the least cost alternative.

The city has indicated a possibility of tapping another shallow aquifer, thereby providing an additional source of water. It is possible that use of a shallow aquifer in part or total would be less expensive. However, at this time, information is not available.

Benefits represented by the least cost alternative are equated to the annual cost of the alternative. To estimate annual costs, it is necessary to estimate the division between (1) first costs of constructing the two deep wells and installing their equipment and (2) the operation and maintenance costs, including water treatment needed for deep well water sources.

Operation and maintenance was based upon updated values taken from Appendix 5 of the Ames Reservoir Environmental Study prepared by ISWRRI. Appendix 5, table 5-3-10, represents annual values of estimated costs using various interest rates and a 45-year life. The annual costs of well, pump, and maintenance were converted to first costs. The result represents "comparative incremented cost" as defined by ISWRRI and does not include costs of installing and operating a well. Therefore, these costs were increased by an estimated installation and operation cost. The water treatment cost was computed by subtracting costs for well and pumps from the $2.5 million total costs estimated by the city. Table B-10 illustrates the breakdown of costs and how updated.

TABLE B-10

Computation of Water Treatment Costs

Conversion of ISWRRI Annual Costs to 1986 First Costs

Type of Unit or Operation	Annual Cost Per Unit ($1,000)	C.F. Factor to First Cost (45-yr. Life at 7%)	First Cost Per Unit ($1,000)	ENR Index Update to Year 1986	1986 First Cost Per Unit ($1,000)	Number of Units	Total First Cost ($1,000)
Deep Well	8.1	13.61	110.2	3.13	344.9	2	689.9
Deep Well Pump	1.9	13.61	25.9	3.13	81.1	2	162.2
Maintenance and Operation	1.0	13.61	13.6	3.13	42.6	2	85.2
Total							937.3

The following costs are estimated for labor to drill wells and install pumps:

Item	Cost ($1,000)
Drilling Wells	481.2
Installing Pumps	362.9
Total	844.1

Total First Costs ($1,000) = 937.3+844.1 = 1,781.4

Assuming that the remaining costs are water treatment costs, these costs can be computed as follows:

City of Ames Total Cost (in $1,000) minus Total First Costs (in $1,000) = 2,500.0 - 1,781.4 = 718.6

Table B-11 shows further itemized data to indicate how the parts make up the total.

TABLE B-11

Total Cost Estimate for Proposed Deep Well Water Supply

Item	ISWRRI Values (Yr. 1970) ($1,000)	Updated Values (ENR Index) ($1,000)	Labor to Install ($1,000)	Total Costs Including Labor ($1,000)
Two Deep Wells	220.4	689.9	481.2	1,171.1
Two Deep Well Pumps	51.8	162.2	362.9	525.1
Maintenance and Operation	27.2	85.2	N.A.	85.2
Treatment		Not Applicable		718.6
Total				2,500.0

Table B-12 adds the pump replacement and interest during construction to the total costs in order to compute annual cost.

TABLE B-12

Annual Costs (6-5/8% Interest) for Deep Well Least Cost Alternative

Item	Amount ($1,000)	Annual Cost ($1,000)
First Cost	1,696.2	
Interest During Construction (at 8-5/8%)	124.1	
Total	1,820.3	

TABLE B-12 (Cont'd)

Interest and Amortization (.086272)	157.0
Operation and Maintenance	7.1
Water Treatment	62.0
Pump Replacement (at $310,800)	
Assume replaced every 50 years	
(.01598) ($310,800) (.086272)	0.4
Total	266.5

Assuming that benefits are equal to annual costs, water supply benefits are $266,500.

WATER QUALITY

According to table B-7, the Ames Lake requirement for water quality control is 13,600 acre-feet. The least cost alternative for water quality control is a single-purpose lake with capability to provide this storage. Using plate B-2, a first cost of $3.4 million is indicated.

Annual costs were estimated as indicated by table B-13.

TABLE B-13

Annual Costs (8-5/8% Interest) for
Single-Purpose Lake for Water Quality Storage

Item	Amount ($1,000)	Annual Cost ($1,000)
First Cost	3,400.0	
Interest During Construction (at 8-5/8%)	536.2	
Total	3,936.2	
Interest and Amortization (.086272)		339.6
Operation and Maintenance		30.9
Total		370.5

Benefits can be equated to annual charges. Therefore, water quality control benefits of $370,500 are credited to the project.

FISH AND WILDLIFE

According to table B-7, the Ames Lake storage requirement for the Fish and Wildlife Purpose is 26,800 acre-feet. The 10 ft^3/s safe yield used to

compute this storage requirement results from an analysis given by the U.S. Fish and Wildlife Service in 1968, and recently verified by Rock Island District's Environmental Branch for use in 1986.

The cost indicated by plate B-1 for a lake that would provide 26,800 acre-feet of storage is approximately $9 million, representing an annual cost of $980,600. Since benefits can be equated to annual costs, this method would indicate annual benefits of $980,600.

The method of computation used by the U.S. Department of Interior, as given by a letter dated 21 November 1968 included in the 1968 Ames Reservoir GDM No. 1, gave benefits amounting $41,860 at 1968 prices, amounting to $155,800 when updated to 1986.

Table B-14 gives the computations of fish and wildlife benefits used by the U.S. Fish and Wildlife Service.

TABLE B-14

Computation of Fish and Wildlife Benefits

Item	Annual Net Value ($)
Estimated Annual Fishery Values	
Stream above Dam	-400
Stream below Dam	750
Ames Lake	35,625
Subimpoundment	4,940
Total Net	40,915
Item	**Annual Net Value ($)**
Estimated Annual Wildlife Values	
Deer	-125
Upland Game	-230
Waterfowl	1,350
Damsite Impoundment	0
Total Net	945

Total Fish and Wildlife = $40,915 + $945 = $41,860

Updated to 1986 (ENR 3.72) = $155,800

Because of the preliminary nature of the study, sources of more reliable information were not readily available. Therefore, an average value was used amounting to $568,200 [($980,600 + $155,800) ÷ 2].

RECREATION

The safe yield studies made by Rock Island District's Hydraulics Branch indicated that a 5-foot drawdown from the conservation pool level could be allowed during drought years. With the surface of the conservation pool at 950 feet NGVD, the 5-foot drawdown would place the water surface at elevation 945, and, according to pool elevation probability given by table 1-15 (Exhibit 1, Hydrology and Hydraulic Design) of the 1968 GDM report, would occur once every 2 years on the average. Drawdown to the elevation of the sediment pool (elevation 933) would occur once every 50 years. Therefore, according to the information given by the table, there appears to be some hazard potential allowed in the storage requirements assumed for the recreation pool of the 1968 analysis.

For the purpose of preliminary analysis, the basis of recreational facilities expense was assumed to be that used by the 1968 GDM, with the conservation pool considered to be established at elevation 950 feet NGVD.

Projections in Appendix 3, "Outdoor Recreation and Open Spaces," of the ISWRRI report differ from those used in the 1968 GDM and appeared to use a more detailed analysis. Therefore, the ISWRRI projections were used herein.

There are recreational benefits currently generated through public use of "greenbelt" facilities, a project constructed and used at a later date than that of the 1968 GDM report for Ames Lake. For the proposed Ames Lake project, those "greenbelt" facilities located within that part of the Skunk River Valley to be occupied by the proposed lake would be removed and replaced by the lake. Therefore, the affected greenbelt benefits are deducted from the recreational benefits that would be generated by the proposed Ames Lake.

The following assumptions and procedures were used in the computation of recreational benefits:

a. Public demand will force maximum recreational development.

b. The number of visitation days listed in Appendix 3 was modified to represent the 1986 to 2086 period and used in the analysis.

c. The current recreational value per visitor day was derived using the point system in the 1965 Water Resources Planning Act, "Principles and Guidelines for Water Related Land Resources Implementation Studies," and EC 1105-2-161, FY 1986 Reference Handbook. Using these procedures, the value of a 1986 visitor day was determined to be $3.39 for the Ames Lake, and $2.83 for the greenbelt facilities.

Benefit computations were made as indicated by table B-15.

TABLE B-15

Recreational Use for 1986
Ames Lake Project (5.2" Capacity)
100-Year Period of Analysis at 8-5/8%

Year Interval	Annual Visitation ($1,000)	Annual Benefit at $3.39 Per Visitor Day ($1,000)	Capital Value For Indicated Interval ($1,000)	Present Worth Factor ($1,000)	Present Worth ($1,000)
1986 to 1991	320.7	1,087.2	4,270.3	1.0000	4,270.3
1991 to 1996	335.5	1,137.7	4,466.7	0.6612	2,953.4
1996 to 2001	349.9	1,186.2	4,659.1	0.4372	2,036.9
2001 to 2006	366.9	1,243.8	4,885.4	0.2891	1,412.4
2006 to 2011	386.6	1,310.6	5,147.8	0.1912	984.3
2011 to 2016	408.4	1,384.5	5,438.0	0.1260	685.2
2016 to 2021	431.0	1,461.1	5,738.9	0.0836	479.8
2021 to 2026	454.9	1,542.1	6,057.0	0.0553	334.9
2026 to 2031	480.6	1,629.2	6,367.7	0.0365	233.6
2031 to 2036	508.2	1,722.8	6,760.8	0.0160	101.6
2036 to 2086	5,082.0	17,228.0	196,553.5	0.00026	50.2

Total Present Worth Value $13,542.6
Annual Value at 8-5/8% for 100 Years
= .086272 x $13,542,600 = $1,168,300

Benefit computations for the greenbelt area to be occupied by the Ames Lake were made as indicated by table B-16.

TABLE B-16

Recreational Use for the
Greenbelt Development
100-Year Period of Analysis at 8-5/8%

Year Interval	Annual Visitation ($1,000)	Annual Benefit at $2.83 Per Visitor Day ($1,000)	Capital Value For Indicated Interval ($1,000)	Present Worth Factor ($1,000)	Present Worth ($1,000)
1986 to 1991	46.5	131.6	516.9	1.0000	517.2
1991 to 1996	47.9	135.6	532.6	0.6612	352.1
1996 to 2001	49.3	139.5	547.9	0.4372	239.5
2001 to 2006	51.6	146.0	573.9	0.2891	165.9
2006 to 2011	55.8	157.9	620.2	0.1912	118.5
2011 to 2016	61.1	172.9	679.1	0.1260	85.6
2016 to 2021	65.3	184.8	725.9	0.0836	60.7
2021 to 2026	69.3	196.1	770.2	0.0553	42.6
2026 to 2031	73.4	207.7	815.8	0.0365	29.8
2031 to 2036	77.5	219.3	861.3	0.0160	13.8
2036 to 2086	775.0	2,193.2	25,022.1	0.00026	6.5

Total Present Worth Value $1,632.2
Annual Value at 8-5/8% for 100 Years
= .086272 x $1,632,200 = $140,800

The recreation benefit accredited to the Ames Lake project is $1,027,500 ($1,168,300 - $140,800).

TOTAL BENEFITS

Table B-17 summarizes the benefits that can be credited to the 5.2-inch Ames Lake project.

TABLE B-17

A Benefit Summary for the 1986
5.2-Inch Ames Lake Project

Item	Benefit ($1,000)
Flood Control	* 3,675.0
Water Supply	266.5
Water Quality Control	370.5
Fish and Wildlife	568.2
Recreation	1,027.5
Total	5,907.7

* includes future growth

BENEFITS VERSUS COSTS

Annual costs are the same as those given on table B-6 for the updated 1968 Ames Lake, in the amount of $8,339,700. The BCR is therefore 0.71 ($5,907,700 ÷ $8,339,700).

SECTION 8 - THE 3.6-INCH AMES LAKE PROJECT

BACKGROUND

To evaluate the 3.6-inch lake, a comparison of storage requirements of the 3.6-inch lake with those of the 5.2-inch lake and corresponding benefits for each purpose should be made.

Flood Control - Full flood pool for the 5.2-inch lake is at elevation 976 feet NGVD compared to a 968-foot elevation for the 3.6-inch lake. The reduced capacity for the flood control pool will not significantly impact damage for floods lower than the 100-year frequency. Damage for floods higher than the 100-year flood would be greater than that experienced for the 5.2-inch lake, but would not impact AAD significantly because of the lower frequency of occurrence of floods.

It was therefore assumed that the flood control benefit for the 3.6-inch lake would be the same as the flood control benefit for the 5.2-inch lake.

Water Supply, Water Quality, and Fish and Wildlife - Since all three of these purposes are satisfied by the storage required by the 10 ft^3/s safe yield, and the 3.6-inch lake project is considered to be in the same location as that for the 5.2-inch lake, the 3.6-inch lake benefits for these three purposes are assumed to be the same as those for the 5.2-inch lake.

Recreation - The conservation pool for the 3.6-inch lake is considered to be at elevation 949 feet NGVD as compared to conservation pool elevation 950 feet NGVD for the 5.2-inch lake. Change in recreation activity that would result from this 1-foot difference in pool elevation is considered to be minimal; therefore, use of the same recreation benefits as used for the 5.2-inch lake is considered adequate.

BENEFITS AND COSTS

Therefore, to compute the BCR for the 3.6-inch Ames Lake project, benefits equal to those of the 5.2-inch reservoir were used for all purposes.

The estimated construction costs were $48,734,000. The estimated interest during construction was computed in accordance with table B-18.

TABLE B-18

Construction Cost Estimated by Year and Interest During Construction (8-5/8% Interest)

Stage (Year)	Constr. Cost ($1,000)	Time to Base Year and Payments	Factor for Compd. Interest Increase at 4-5/16% Per Payment	Accumulated Interest to Base Year ($1,000)
I 1988	6,582	3.5 (7)	.3439	2,263.5
II 1989	10,970	2.5 (5)	.2350	2,577.9
III 1990	16,264	1.5 (3)	.1351	2,197.3
IV 1991	14,918	0.5 (1)	.0432	644.4
	48,734			7,683.1

Annual costs are computed in accordance with table B-19, using a 100-year period of analysis.

TABLE B-19

Annual Costs for the 3.6-Inch Ames Lake Project

Item	Costs ($1,000)	Annual Costs ($1,000)
Construction Cost	48,734.0	
Interest During Construction	7,683.1	
Total	56,417.1	
Interest and Amortization (.086272)		4,862.2
Annual Operation and Maintenance		471.0
Total		5,338.2

The BCR using the benefits designated for the 3.6-inch reservoir is 1.11 ($5,907,700 ÷ $5,338,200).

SECTION 9 - THE 3.0-INCH AMES LAKE PROJECT

BENEFITS FOR VARIOUS PURPOSES

Similar to the assumptions made for the 3.6-inch Ames Lake project, benefits for the 3.0-inch project are assumed to be the same as those for the 5.2-inch project, with the exception of that for the recreation purpose. The benefit computation is explained in paragraphs that follow.

RECREATION PURPOSE

The conservation pool for the 3.0-inch lake is considered to be at elevation 946 feet NGVD. This is 4 feet lower than the conservation pool for the 5.2-inch lake; therefore, recreational benefits based upon shoreline at the lower elevations were computed. The shoreline at the pool elevation after 5 feet of drawdown would be 941 feet NGVD. The visitation curve of table 3-4-2 (ISWRRI, Appendix 3) represents pool elevation 940. Using elevation 940 in lieu of elevation 941 would introduce minimal error and, therefore, was used in the analysis. The visitation curve of ISWRRI table 3-4-2 was modified to represent projections of visitations from 1986 through 2086. The computation was made by moving the shape of curve ahead 11 years and then assuming constant rate increase of 439,500 visits each 5 years (87,900 per year) between years 2036 through 2086. Computations using this modified projection are shown by table B-20.

TABLE B-20

Benefit of Recreational Use for
the 3.0-Inch Ames Lake Project for
100-Year Period of Analysis (8-5/8% Interest)
Conservation Pool Elevation 940

Year Interval	Modified Annual Visitation ($1,000)	Annual Benefit at $3.39 Per Visitor Day ($1,000)	Capital Value For Indicated Interval ($1,000)	Present Worth Factor ($1,000)	Present Worth ($1,000)
1986 to 1991	280.8	951.9	3,739.1	1.0000	3,739.1
1991 to 1996	293.5	995.0	3,908.4	0.6612	2,584.2

TABLE B-20 (Cont'd)

1996 to 2001	305.7	1,036.3	4,070.6	0.4372	1,779.7
2001 to 2006	320.0	1,084.8	4,261.1	0.2891	1,231.9
2006 to 2011	336.8	1,141.8	4,485.0	0.1912	857.5
2011 to 2016	355.2	1,204.1	4,729.7	0.1260	595.9
2016 to 2021	374.2	1,268.5	4,982.7	0.0836	416.5
2021 to 2026	394.4	1,337.0	5,251.7	0.0553	290.4
2026 to 2031	416.1	1,410.6	5,540.8	0.0365	202.2
2031 to 2036	439.5	1,489.9	5,852.3	0.0160	93.6
2036 to 2086	4,395.0	14,899.0	169,983.3	0.00026	44.2

Total Present Worth Value 11,835.2
Annual Value at 8-5/8% for 100 Years
= .086272 x 11,835,200 = 1,021.0

Because of the decreased shoreline for the 3.0-inch lake, benefits for the greenbelt area that would be replaced by the lake were assumed to be decreased by 9 percent from that computed for the 5.2-inch lake. The resulting greenbelt benefits are $127,800. Therefore, the recreation benefits for the 3.0-inch lake are $893,200 ($1,021,000 minus $127,800).

BENEFITS VERSUS COSTS

Table B-21 summarizes the benefits that can be credited to the 3.0-inch Ames Lake project.

TABLE B-21

Summary of Benefits for
Various Purposes of the 3.0-Inch Project

Item	Benefit (8-5/8%) ($1,000)	Benefit (8-7/8%) ($1,000)
Flood Control	* 3,675.0	* 3,675.1
Water Supply	266.5	274.5
Water Quality Control	370.5	381.6
Fish & Wildlife	568.2	576.7
Recreation	893.2	823.8
TOTAL	5,773.4	5,731.6

* includes future growth

A summary of benefits versus cost is given by table B-22.

TABLE B-22

Benefits Versus Costs Summarized
Using Two Interest Rates

Item	Costs (8-5/8%) ($1,000)	Costs (8-7/8%) ($1,000)	Annual Costs 8-5/8% ($1,000)	Annual Costs 8-7/8% ($1,000)
Construction Cost	42,000.0	42,000.0		
Interest During Construction	6,621.5	6,829.2		
TOTAL	48,621.5	48,829.2		
Interest & Amortization			4,194.7	4,334.5
Annual Operation and Maintenance			405.7	405.7
TOTAL			4,600.6	4,740.2
Benefits			5,773.4	5,731.6
BCR's			1.25	1.21
Net Benefit			1,172.8	991.4

SECTION 10 - COST-SHARING

INTRODUCTION

Cost-sharing studies are used to inform local interests of their expected costs based upon the benefits they would receive from the various purposes designed into the project. Such studies are performed after a decision has been made regarding the project capacity that appears to be most cost effective.

ALLOCATION STUDIES

Cost-sharing is based upon the results of cost allocation studies made to determine an equitable distribution of project costs. The method used for projects studied by the Corps of Engineers is known as "the Separable Costs-Remaining Benefits Method" conducted upon the most cost-effective project. Based upon the BCR's and net benefits for the three sizes of the Ames Lake projects studied, the 3.0-inch lake was selected as being the most cost-effective of the three, and, therefore, most acceptable for cost-sharing considerations.

ELEMENTS OF THE ALLOCATION

The elements of the allocation are (1) the alternative single-purpose annual costs, (2) the separable costs and (3) the remaining benefits. Benefits used for determining the allocation are limited by the alternative single purpose costs (the lesser of the two). Remaining benefits are the differences between separable costs and the benefits limited. The percentages of each remaining benefit as compared to the total are used to compute the allocation.

ALTERNATIVE SINGLE-PURPOSE COSTS

These costs are derived by computing the annual costs of each single-purpose lake project designed to provide the required storage for each purpose. Each single-purpose storage requirement is based upon the safe yield requirement computed by the Hydraulics Branch. After storage requirements are identified, the corresponding first cost of single-purpose reservoirs are provided through use of the acre-foot, cost curve of plate B-2.

The storage requirements, single-purpose costs, and corresponding annual costs (alternative single-purpose costs) are shown by table B-23.

TABLE B-23

Single-Purpose Dam Costs
for
Designated Purposes

Purpose	Storage Requirement (Acre-Ft)	Single-Purpose Cost ($1,000)	Annual Costs ($1,000)
Flood Control	57,600	29,000	3,159.7
Water Supply	19,600	5,500	599.2
Water Quality	13,600	3,400	370.5
Fish & Wildlife	26,800	9,000	980.6
Recreation	26,800	9,000	980.6

Table B-24 gives costs and benefits for multiple-purpose and single-purpose projects. The cost of recreation facilities is included, where appropriate.

Table B-24 also indicates that the only specific cost applicable to the study is for recreation facilities and improvements.

TABLE B-24

Ames Reservoir: Multiple-Purpose and Single-Purpose

Costs and Benefits
3.0-Inch Lake -- Cost Allocation Studies

	Item	Multiple Purpose ($1,000)	Flood Control ($1,000)	Water Supply ($1,000)	Water Quality Control ($1,000)	Fish and Wildlife ($1,000)	Recreation ($1,000)
1.	Project Investment						
	Dam Structure	37,218.4	29,000.0	5,500.0	3,400.0	9,000.0	9,000.0
	Recreation Facilities	4,781.6					4,781.6
	Interest During Construction	6,621.5	4,573.3	867.4	536.2	1,419.3	2,173.3
	Total Cost	48,621.5	33,573.3	6,367.4	3,936.2	10,419.3	15,954.9
2.	Annual Financial Cost						
	Interest and Amortization	4,194.7	2,896.4	549.3	339.6	898.9	1,376.5
	Maintenance and Operation	400.9	263.3	49.9	30.9	81.7	125.1
	Total Annual Cost	4,595.6	3,159.7	599.2	370.5	980.6	1,501.6
3.	Annual Benefits						
	Flood Control	3,675.0					
	Water Supply	266.5					
	Water Quality Control	370.5					
	Fish and Wildlife	568.2					
	Recreation	893.2					
	Total Annual Benefits	5,773.4					

SEPARABLE COSTS

Table B-25 indicates the method used to compute a separable cost for each purpose. The separable cost of a purpose is the multiple-purpose project cost minus the cost of a project with the purpose omitted. Since the purposes of water supply, water quality control, fish and wildlife, and recreation all use the same storage pool, the cost of the dam structure for the project representing each purpose omitted is the same as that for the multiple-purpose project. The cost of recreation facilities is included in each project cost omitting a purpose, with the exception of the

project that has the recreation purpose omitted. The result of these computations indicates zero separable costs for the purposes of water supply, water quality, and fish and wildlife. The separable cost for the recreation purpose is the same as the recreation facilities cost indicated for the multiple-purpose project.

Table B-26 was used to indicate the method of allocating the total costs of the multiple-purpose lake to its various purposes using the separable cost-remaining benefit method.

TABLE B-25

3.0-Inch Ames Lake Cost Allocation Studies

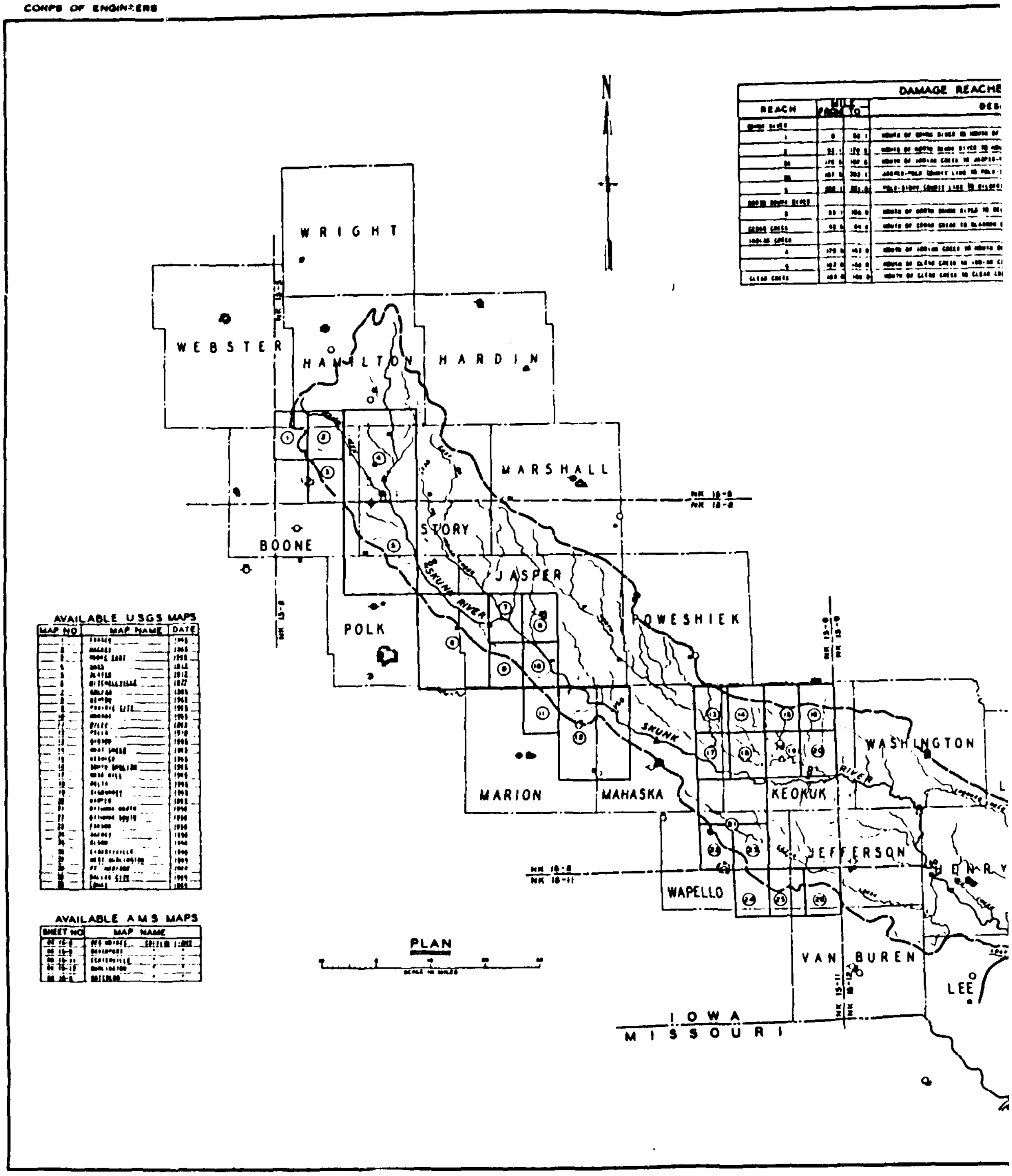
Item	Multiple Purpose ($1,000)	Alternative Project with one Purpose Omitted: Flood Control Omitted ($1,000)	Water Supply Omitted ($1,000)	Water Quality Omitted ($1,000)	Fish & Wildlife Omitted ($1,000)	Recreation Omitted ($1,000)	Separable Costs: Flood Control ($1,000)	Water Supply ($1,000)	Water Quality ($1,000)	Fish & Wildlife ($1,000)	Recreation ($1,000)
Storage Acre-Feet	77,000	27,800	77,000	77,000	77,000	77,000					
Fist Cost, Dam ($1,000)	37,218.4	7,718.4	37,218.4	37,218.4	37,218.4	37,218.4	29,500.0	0.0	0.0	0.0	0.0
Recreation Facilities ($1,000)	4,781.6	4,781.6	4,781.6	4,781.6	4,781.6	0.0	0.0	0.0	0.0	0.0	4,781.6
Project Investment ($1,000)	42,000.0	12,500.0	42,000.0	42,000.0	42,000.0	37,218.4	29,500.0	0.0	0.0	0.0	4,781.6
Interest During Const.	6,621.5	2,906.2	6,621.5	6,621.5	6,621.5	5,867.5	3,715.3	0.0	0.0	0.0	754.0
Total Project Investment	48,621.5	15,406.2	48,621.5	48,621.5	48,621.5	43,085.9	33,215.3	0.0	0.0	0.0	5,535.6
Annual Costs											
Interest & Amortization	4,194.7	1,329.1	4,194.7	4,194.7	4,194.7	3,717.1	2,865.6	0.0	0.0	0.0	477.6
Maintenance & Operation	400.9	127.0	400.9	400.9	400.9	380.5	273.9	0.0	0.0	0.0	20.4
Total Annual Costs	4,595.6	1,456.1	4,595.6	4,595.6	4,595.6	4,097.6	3,139.5	0.0	0.0	0.0	498.0
Annual Benefits											
Flood Control	3,675.0	-	3,675.0	3,675.0	3,675.0	3,675.0					
Water Supply	266.5	266.5	-	266.5	266.5	266.5					
Water Quality	370.5	370.5	370.5	-	370.5	370.5					
Fish & Wildlife	568.2	568.2	568.2	568.2	-	568.2					
Recreation	893.2	893.2	893.2	893.2	893.2	-					
Total Annual Benefits	5,773.4	2,098.4	5,506.9	5,402.9	5,205.2	4,880.2					
Net Project Benefits	1,178.0	642.3	911.3	807.3	609.6	782.6					

TABLE B-26

Ames Reservoir - Cost Allocation by Separable Cost-Remaining Benefits Allocation of Costs to Project Purposes

	Flood Control ($1,000)	Water Supply ($1,000)	Water Quality ($1,000)	Fish & Wildlife ($1,000)	Recreation ($1,000)	Total ($1,000)
1. Benefits	3,675.0	266.5	370.5	568.2	893.2	5,773.4
2. Alternative Single Purpose Annual Costs	3,159.7	599.2	370.5	980.6	1,501.6	6,611.6
3. Benefits Limited by Alternative Costs (lesser of items 1 and 2)	3,159.7	266.5	370.5	568.2	893.2	5,258.1
4. Separable Costs	3,139.5	0.0	0.0	0.0	498.0	3,637.5
5. Remaining Benefits (items 3-4)	20.2	266.5	370.5	568.2	395.2	1,620.6
6. Percentage of item 5	1.2	16.4	22.9	35.1	24.4	100.0
7. Joint Costs $4,595.6 - $3,637.5 x item 6	11.5	157.1	219.4	336.3	233.8	958.1
8. Total Allocations (items 4 + 7)	3,151.0	157.1	219.4	336.3	731.8	4,595.6
9. Total O & M Costs, in proportion to 6	4.8	65.7	91.8	140.8	97.8	400.9
10. Net Annual Costs (items 8-9)	3,146.2	91.4	127.6	195.5	634.0	4,194.7
11. Project Investment (item 10 ÷ .086272)	36,468.4	1,059.4	1,479.0	2,266.1	7,348.9	48,621.8
12. Project First Cost (item 11 ÷ 1.08625)	33,572.9	975.3	1,361.6	2,086.1	6,765.3	44,761.2
13. Approximate Benefit - Cost Ratio (item 1 ÷ 8)	1.17	1.70	1.69	1.69	1.22	1.26
14. Recommended Project First Cost Allocation in Proportion to Item 12	31,483.2	913.5	1,275.1	1,953.8	6,336.5	42,000.0
Percent of Project First Cost	75.0	2.2	3.0	4.7	15.1	

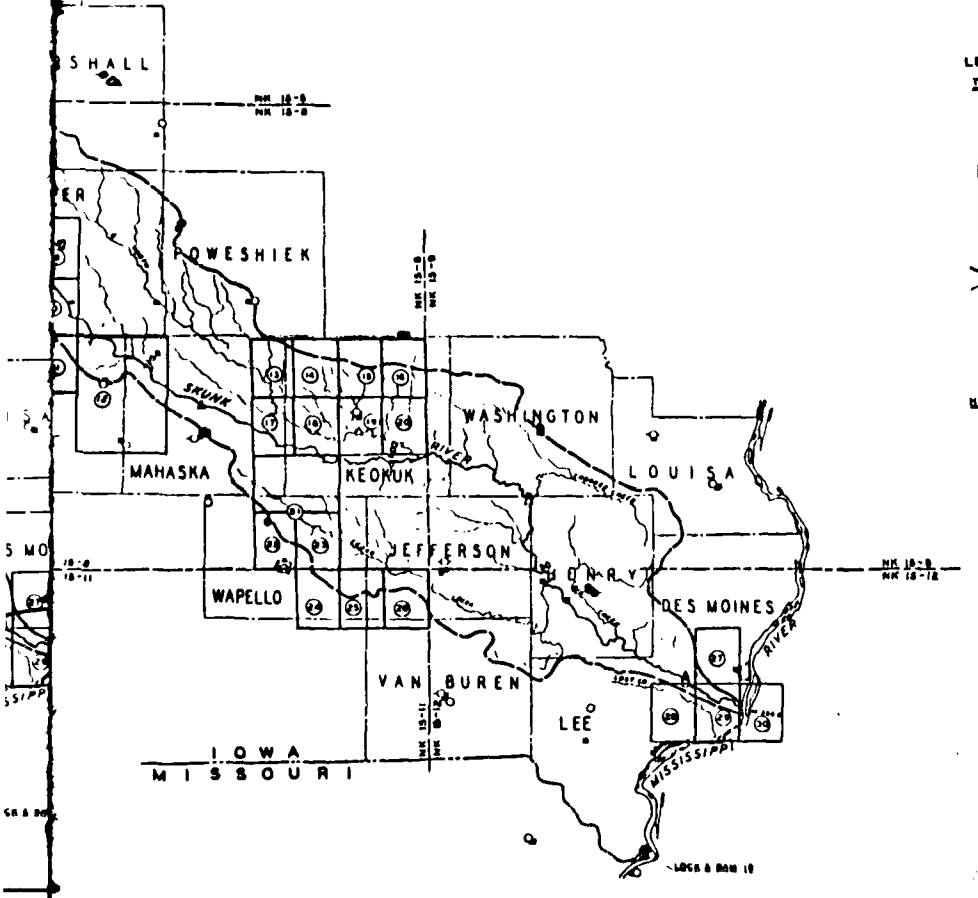
CORPS OF ENGINEERS



U S ARMY

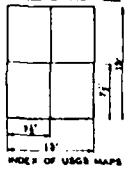
DAMAGE REACHES			
REACH	MILES ABOVE MOUTH FROM	TO	DESCRIPTION
Skunk River			
	1	0	88.1	MOUTH OF SKUNK RIVER TO MOUTH OF NORTH SKUNK RIVER
	2	88.1	179.5	MOUTH OF NORTH SKUNK RIVER TO MOUTH OF INDIAN CREEK
	3A	179.5	187.0	MOUTH OF INDIAN CREEK TO JASPER-POLK COUNTY LINE
	3B	187.0	268.1	JASPER-POLK COUNTY LINE TO POLK-STORY COUNTY LINE
	4	268.1	321.0	POLK-STORY COUNTY LINE TO GILBERT DAM SITE
North Skunk River			
	A	88.1	166.0	MOUTH OF NORTH SKUNK RIVER TO DELTA DAM SITE
Cedar Creek		88.5	94.0	MOUTH OF CEDAR CREEK TO OLDHAM DAM SITE
Indian Creek			
	A	179.5	187.0	MOUTH OF INDIAN CREEK TO MOUTH OF CLEAR CREEK
	B	187.0	196.0	MOUTH OF CLEAR CREEK TO INDIAN CREEK DAM SITE
Clear Creek		187.0	196.0	MOUTH OF CLEAR CREEK TO CLEAR CREEK DAM SITE

VICINITY MAP



LEGEND

TOPOGRAPHIC DATA:



INDEX OF USGS MAPS

MAPS	CONTOUR INTERVAL	SCALE
USGS 7½'	10 FOOT	1:24,000
USGS 15'	20 FOOT	1:62,500
ARMY MAP SERVICE (AMS)*	50 FOOT	1:250,000

*AMS COVERS ENTIRE BASIN

OUTLINE OF WATERSHED

MILES ABOVE MISSISSIPPI RIVER

URBAN AREA (FOR NAMES SEE PLATE 1)

AVAILABLE U S G S MAPS

HYDROLOGIC DATA:

GAGES: RECORDING	GAGES: NON-RECORDING	
●	○	PRECIPITATION STATION
●	○	PRECIPITATION AND TEMPERATURE
◆	◇	PRECIPITATION, TEMPERATURE AND EVAPORATION
●	●	COMPLETE METEOROLOGICAL STATION
▲	△	RIVER GAGE RATED
	∴	DISCONTINUED RIVER GAGE

REFERENCE:

1 MILEAGES ARE TAKEN FROM HOUSE DOCUMENT NO 179, 72ND CONGRESS, 1ST SESSION

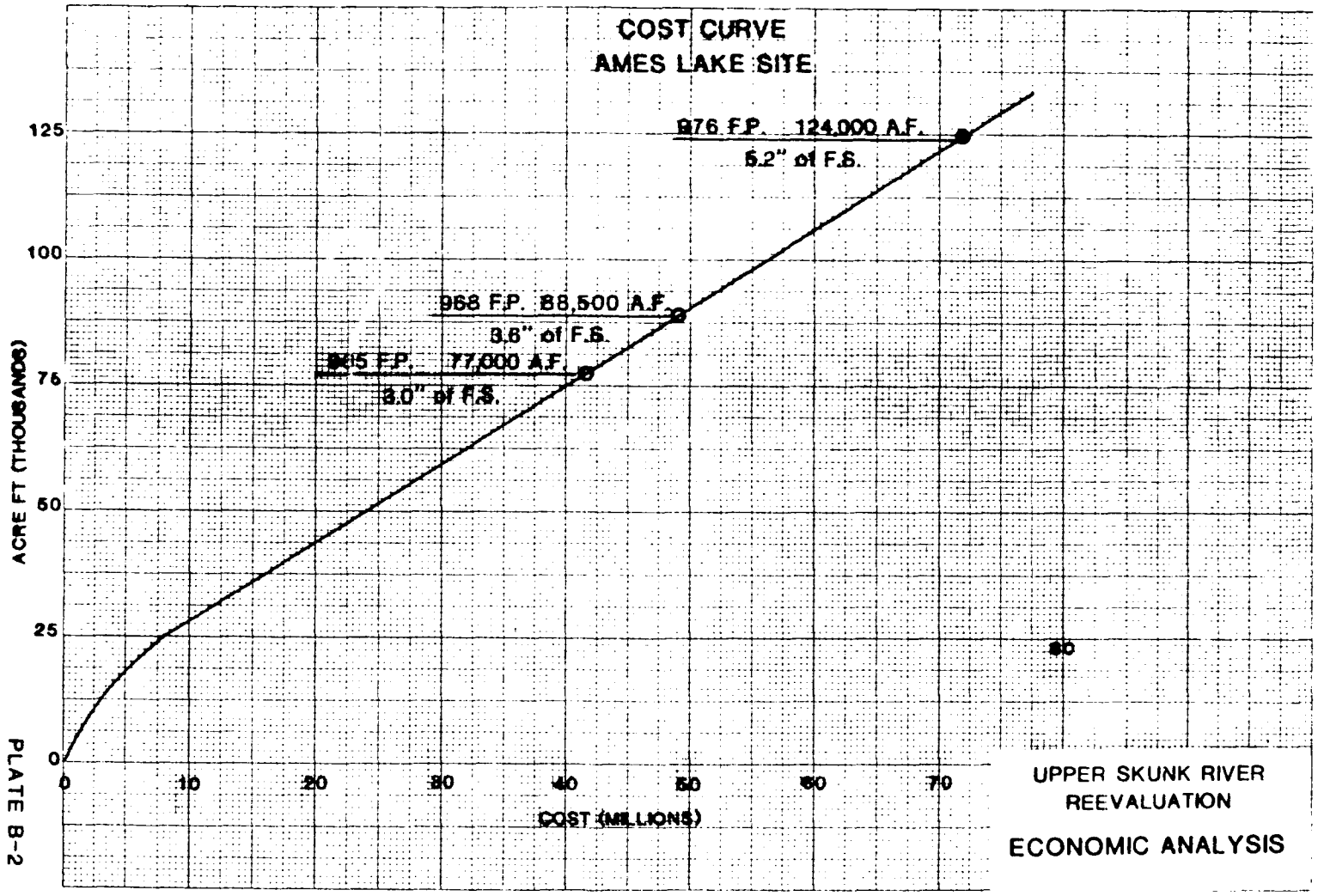
SKUNK RIVER, IOWA

TOPOGRAPHIC, HYDROLOGIC, AND FLOOD DAMAGE DATA

SCALE AS SHOWN

CORPS OF ENGINEERS U S ARMY — ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

PLATE B-1


COST CURVE
AMES LAKE SITE
976 F.P. 124,000 A.F.
5.2" of F.S.
968 F.P. 88,500 A.F.
3.6" of F.S.
965 F.P. 77,000 A.F.
3.0" of F.S.
ACRE FT (THOUSANDS)
0
25
50
75
100
125
0
10
20
30
40
50
60
70
80
COST (MILLIONS)
PLATE B-2
UPPER SKUNK RIVER
REEVALUATION
ECONOMIC ANALYSIS

APPENDIX C

PERTINENT CORRESPONDENCE

GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

APPENDIX C
PERTINENT CORRESPONDENCE

TABLE OF CONTENTS

Correspondence	Page
Letter from Rock Island District, dated 15 February 1984, seeking views and recommendations on the authorized Ames Lake project and other water resource needs in the Skunk River Basin	C-1
Letter from Rock Island District, dated 11 May 1984, recommending that the Ames Lake, Iowa, project be reclassified from "inactive" to "active." Letter references Ames, Iowa, City Council resolution to reactivate the Ames Lake project, emphasizing water supply and low-flow augmentation needs. First, second, and third endorsements are attached.	C-7
Notice of Reevaluation of Ames Lake Project, Skunk River Basin, dated 27 September 1984	C-13
Letter from Keokuk County Board of Supervisors, dated 20 March 1985	C-15
Letter from Rock Island District to U.S. Department of Agriculture - Soil Conservation Service, dated 30 April 1985, with Scope of Work	C-16
Letter from Rock Island District to U.S. Department of Agriculture - Soil Conservation Service, dated 18 June 1985, with Revised Scope of Work	C-20
Letter from Iowa Department of Water, Air and Waste Management, dated 14 August 1985	C-23
Letter from U.S. Department of Agriculture - Soil Conservation Service, dated 17 January 1986	C-25
Letter from Iowa State Historic Preservation Officer, dated 2 April 1986	C-26
Planning Aid Letter, dated 10 April 1986, from U.S. Department of the Interior, Fish and Wildlife Service	C-27
Letter from Iowa Department of Natural Resources, dated 27 August 1986	C-44

TABLE OF CONTENTS (Cont'd)

Correspondence

Letter from Mayor of Ames, Iowa, dated 9 September 1986 C-45

Resolution from the City Council, Story City, Iowa, dated 6 October 1986 C-47

Resolution from the Story County Board of Supervisors, dated 4 November 1986 C-49

Resolution from the Iowa Association of Soil Conservation District Commissioners, dated 26 January 1987 C-50

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT. CORPS OF ENGINEERS
CLOCK TOWER BUILDING
ROCK ISLAND. ILLINOIS 61201

REPLY TO ATTENTION OF:

February 15, 1984

Planning Division

SEE DISTRIBUTION

The purpose of this letter is to seek your views and recommendations on the authorized Ames Lake project and other water resource needs in the Skunk River basin.

Congress authorized construction of the Ames Lake, Iowa, project in 1961 based on a feasibility study of the Skunk River basin directed by Congress. The authorized project consists of a dam and lake located on the Skunk River about 5 miles north of Ames, Iowa, shown on the enclosed map. The authorized purposes of the project are urban and rural flood control, low flow augmentation of the Skunk River during dry periods, and recreation on the lake and adjacent project lands. Water supply was not authorized but was recommended for addition when the need developed. The project was placed in an inactive status in 1973 because State and local interests did not support further work.

Since 1973, the city of Ames has recommended reassessment of reservoir sites in the Skunk River basin with special emphasis on water supply. In meetings with local officials in November 1983, a projected need fo additional water supply and an existing need for low flow augmentation of the Skunk River during dry periods was cited. Rural and urban flooding is a continuing problem. For example, flood damages from the June 1975 flood on Squaw Creek and the Skunk River below Ames, are estimated at more than $7 million at current price levels.

There are two options for Corps of Engineers' future activities in the Skunk River basin:

a. Reactivate the Ames Lake project, review project recommendations, and revise those recommendations to satisfy existing needs. Complete the basin study and report to Congress on any additional water resource programs which meet the criteria for Federal participation.

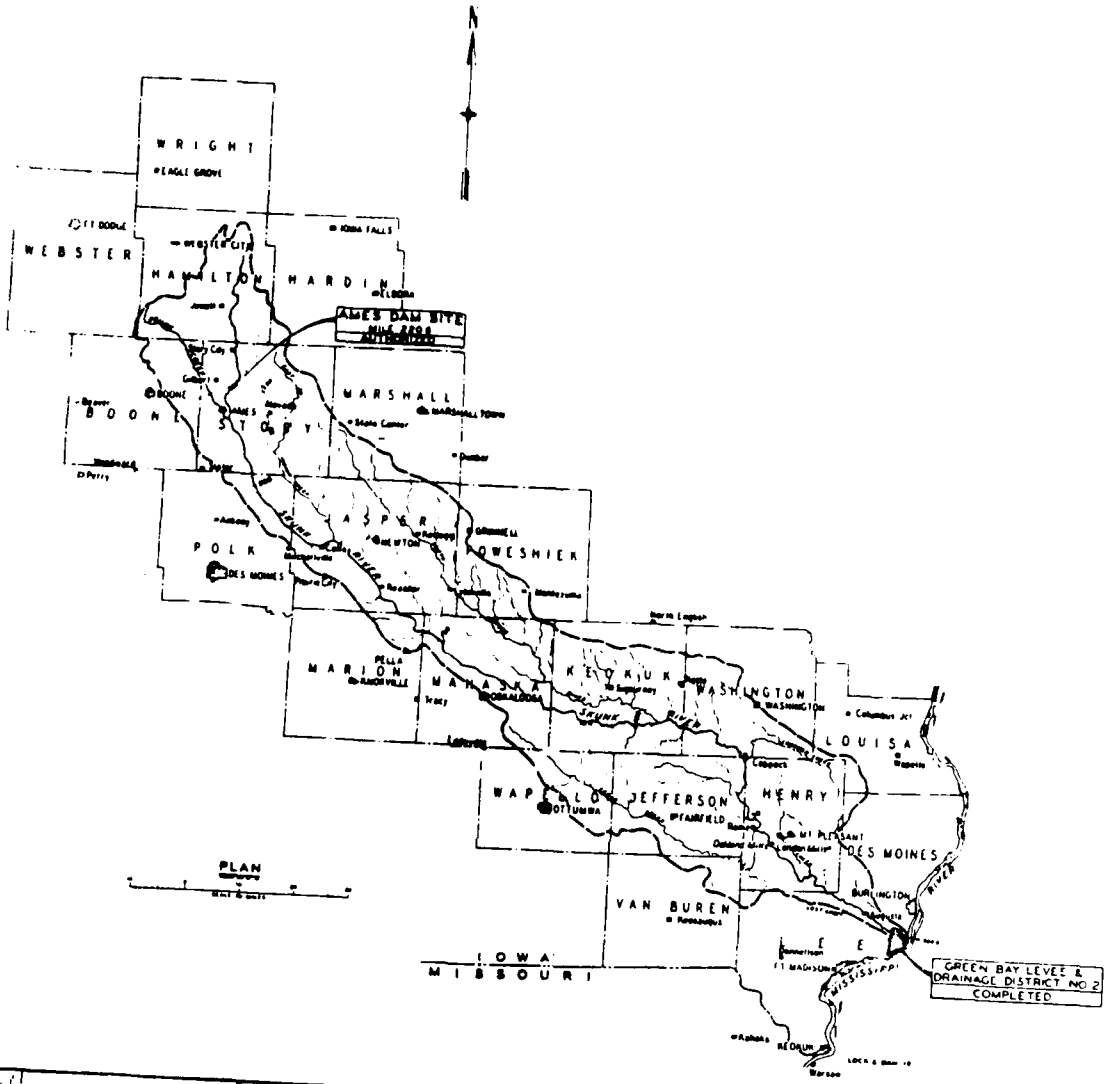
b. Deauthorize the Ames Lake project and terminate the basin study with a report recommending no further Federal action. Congress has established the deauthorization process to remove projects from our study backlog which lack local support and are not likely to be built. We are required to start the process for deauthorization if a project has not been funded since 1974.

Attached is a response sheet soliciting your views and recommendations on future water resource programs in the Skunk River basin. The response sheet contains items which you may wish to consider in your reply. You may also wish to mark up and return the enclosed Ames area map or Skunk River basin map to indicate locations of problem areas or proposed water resource projects. Please return the response sheet in the postage paid envelope by March 15, 1984.

Sincerely,

for Bernard P. Slofer
Colonel, Corps of Engineers
District Engineer

Enclosures

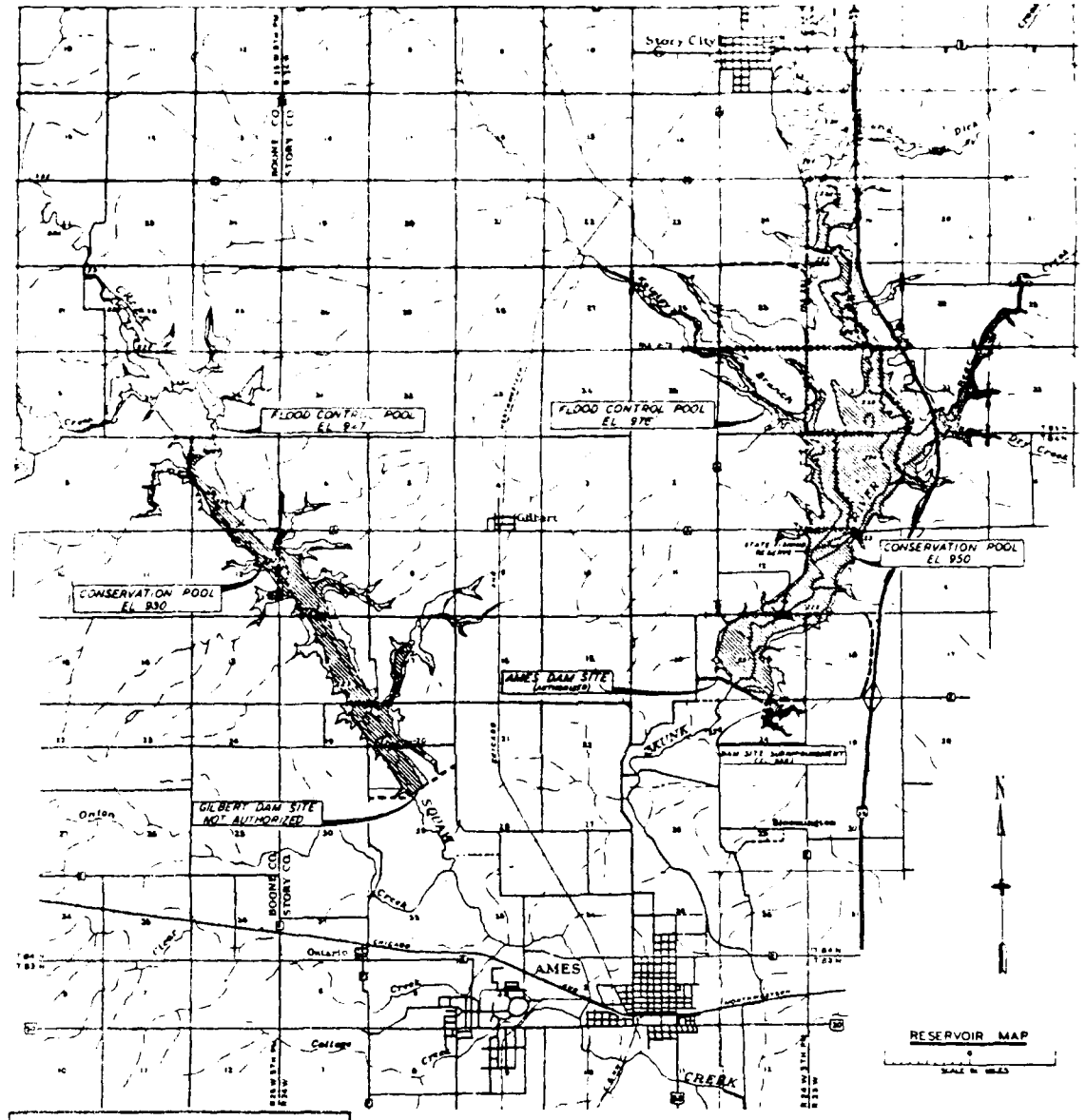


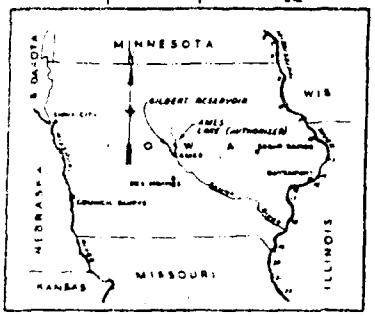
C-3

SKUNK RIVER, IOWA

BASIN MAP

SCALE AS SHOWN





VICINITY MAP

SKUNK RIVER, IOWA

AMES LAKE PROJECT

SCALE AS SHOWN

RESPONSE SHEET

February - 1984

Please identify problems and locations and give your recommendation on solutions to those or other water resource problems. Identify specific locations on the attached maps.

1. Ames Lake Project

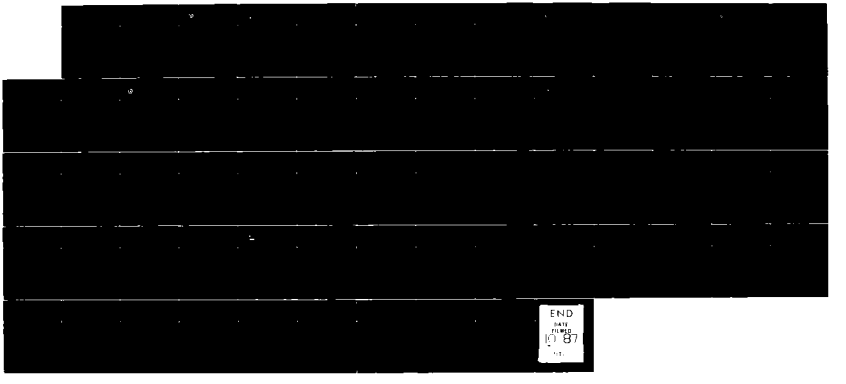
2. Urban and Rural Water Supply

3. Urban and Rural Flooding

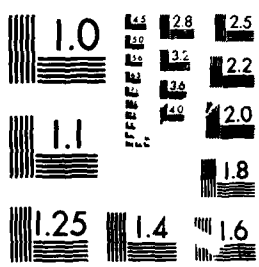
4. Low Flow Augmentation and Water Quality

AD-A184 444 GENERAL REEVALUATION REPORT UPPER SKUNK RIVER BASIN IOWA (AMES LAKE)(U) ARMY ENGINEER DISTRICT ROCK ISLAND IL JUL 87 3/3

UNCLASSIFIED F/G 13/2 NL



END
DATE FILMED
10 87



5. Recreation and Environmental Quality

6. Other

Name _____

Address _____

City _____

Representing _____

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS 61201

REPLY TO ATTENTION OF:

11 MAY 1984

NCRPO

SUBJECT: Reclassification of Authorized Project, Ames Lake, Iowa

Commander, North Central Division
ATTN: NCDPO

1. Reference is made to DAEN-CWP-C 2nd indorsement dated 20 June 1974, subject, "Reclassification of Authorized Projects," (30 May 74 - NCRED-P). This correspondence approved the reclassification of the Ames Lake, Iowa project from "Active" to "Inactive."

2. This project was authorized by the 1965 Flood Control Act (HD 267/89/1), and was funded for Land Acquisition in FY 1970 and for initiation of Construction in FY 1971. At the time of reclassification there was strong opposition to the project from upstream landowners and from conservationists. The Governor of Iowa stated that the State's position at that time had to be that of general opposition to the project.

3. Recently there has been renewed Congressional and local interest in this project. By letter dated March 6, 1984, the city of Ames, Iowa, provided us with a copy of a resolution of the City Council adopted 28 February 1984, requesting reactivation of the Ames Lake project (letter and resolution inclosed).

4. The latest approved Project Cost Estimate (PB-3) for this project, 1 July 1973 prices is $21,900,000 Federal. A revised estimate would have to be based on a reevaluation of the project. After approval of reactivation, our first year funding requirement would be $250,000. These funds would be used to initiate a reevaluation report, examine the alternatives to serve the authorized purpose of flood control, low-flow augmentation, recreation, and addition of water supply for the city of Ames. The city's request for reactivation and reevaluation of the project emphasized water supply and low-flow augmentation.

5. It is recommended that the Ames Lake, Iowa, project be reclassified from "Inactive" to "Active."

1 Incl (trip)
as

ARTHUR E. MILLER
LTC, Corps of Engineers
Acting Commander

ALL-AMERICA CITY
1982-1983

CITY OF AMES, IOWA 50010

515/232-6210

March 6, 1984

Colonel Bernard P. Slofer
Rock Island District Corps of Engineers
Clock Tower Building
Rock Island, IL 61201

SUBJECT: Ames Lake (Reservoir) Project

Dear Colonel Slofer:

This letter is in response to your February 15, 1984 request for input regarding the Ames Lake Project. Specifically, the City of Ames was requested to respond concerning the reactivation or deauthorization of the Ames Lake Project.

The Ames City Counicl met on February 28, 1984 and adopted Resolution No. 84-48 (copy enclosed) requesting the Army Corps of Engineers to reactivate the Ames Lake Project. While not endorsing a specific project, the Council actively supports a re-evaluation of the Ames Lake Project and requests additional studies evaluating long-term water resource capabilities and low-flow stream augmentation. The droughts which occurred in Central Iowa during the last 8 years have demonstrated a need for the development of long-term water resource capabilities and low-flow stream augmentation.

Ames and other Story County governments formally requested Corps of Engineers' assistance following the 1976-77 drought. Their request was specifically for planning and development assistance, particularly for the side stream impoundment/greenbelt concept, to help prevent future water supply shortages in the county.

Thank you for this opportunity to comment.

Yours very truly,

Steven L. Schainker
City Manager

SLS:bas
Enclosure

RESOLUTION NO. 84-48

RESOLUTION REQUESTING CORP OF ENGINEERS TO REACTIVATE THE AMES LAKE (RESERVOIR) PROJECT, FOR THE CITY OF AMES, IOWA.

WHEREAS, the Ames Reservoir Project was actively considered in the mid-1960's; and

WHEREAS, in 1971-73 the Corps of Engineers contracted with Iowa State University and the University of Iowa for a major environmental study of this project which resulted in a conclusion that the large multi-purpose reservoir originally planned was environmentally unacceptable and no longer viable on a benefit/cost basis, suggesting alternatives of green-belt with or without small recreational lake developments; and

WHEREAS, the Corps of Engineers must now either recommend to Congress that this project be reactivated or deauthorized; and

WHEREAS, the enhancement of water supply resources for the City of Ames and low-flow augmentation of the Skunk River during dry periods are reasons for reactivating this project; and

WHEREAS, reactivation of this project will keep open the possibility of additional water resource studies in the Ames area and possibly assist in that development; and

WHEREAS, deauthorization of this project will prevent additional study of this area, and prevent securing of reauthorization for a period of five to ten years;

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Ames, Iowa, that the Corp of Engineers be requested to reactivate the Ames Lake (Reservoir) Project.

ADOPTED THIS 28TH DAY OF FEBRUARY, 1984.

Nancy Gibbons — Paul Goodland

NANCY GIBBONS, CITY CLERK — F. PAUL GOODLAND, MAYOR

Introduced by: Parks
Seconded by: Thurston
Voting aye: Curtis, Parks, Shank, Thurston
Voting nay: Atherly, Brown Absent: None

Resolution declared adopted and signed by the Mayor this 28th day of February, 1984.

NCDPO (11 May 84) 1st Ind
SUBJECT: Reclassification of Authorized Project, Ames Lake, Iowa

DA, North Central Division, Corps of Engineers, 536 South Clark Street, Chicago, Illinois 60605 MAY 1984

TO: Cdr, USACE (DAEN-CWP-C) WASH, D.C. 20314

1. We concur with the recommendation of the Acting District Commander that the Ames Lake, Iowa, project be reclassified from the inactive to the active status for the reasons stated in the basic correspondence.

2. Prompt approval action is requested as this project has been included the House Subcommittee mark-up of the FY 85 Appropriations Bill, Report No. 98-755, accompanied by HR 5653.

FOR THE COMMANDER:

for BING C. CHIN, P.E., Chief
Program Development Office

1 Incl
nc

DAEN-CWP-C (11 May 84) 2d Ind
SUBJECT: Reclassification of Authorized Project, Ames Lake, Iowa

HQ, U.S. Army Corps of Engineers, Washington, D.C. 20314 2 JUL 1984

TO: Commander, North Central Division ATTN: NCDPO

1. We approve your recommendation to reclassify the Ames Lake, Iowa, project from the "inactive" to "active" category of Civil Works projects.

2. Based on comments received from the State of Iowa, the City of Ames, and others, it is our understanding that you will reevaluate the project prior to making any recommendation for construction.

FOR THE COMMANDER:

wd all incl

L. H. BLAKEY
Chief, Planning Division
Directorate of Civil Works

CF:
Rock Island Dist.

NCDPO (11 May 84) 3rd Ind
SUBJECT: Reclassification of Authorized Project, Ames Lak , Iowa

DA, North Central Division, Corps of Engineers, 536 South Clark Street, Chicago, Illinois 60605-1592 11 JUL 1984

TO: Commander, Rock Island District

Your request for reclassification of the Ames Lake, Iowa, project, from the "inactive" to the "active" category of Civil Works projects has been approved. Please notify the applicable Congressionai and local interests.

FOR THE COMMANDER:

BING C. CHIN, P.E., Chief
Program Development Office

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT CORPS OF ENGINEERS
CLOCK TOWER BUILDING - P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO ATTENTION OF
Planning Division

27 SEP 1984

NOTICE OF REEVALUATION
OF
AMES LAKE PROJECT
SKUNK RIVER BASIN

Due to renewed State and local interest, the Ames Lake project has been reclassified from "inactive" to "active." Reactivation was approved by the Office of the Chief of Engineers on July 2, 1984. Funds have been appropriated by Congress to initiate a reevaluation report, in fiscal year 1985 (October 1984 to September 1985).

The Ames Lake project was authorized by the 1965 Flood Control Act (PL 89-298), and consists of a dam and reservoir located 3 miles upstream of Ames, Iowa, on the Skunk River. However, opposition to the project from upstream landowners in and adjacent to the reservoir and from conservationists, prompted Governor Robert Ray to withdraw support for the project in October 1973. The project was classified as "inactive" in 1974.

Water resource problems and needs continue to affect the Skunk River Basin. Water supply needs and low-flow augmentation are particular needs in the Ames area, while flooding continues to be a problem throughout the Skunk River basin.

The study associated with this reactivation will evaluate alternative plans which would serve the authorized purposes of flood control, low-flow augmentation, and water based recreation. The study will be directed toward current needs, including water supply for the Ames area. It will be conducted in accordance with current criteria for planning and construction of federally assisted water resource programs. The objective of the study will be to determine if a project can be developed which is acceptable, serves the same purposes as the authorized project, and meets the criteria for Federal participation in a project.

The study will be conducted with the assistance of State and local interests who will be encouraged to participate as full planning partners.

You are invited to assist in the development and evaluation of alternatives during the study process. You will be informed of any study developments and also provided opportunities to input to the study at decision points.

For further information call Mr. Joe Ross, 788-6361, Ext. 6301, or write to:

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

Sincerely,

William C. Burns

William C. Burns
Colonel, Corps of Engineers
District Engineer

KEOKUK COUNTY SUPERVISORS

Phone 515-622-2902

Sigourney, Iowa 52591

March 20, 1985

District Engineer
U.S. Army Engineer District Rock Island
Attention: Planning Division
Clock Tower Building, P. O. Box 2004
Rock Island, Illinois 61204-2004

Attention: Mr. Joe Ross

Dear Mr. Ross:

We wish to thank you and your assistant for the presentation you made to Keokuk County on March 19, 1985 concerning the Skunk River Basin and its flood problems.

As you indicated in your presentation, you would be willing to fly the Skunk River Basin in Keokuk County by helicopter and record by video camera the entire system. The county would like to request at this time that this flight be conducted to facilitate the study of problems in the flood plain area and assist in the evaluation of corrective measures deemed necessary for future planning.

I understand this flight could possibly be conducted by your staff as a public service to Keokuk County and its flood plain problems. In the event you need to assess any costs of this flight to the county, please so advise the Board of Supervisors prior to conducting the flight.

Thank you again for any assistance you may be able to render Keokuk County.

Very truly yours,

Dale Sasseen

Dale Sasseen, Chairman
Keokuk County Board of Supervisors

DS:kqb

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING – P O BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

April 30, 1985

Planning Division

SUBJECT: Letter Order No. NCR-IA-85-0125

Mr. J. Michael Nethery
State Conservationist
United States Department of Agriculture
Soil Conservation Service
Federal Building, Room 693
210 Walnut Street
Des Moines, Iowa 50309

Dear Mr. Nethery:

This letter constitutes funding authority under Fiscal Year (FY) 85 appropriations in the total amount of $30,000.00 for use by the United States Department of Agriculture, Soil Conservation Service to provide input for a reevaluation study of alternative plans for the proposed Ames Lake, Iowa, Flood Control project in the Upper Skunk River Basin in accordance with the attached Scope of Work.

The FY 85 amount of $30,000.00 authorized by the Letter Order may not be exceeded without prior written approval from this office. Billing shall be on an SF 1080, indicating either partial or final payment, and forwarded to the Comptroller, U.S. Army Engineer District at the above letterhead address. Billing shall be for work covered only by the Scope of Work and shall cite the subject Letter Order number and appropriation 96x3122, Construction General, account No. BE 138 30 610 0 0000 PL. Services performed pursuant to this Letter Order are chargeable to the cited FY 85 appropriation until December 31, 1985, the expiration date of this order.

Point of contact for technical questions shall be Mr. Joe Ross, 309/788-6361, Ext. 301, and for administrative matters please call Mr. Paul VanHoorebeke, Ext. 296.

Sincerely,

ORIGINAL SIGNED BY

James T. Schnerre
Acting Chief, Planning Division

Enclosure

SCOPE OF WORK
FOR
STUDY INPUT BY THE
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
IN CONJUNCTION WITH
THE UPPER SKUNK RIVER BASIN REEVALUATION STUDY
(AMES LAKE)

BACKGROUND

Reactivation of the previously authorized Ames Lake project was approved by the Office of the Chief of Engineers on July 2, 1984. Subsequently, the Corps of Engineers, Rock Island District initiated a reevaluation study in Fiscal Year 1985. This study, associated with the reactivation, will evaluate alternative plans to the Ames Lake project which would serve the authorized purposes of flood control, low-flow augmentation, and water-based recreation. The study will be directed toward current needs, including water supply for the Ames area. The objective of the study will be to determine if a project can be developed in the Upper Skunk River Basin (above Ames) which is acceptable, serves the same purposes as the authorized project, and meets the criteria for Federal participation in a project. Preliminary findings are expected by December 1985.

REQUIREMENTS

In conjunction with the reevalution study, it is requested that the United States Department of Agriculture, Soil Conservation Service (USDA-SCS) provide the following input:

1. During the ongoing SCS Skunk River Basin Study, the SCS will investigate flood damage in small watersheds and propose remedies for a few sample watersheds. Determine if the data could be extrapolated to the watersheds above Ames, and what the conclusions are.

2. Evaluate the effects of soil conservation/land treatment measures on:

a. Sheet and rill erosion rates.

b. Delivered sedimentation rates to potential reservoir sites (four site locations to be given).

c. Flood peak reduction/runoff rates on a per square mile basis and on the main stem Skunk River and Squaw Creek. Evaluate a 2-year to 100-year frequency range.

d. Surface aquifer recharge characteristics. Estimate potential benefits to the aquifer serving the Ames well fields.

3. The SCS Skunk River Basin Study will examine the effects of extensive tile drainage on flow during droughts. Furnish any preliminary findings.

4. Address the effects of fluctuating reservoir levels on tile drainage outlets. Both underground and open channel outlets should be addressed. Mitigative alternatives which will cause the least damage to tile outlets located adjacent to proposed reservoir sites should be identified. An inventory of existing tile outlets located below potential pool levels is required.

5. The general process required to initiate, implement, and maintain a watershed project in the Skunk River or Squaw Creek Basin above Ames. Include background history on what soil conservation measures have been taken in the area above Ames.

6. Information on low-flow impacts on water quality between Ames and Newton.

7. Proposed construction needed for improved drainage of cropland above Ames.

8. An inventory of potential small impoundment sites for drainage areas less than 5 square miles in the Skunk River and Squaw Creek Basins above Ames.

The above information should be furnished in a letter report to the Rock Island District, Corps of Engineers by December 31, 1985.

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING – P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO ATTENTION OF

JUN 18 1985

Planning Division

SUBJECT: Letter Order No. NCR-IA-85-0125, Revised Scope of Work

Mr. J. Michael Nethery
State Conservationist
United States Department of Agriculture
Soil Conservation Service
Federal Building, Room 693
210 Walnut Street
Des Moines, Iowa 50309

Dear Mr. Nethery:

Attached is a revised Scope of Work to supersede the Scope of Work attached to Letter Order No. NCR-IA-85-0125, dated April 30, 1985. The Scope of Work was revised and mutually agreed upon during a coordination meeting on May 23, 1985, between Rock Island District representatives Messrs. Joe Rose and Roger Lees and Mr. James Reel and other USDA-SCS staff members.

Funding and time restrictions and other administrative matters remain as stated in our April 30, 1985, correspondence to you.

Sincerely,

Signed By
J. T. SCHNERRE

Arthur T. Klingerman
Chief, Planning Division

Enclosure

(REVISED)
SCOPE OF WORK
FOR
STUDY INPUT BY THE
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
IN CONJUNCTION WITH
THE UPPER SKUNK RIVER BASIN REEVALUATION STUDY
(AMES LAKE)

BACKGROUND

This revised Scope of Work supersedes the original Scope of Work attached to Letter Order No. NCR-IA-85-0125 dated April 30, 1985. Revisions to the original Scope of Work were required and mutually agreed upon following a May 23, 1985, coordination meeting with Mr. Joe Ross and Mr. Roger Less of the U.S. Army Corps of Engineers, Rock Island District, and the United States Department of Agriculture, Soil Conservation Service (USDA-SCS) represented by Mr. James Reel, Leader of Water Resources Planning, and other team members.

REQUIREMENTS

In conjunction with the Upper Skunk River Basin Reevaluation Study and the May 23, 1985, coordination meeting, it is requested that the USDA-SCS provide the following input: (For referencing purposes, numbered items correspond to the original Scope of Work items.)

1. Determine on a feasibility level if any economically feasible soil conservation projects can be identified in the watersheds above Ames.

2. Evaluate the effects of soil conservation/land treatment measures on:

a. Erosion, with and without land treatment.

b. Delivered sedimentation rates to the following four identified potential reservoir sites:

(1) Old authorized Ames Lake dam site on the Skunk River, sec. 13, T. 84 N., R. 24 W., Story County

(2) Bear Creek at Interstate 35, sec. 5, T. 84 N., R. 23 W., Story County

(3) Onion Creek - Squaw Creek Basin, sec. 32, T. 84 N., R. 24 W., Story County

(4) Squaw Creek, sec. 18, T. 84 N., R. 24 W., Story County

c. Flood peak reduction/runoff rates for present and future conditions for inventory watersheds above Ames. The Rock Island District, Corps of Engineers will provide flow-frequency data.

d. Acquifer recharge characteristics on Skunk River Basin upland soils.

3. Delete this item which was to examine the effects of extensive tile drainage on flow during droughts.

4. Address the effects of fluctuating reservoir levels on tile drainage outlets. Plot any known private tile outlets of 10-inch diameter or larger. Locate outlets of all legal drainage district tile on 7-1/2 minute quadrangle maps. Locate above tile outlets for only those areas surrounding the four potential reservoir sites identified in paragraph 2.b. The Rock Island District, Corps of Engineers, will provide the various pool elevations for the four study sites. Mitigative alternatives which will cause the least damage to tile outlets will not be addressed.

5. Provide a general assessment of project potential in the Upper Skunk River Basin.

6. Delete this item which was to provide information on low-flow impacts on water quality between Ames and Newton.

7. Delete this item which was to identify proposed construction needed for improved drainage of cropland above Ames.

8. Provide an inventory of potential small impoundment sites for drainage areas less than 5 square miles in the Skunk River and Squaw Creek Basins above Ames.

The above information for this revised Scope of Work should be furnished in a letter report to the Rock Island District, Corps of Engineers, by December 31, 1985.

Iowa department of water, air and waste management

August 14, 1985

District Engineer
U.S. Army Engineer District, Rock Island
Attention: Planning Division - Arthur Klingerman
Clock Tower Building, Box 2004
Rock Island, IL 61204-2004

RE: Flow Augmentation - Upper Skunk River

Dear Mr. Klingerman:

The department staff has spent considerable time and effort in the past several years on documenting the need for advanced wastewater treatment facilities for Ames. This documentation included an evaluation of the stream flow conditions at which Iowa's water quality standards would apply. It was determined that a stream flow of 2 cfs would be used in lieu of the 7Q10 (0.08 cfs) at the Ames USGS gage. The need for advanced treatment and subsequent design of a new waste treatment facility for Ames is based on this stream flow. Therefore, any discussion regarding low-flow augmentation should consider the flow of 2 cfs for water quality.

Based on historic gaging data at the existing Ames gage and the discontinued gage, the seasonal 7Q10 levels are below the 2 cfs during all periods except April - June. During this April - June period the 7Q10 is 2.5 cfs at the Ames gage. Low flow augmentation would be beneficial during the seasons when the natural flow drops below 2 cfs. Flow augmentation would not be necessary during the April - June periods since both adequate stream flow and advanced treatment will ensure protection of the aquatic resource. The accompanying table (similar to the August 1966 FWPCA table) is provided to show the augmented monthly stream flow values (at the Ames gage) which would be benefical in reducing elevated instream ammonia nitrogen concentrations when the natural flow drops below 2 cfs.

It is hopeful that this provides the necessary data on flow augmentation. Please feel free to contact Ralph Turkle (281-8779) if any questions arise.

Sincerely,

Stephen W. Ballou, Ph.D.
Executive Director

SWB/sjh

henry a. wallace building • 900 east grand • des moines iowa 50319 • 515/281-8690

Monthly Distribution of Benefical Flows

Month	Flow Rate (cfs)
January	2
February	2
March	2
April	*
May	*
June	*
July	2
August	2
September	2
October	2
November	2
December	2

* Natural flows are sufficient

United States Department of Agriculture
Soil Conservation Service
210 Walnut Street
693 Federal Building
Des Moines, Iowa 50309

January 17, 1986

Mr. Arthur J. Klingerman
Chief, Planning Division
Department of the Army
Rock Island District Corps of Engineers
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

Dear Mr. Klingerman:

As per agreements between Mr. Joe Ross and Roger Less of your agency and myself, six copies of information relative to the Upper Skunk River Basin in Iowa are being provided for your use. Specifically, the information outlined in the revised scope of work, agreed to as per the letter dated June 18, 1985 from yourself to Mr. J. Michael Nethery, has been completed.

It has been a pleasure working with your staff. If we can be of any further assistance or if the need for our assistance at up coming meetings is required due to the information we have provided, please contact me directly.

Sincerely,

James M. Reel

James M. Reel
Staff Leader
Water Resources Planning Staff

IOWA STATE HISTORICAL DEPARTMENT
OFFICE OF HISTORIC PRESERVATION

DAVID CROSSON, EXECUTIVE DIRECTOR

STATE HISTORIC PRESERVATION OFFICER

April 2, 1986

Dudley M. Hanson, P.E.
Acting Chief, Planning Division
Rock Island District Corps of Engineers
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

RE: CULTURAL RESOURCES, UPPER SKUNK RIVER BASIN, AMES LAKE, IOWA.

Dear Mr. Hanson:

Thank you for the opportunity to review this document. The appraisal of past research in the Ames Reservoir is concise and summarizes well the initial efforts to evaluate cultural resources in this project area. We concur with the Corps that additional research must be performed. We recommend that geomorphological studies be conducted first to develop landscape models that can be used to identify where archeological sites are likely located, whether buried manifestations are expected, and where sites are likely to be preserved or destroyed. The Corps should then conduct surveys based upon landform/context models to identify and evaluate sites that may be impacted by the proposed work.

We look forward to working with you on this project.

Sincerely,

Kay Simpson for

Dr. Lowell J. Soike, Director
Deputy State Historic Preservation Officer

LJS/ks

Historical Building-East 12th & Grand-Des Moines, Iowa 50319 · (515) 281-6825-6826

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ROCK ISLAND FIELD OFFICE (ES)
1830 Second Avenue, Second Floor
Rock Island, Illinois 61201

IN REPLY REFER TO
[illegible]
File: [illegible]

April 16, 1980

Colonel William C. Burns Jr.
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Burns:

This is our Planning Aid Letter for the general re-evaluation study for flood control on the Skunk River. It was prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.); the National Environmental Policy Act of 1969, as amended; the Endangered Species Act of 1973, as amended; and in accordance with the Fish and Wildlife Service's Mitigation Policy.

By copy of this letter we are requesting comments from the Iowa Conservation Commission. This report discusses available data pertinent to fish and wildlife resources in the Upper Skunk River Basin, with emphasis on areas impacted by the proposed project alternatives. The study area for the re-evaluation is the Upper Skunk River from its headwaters to the mouth of Indian Creek near Colfax. It includes all, or parts of Boone, Hamilton, Story, Polk and Jasper counties in central Iowa (Figure 1).

Description of the Study Area

The Skunk River rises out of the nearly level, recently glaciated, prairie pothole region in Hamilton County, north-central Iowa. The headwaters area is fed largely by artificial drainage ways (open ditches and field tile) constructed to drain the potholes for agricultural use. The river valley is narrow with relatively steep wooded sides ascending to the now intensively cultivated uplands. The upper river from Story City to just north of Ames is characterized by a stable pool and riffle bottom which varies from cobble to gravel. About one mile north of Ames, the physical character of the river and the valley changes drastically due primarily to geologic formations. The lower valley is wide and flat and the river has a shifting sand substrate. Through this area as well, the river has been straightened, and spoil banks were built to protect the cropland from flooding.

Tributary streams have the same characteristics as the Skunk River in this area, and their wooded corridors provide the only relief from the very open, rolling, intensively cultivated land until the Des Moines River and its tributaries are encountered nearly 30 miles to the west.

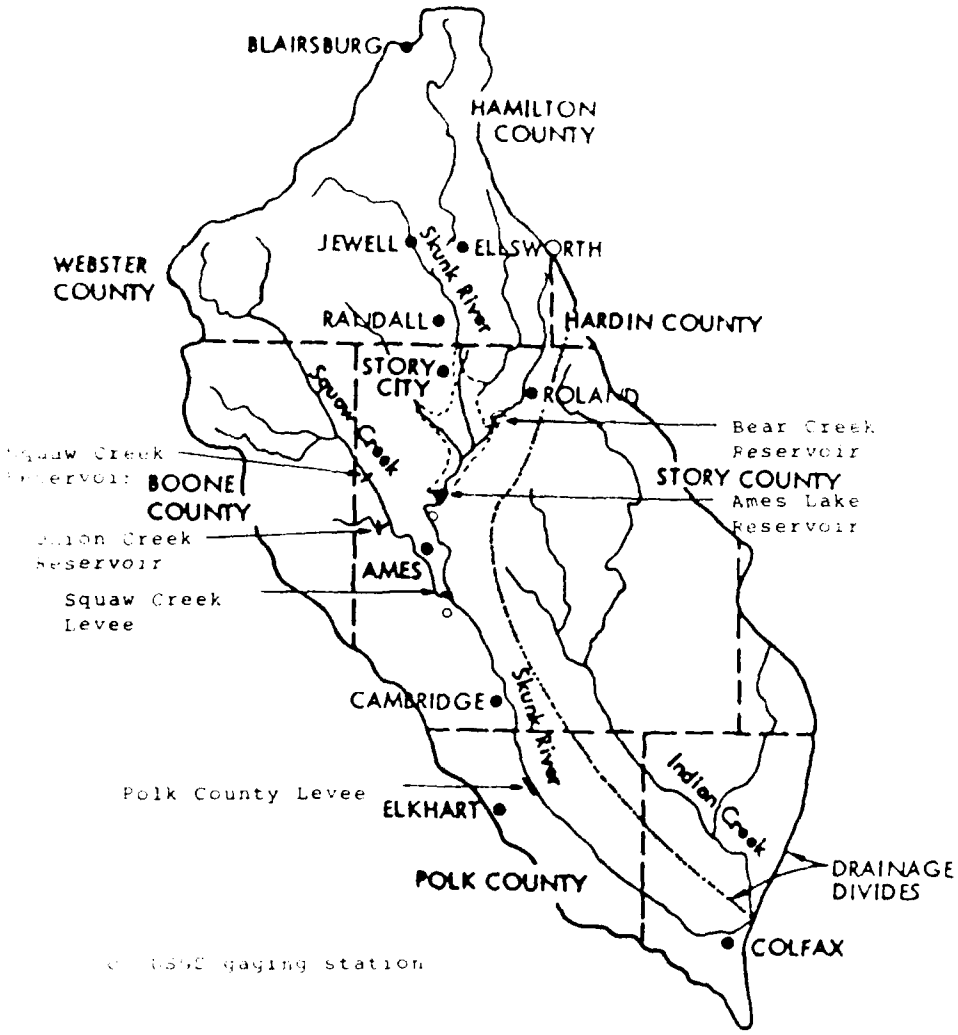


Figure 1. Study area for Upper Skunk River Basin reevaluation and locations of proposed project alternatives.

Description of Proposed Alternatives

An array of alternatives has been proposed for flood control, recreation, water supply, aquifer recharge and low-flow augmentation in the study area. Table 1 is a list of the project alternatives and the general specifications and purposes of each. Locations of the proposed alternatives are illustrated in Figure 1.

Fish and Wildlife Resources Without the Project

A. Flows

The Skunk River is classified as a warm water fishing stream by the State of Iowa. It experiences both flooding and extremely low flows, with natural flows dwindling to nothing in most years at the gage below Ames. Table 2 is a presentation of flow characteristics at the two USGS gaging stations on the Skunk River, and the station on Squaw Creek in Ames. It should be noted that the flows at the station below Ames are affected by the City of Ames pumping from the surficial aquifer in the Skunk River/Squaw Creek Basin for domestic water supply. Thus, the low flows below Ames do not represent the natural flow of the stream.

Squaw Creek has a flow regime similar to the Skunk River, while Bear Creek and Onion Creek would most likely be intermittent. No flow data is available for either Bear Creek or Onion Creek.

The state of Iowa has established protected flow parameters for both gaging stations on the Skunk River near Ames. The protected flows are 4.5 cfs at the gaging station north of Ames, and 23 cfs at the gaging station below the mouth of Squaw Creek.

B. Water Quality

Water quality is a concern in the Upper Skunk River Basin due to a combination of factors including agricultural runoff and waste treatment plant outfalls at Story City and Ames. We understand that a new waste treatment facility for the City of Ames is in planning, which will reduce the flow needed for dilution at Ames.

A limnological study by Jones (1972) provided baseline on water quality parameters for the Skunk River between Story City and Cambridge. No more recent data is available for the Skunk River; thus we feel that water quality should be determined on any stream considered for impoundment, as part of the detailed project planning process.

C. Fish

The Skunk River in the study area supports a permanent fishery despite an occasional drought and low stream flows. Several fishery surveys have been conducted on the Skunk River and Squaw Creek. Meek (1892) conducted the first survey and recorded 49 species while Coon (1970) reported 35 species between Ames and Cambridge. The modern surveys beginning with Harlan and Speaker (1951), Paloumpis (1956), Zack (1968), Laser, et al. (1969) and Coon (1970) reveal a relatively consistent variety of fish species (Table 3). These surveys have also shown a greater diversity of

Table 1. Proposed project alternatives for the Upper Skunk River Basin.

Alternative/Location	Specifications		Purpose(s)
1. Ames Lake Reservoir NE of Ames	Conservation Pool Flood Pool	2100 acres @ 950' MSL 5100 acres @ 976' MSL	Flood Control Recreation Low Flow Augmentation Aquifer Recharge Wildlife Propagation
2. Ames Lake Reservoir (reduced) NE of Ames	Conservation Pool Flood Pool	1300 acres @ 940' MSL 3500 acres @ 965' MSL	Flood Control Recreation Low Flow Augmentation Aquifer Recharge Wildlife Propagation
3. Bear Creek Lake NE of Ames	Normal Pool	155 acres @ 970' MSL	Water Supply Low Flow Augmentation Recreation
4. Squaw Creek Reservoir NW of Ames	Conservation Pool Flood Pool	1000 acres @ 935' MSL 1500 acres @ 950' MSL	Flood Control Recreation Low Flow Augmentation Aquifer REcharge Wildlife Propagation
5. Onion Creek Lake NW of Ames	Normal Pool	200 acres @ 950' MSL	Water Supply Low Flow Augmentation Recreation
6. Squaw Creek Levee Ames	Length 7000 feet		Flood Control
7. Polk County Ag. Levee	Length 18,000 feet with 7000 feet of tiebacks		Flood Control

Table 2. Flow characteristics in the Upper Skunk River Basin.

Criteria / Station	Stream Flows ft^3/sec		
	Skunk River above Ames	Squaw Creek in Ames	Skunk River below Ames
Yearly average flow	157	125	301
Q_{75} flows			
Jan	4	1	1
Feb	7	2	3
Mar	45	17	47
Apr	52	26	64
May	51	36	117
Jun	43	65	137
Jul	16	21	59
Aug	6	4	12
Sep	4	2	5
Oct	3	2	2
Nov	6	4	4
Dec	4	4	3
Annual	10	6	13
Q_{84} flows			
Apr-Sep	6.8	4.3	15
Annual	4.5	4.8	3.8
$Q_{7,10}$ flows			
Jan-Mar	0.4	0.2	0.0
Apr-Jun	5.0	2.5	6.7
Jul-Sep	0.2	0.1	0.3
Oct-Dec	0.3	0.4	0.0
Annual	0.1	0.1	0.0
Protected flow*	4.8	23	N/E

* from Iowa Administrative Code, Department rule 900--52.8

Table 3. Fish species occurring in the Upper Skunk River near Ames (from ISWRRI, 1973a).

Species	Meek (1892)	Laser et al (1969)	Coon (1971)
Species Remaining Since 1892			
Stoneroller (Campostoma anomalum)	C	C	-
Golden shiner (Notemigonus chrysoleucas)	C	R	-
Emerald shiner (Notropis atherinoides)	A	A	C
Common shiner (Notropis cornutus)	C	A	C
Bigmouth shiner (Notropis dorsalis)	C	A	C
Sand shiner (Notropis stramineus)	R	A	C
Spotfin shiner (Notropis spilopterus)	C	R	-
Suckermouth minnow (Phenacobius mirabilus)	R	C	-
Bluntnose minnow (Pimephales notatus)	C	A	C
Fathead minnow (Pimephales promelas)	C	R	R
Creek chub (Semotilus atromaculatus)	C	A	A
Quillback (Carpoides cyprinus)	C	-	C
White sucker (Catostomus commersoni)	C	C	A
Northern hogsucker (Hypentelium nigricans)	C	-	C
Bigmouth buffalo (Ictiobus cyprinellus)	A	R	R
Northern Redhorse (Moxostoma macrolepidotum)	R	-	C
Black bullhead (Ictalurus melas)	A	R	A
Channel catfish (Ictalurus punctatus)	C	R	C
Green sunfish (Lepomis humilus)	A	R	C
Bluegill (Lepomis macrochirus)	R	-	R
Smallmouth bass (Micropterus dolomieui)	R	R	R
Johnny darter (Etheostoma nigrum)	C	C	-
Species Appearing Since 1892			
Carp (Cyprinus carpio)	-	C	A
Goldfish (Carassius auratus)	-	-	R
Brassy minnow (Hybognathus hankinsoni)	-	R	R
Red shiner (Notropis lutrensis)	-	A	-
River carpsucker (Carpoides carpio)	-	A	C
Highfin carpsucker (Carpoides velifer)	-	-	C
Yellow bullhead (Ictalurus natalis)	-	R	A
Stonecat (Noturus flavus)	-	-	C
White crappie (Pomoxis annularis)	-	R	R

Species	Meek (1892)	Laser et al (1969)	Coon (1971)
Species Found in 1892 but not Reported Recently			
* Mud lamprey (Ammocoetes branchialis)	R	-	-
Northern pike (Esox lucius)	C	-	-
Muskellunge (Esox masquinongy)	R	-	-
Red-bellied dace (Chrosomus erythrogaster)	R	-	-
Silvery minnow (Hybognathus nuchalis)	R	-	-
Brook silverside (Labidesthes sicculus)	R	-	-
Blacknose shiner (Notropis heterolepis)	C	-	-
Blackchin shiner (Notropis heterodon)	R	-	-
Redfin shiner (Notropis umbratilis)	R	-	-
Bullhead minnow (Pimephales vigilax)	C	-	-
Blackstripe topminnow (Fundulus notatus)	R	-	-
Mornyhead chub (Hybopsis biguttata)	C	-	-
Spotted sucker (Minytrema melanops)	R	-	-
Black redhorse (Moxostoma duquesnei)	C	-	-
Brown bullhead (Ictalurus nebulosus)	R	-	-
Slender madtom (Noturus exilis)	R	-	-
Tadpole madtom (Noturus gyrinus)	R	-	-
Orange-spotted sunfish (Lepomis humilus)	R	-	-
Largemouth bass (Micropterus salmoides)	A	-	-
Rock bass (Ambloplites rupestris)	R	-	-
Black crappie (Pomoxis nigromaculatus)	R	-	-
Blackside darter (Percina maculata)	R	-	-
Banded darter (Etheostoma zonale)	R	-	-
Mud darter (Etheostoma asprigene)	R	-	-
Rainbow darter (Etheostoma caeruleum)	R	-	-
Iowa darter (Etheostoma exile)	C	-	-

* Probably larval brook, chestnut, or silver lamprey

Key: A = abundant
C = common
R = rare

species above Ames than below Ames. Coon (1970) attributed this difference in diversity to the greater variety of bottom substrate and habitats in the natural Skunk River north of Ames as opposed to the shifting sand bottom of the channelized portion of the Skunk River below Ames. No fisheries data are available for Bear Creek or Onion Creek.

D. Terrestrial

An extensive study of the vegetation and plant communities was conducted in 1972 (Iowa State Water Resources Research Institute, 1973a) on a 22,000 acre study area which included the authorized project and the Bear Creek impoundment. Approximately two-thirds (16,000 acres) was under cultivation and 2900 acres (13%) was forested or wooded pasture. The predominant forest type was a mixed floodplain forest with Maple-Basswood, Elm-Ash, and Oak-Hickory associations. No information is available on habitat types in the remainder of the study area.

A review of data on woodlands from the 1974 Census of Agriculture for Story County shows a decrease in total woodland acreage from 9,287 acres in 1969 to 6,280 acres in 1974, while 1982 Census of Agriculture for Story County shows woodland acreage steady between 1978 and 1982 at about 8000 acres. The apparent woodland increase between 1974 and 1978 is due to a revision in reporting categories, not an actual increase.

Since 1972, the Story County Conservation Board has actively pursued the preservation of the upper Skunk River through development of a greenbelt. To date, over 820 acres of the corridor is owned by or under the control of the Conservation Board. In addition, 2700 acres of the river corridor are protected from future development by a county zoning ordinance. The Skunk River Greenbelt is being carefully developed to preserve the unique nature of the corridor while providing recreational opportunities for the public.

E. Wildlife

The project area provides habitat primarily for small game and furbearers. Petersen, in ISWRRI (1973a) directed a study of the potential impacts of the proposed Ames Lake reservoir upon wildlife of the area. The study, conducted in April and May 1972, examined habitat quality and population density of 57 species and groups of species (Table 4). Averages of the habitat quality and population quality values indicated that the area was composed of only fair wildlife habitat and less than fair population densities. Petersen (in ISWRRI 1973a) explained that these values were probably low because 1) of the uneven distribution of species throughout the study area, 2) the short census period, and 3) the averaging of the values. He concluded, however, that the area contained good habitat for raccoons, sparrows and rabbits, while conditions for river otters, dabbling ducks and rails were poor.

No information is available concerning wildlife species in the remainder of the study area.

Table 4. Animal species and estimated habitat quality and population densities in the Upper Skunk River study area, 1973 (from Petersen).

SPECIES	HABITAT QUALITY	POPULATION DENSITY CLASSIFICATION	SPECIES	HABITAT QUALITY	POPULATION DENSITY CLASSIFICATION
Herons	3.76	2.66	Jack Rabbit	4.37	3.41
Wood Duck	3.01	2.49	Chipmunk	2.80	3.08
Other Waterfowl	3.33	3.19	Woodchuck	2.76	2.06
Hawks	2.12	1.49	13 Lined Gd. Sq.	3.42	3.04
Eagles	4.11	----	Franklin's Gd. Sq.	3.54	3.10
Quail	3.53	3.38	Gray Squirrel	2.96	3.14
H. Partridge	3.86	----	Fox Squirrel	2.15	1.95
Pheasant	3.37	2.16	Red Squirrel	3.43	----
Rails	4.22	3.41	S. Flying Squirrel	2.99	----
Doves	2.30	1.86	Pocket Gopher	3.32	3.07
Owls	2.42	2.57	Beaver	3.52	2.58
Swifts	3.52	2.98	Cricetidae	2.31	2.10
Kingfishers	3.43	2.56	Muskrat	3.54	2.77
Woodpeckers	1.80	1.61	Coyote	3.58	3.39
Flycatchers	2.71	2.39	Red Fox	3.07	2.70
Larks	4.08	3.54	Gray Fox	2.53	----
Swallows	3.47	1.71	Raccoon	2.02	1.77
Jays	1.83	1.32	Mink	3.44	2.76
Titmice	2.12	2.17	Weasels	3.14	2.84
Nuthatches	1.79	1.81	Badgers	3.29	3.16
Wrens	2.38	2.55	Striped Skunk	2.84	2.31
Thrashers	2.62	3.97	Spotted Skunk	3.45	3.19
O. W. Warblers	2.64	2.55	River Otter	4.43	----
Waxwings	3.21	2.99	Wh. Tailed Deer	2.85	2.19
Starlings	2.61	2.31	Salamanders	3.35	----
Vireos	2.63	3.13	Toads	2.74	2.98
Warblers	2.20	2.11	Frogs	2.83	2.51
House sparrows	1.96	2.06	Turtles	3.84	3.38
Grackles	2.96	1.74	Lizards	3.90	3.21
Blackbirds	2.76	1.47	Snakes	2.61	2.70
Cowbirds	2.80	2.42			
Tanagers	3.24	----	Average for all Wildlife Categories	3.02	2.69
Sparrows	3.39	2.68			
Opossum	2.77	2.51			
Insectivores	2.43	1.88			
Bats	3.56	2.91			
Cottontail Rabbit	2.42	2.44			

Habitat/Density Ratings

1 = optimum
2 = good
3 = fair
4 = poor

Federally Endangered Species

The Fish and Wildlife Service lists only one species protected by the Endangered Species Act of 1973, as amended, that may occur in the study area. The Indiana bat (Myotis sodalis) has been documented in Jasper County, in the extreme southeast part of the study area. The Indiana bat utilizes small stream corridors with well developed riparian zones consisting of mature trees (generally greater than 16 inches in diameter). They roost and rear their young under the loose bark or in cavities of dead or dying trees. They feed over the stream by flying underneath the overhanging forest canopy, occasionally dropping to the water surface to drink. Future studies should investigate if suitable habitat exists in the project area.

Prairie bush clover (Lespedeza leptostachya), a species proposed to be listed as threatened has been documented in Story County. The prairie bush clover inhabits dry mesic native prairies that are well-drained, often gravelly, and located on kanes or eskers (hills of glacially deposited material) and river terraces. Future studies should also investigate if suitable habitat exists for this species in the project area.

The bald eagle (Haliaeetus leucocephalus) is found occasionally in the tailwaters of Saylorville Reservoir, Polk County, during the winter. The reservoir alternatives could affect the bald eagle positively by providing additional open water feeding habitat in the area.

In accordance with Section 7(c) of the Endangered Species Act of 1973, as amended, the Federal agency responsible for actions authorized, funded, or carried out in furtherance of a construction project that significantly affects the quality of the human environment, is required to conduct a biological assessment. The purpose of the assessment is to identify listed or proposed species likely to be adversely affected by their action and to assist the Federal agency in making a decision as to whether they should initiate consultation.

State Protected Species

The Iowa Conservation Commission (Wilson 1985, pers comm) has provided a list of endangered species which may be affected by various project alternatives (Table 5). No detailed surveys have been conducted in the study area. Such studies will be necessary for each of the feasible alternatives.

Table 5. Iowa endangered and special interest species which will be affected by proposed alternatives.

	State Status	INAI Rank*
Ames Lake Dam Site		
Blacksoil prairie		S3
Prairie bush clover (proposed for federal listing)	Endangered	S1

	State Status	INAI Rank*
Onion Creek Dam Site		
Dissected grape fern		S3
Coral root orchid		S2
Foxtail sedge		S3
Dry Dam Site SE of Story City		
Blanding's turtle		S3
Prairie white-fringed orchid	Endangered	S3
Bobcat	Endangered	S1,S2

* Iowa Natural Area Inventory (INAI) Rank Key.

S1 - 1-5 occurrences
S2 - 6-20 occurrences
S3 - More than 20 occurrences.

Fish and Wildlife Resources with the Project

In general, impacts to fish and wildlife resources due to any of the impoundment alternatives will include some stabilization of flow variability and reduction of flood stages downstream. The water temperature regime will also be altered, most markedly in the summer due to thermal stratification. Surface temperatures of a reservoir will be higher and bottom temperatures lower than the normal stream flow. These differences will be reflected in the water discharged downstream based on the depth of the outlet structure. Likewise, water quality measured by dissolved solids will improve as salts settle out, but oxygen deficiences could develop because of thermal stratification and lack of aeration in the pool.

Levees generally reduce flood conveyance and storage capacity of the floodplain, while containing overbank flooding. Containment of flood discharges in a smaller cross-sectional area will result in higher water velocities, and may cause scouring and stream bank erosion, degrading fish habitat.

Alternative 1

This is the previously authorized Ames Lake Reservoir as proposed by the Corps of Engineers in Design Memorandum #1. The specifications and purpose are detailed in Table 1. While this alternative provides runoff flood storge for a 5.2 inch event, the ISWRRI Summary Report (1973) reveals that some agricultural levee construction would still be required to protect cropland between Ames and Colfax.

The specific impacts to fishery resources with Alternative #1 will be severe. Foremost is the permanent loss of 80 per cent of the only unstraightened segment of the Skunk River between the upland drainage ditch headwater areas and the downstream straightened main channel reach. This means the loss of

the documented river fishery, although a limited river fishery may persist in the tailwater area.

We expect a lake type fishery to develop in the reservoir proposed in Alternative 1. Of the game fish in the Skunk River, Bachmann and Olsen (ISWRRI 1973) predict that only the smallmouth bass will be eliminated. The balance of their projections about fish species in the proposed reservoir is in Table 6.

Bachmann and Olsen (in ISWRRI 1973a) summarized their predictions of the Ames Reservoir as follows:

1. The combination of high nutrient levels in the river and relatively long turnover time will mean the impoundment will be a fertile body of water with heavy summer algal blooms which can only be controlled by periodic treatments.

2. The fish population will increase many fold including large numbers of rough fish. There should, as well, be a substantial game fish population which can be maintained with intensive management.

3. The poor quality of the river below the reservoir in combination with the variable quality of the outflow will preclude the establishment of a substantial tailwater fishery.

Like the fishery, the wildlife resource in the impoundment area will be severely impacted. Filling the conservation pool will inundate about 400 acres of timber, and periodic and variable filling of the flood pool to full level 976' MSL will severely impact an additional 1200 acres of timber. This represents a loss of up to 15 percent of the woodland resources in Story County. The terrestrial resources in the flood pool will be reduced to mud flats at the lower elevations and to early successional herbs and water tolerant woody species at higher elevations depending on the frequency and duration of flooding. While these vegetative regimes provide wildlife habitat, the diversity of wildlife species using these habitats will be less than for the woodland lost. This alternative would severely impact the Skunk River Greenbelt, inundating most of corridor, eliminating the unique recreational and environmental experiences now available. Finally, the limited benefits to fish and wildlife are short-term only as the reservoir size and quality will be reduced due to sedimentation.

Alternative 2

This alternative is essentially the same as Alternative 1, except that the conservation pool and flood control pool are smaller. The conservation pool would have a surface area of approximately 1300 acres and the flood pool would be 3500 acres. While this would affect less of the natural river, the discussion of impacts due to Alternative 1 are still applicable. Bachmann and Olsen (in ISWRRI 1973a) also addressed this alternative, indicating that while the turnover rate would be cut in half, the increased turbidity and decreased mean depth would favor abundant rough fish populations. From a wildlife standpoint, the impact would be less in terms of total acreage, however, a substantial portion of the developed Skunk River Greenbelt will be inundated.

Table 6. Fish species present in the Skunk River basin with projected abundance of these species in proposed reservoirs (from ISWRRI, 1973a).

Species	Abundance in river (Zach)	(Coon)	Projected abundance in Ames Reservoir
Rough fish			
Carp	R	A	A
River carpsucker	C	C	A-C
Quillback	C	C	A-C
Highfin carpsucker	C	C	A-C
White sucker	C	A	C-R
Northern hogsucker	C	C	-
Bigmouth buffalo	R	R	A (if started)
Northern redhorse	-	C	R-C
Forage fish			
Stoneroller	C	R	-
Brassy minnow	R	C	?
Emerald shiner	R	R	C-A
Common shiner	A	A	-
Big-mouth shiner	A	A	?
Red shiner	C	C	C
Sand shiner	C	A	R
Golden shiner	R	-	A (if started)
Suckermouth minnow	R	R	R-C
Bluntnose minnow	C	A	A
Fathead minnow	C	A	A
Creek chub	A	A	-
Slender madtom	-	R	?
Stonecat	R	C	-
Fantail darter	R	R	-
Johnny darter	C	R	R-C
Game fish			
Black bullhead	C	C	A
Yellow bullhead	C	C	C
Channel catfish	R	C	C (if stocked)
Green sunfish	C	A	A
Orange-spotted sunfish	R	R	R-C
Bluegill	-	R	C
Smallmouth bass	C	C	-
Largemough bass	R	R	C (if stocked initially)
White crappie	-	R	A
Black crappie	-	R	C
Northern pike	-	R	R-C
Walleyed pike	-	-	R-C (if stocked)

Key: A = abundant
C = common
R = rare

Alternative 3

This alternative calls for an impoundment on Bear Creek upstream of the I-35 bridge. This impounds approximately 155 surface acres with an elevation of 970' MSL, and was proposed as part of the previously authorized Ames Lake Reservoir as a stable recreation and fishing lake as part of Alternative 1. Proposed by itself, it is primarily to supply water for the City of Ames, with possible recreation and fishing benefits. There is no fisheries data for Bear Creek, but we would assume that it would have the smaller fauna associated with the Skunk River. We would also expect that it is intermittent, going dry almost yearly. Thus, we would anticipate little impact to the fishery. Bachmann and Olsen (ISWRII 1973a) wrote that sport fishery populations in the sub-impoundments (Bear Creek and Dam site) would be good because of the morphometry of the lake basins. Thus, the lake fishery developed in Bear Creek Lake should have good game fish populations with proper management. The impact to wildlife resources will be moderate due to the open nature of the timber and the fact that most of it is presently pastured.

Alternative 4

This is a multi-purpose reservoir on Squaw Creek with a conservation pool at 935' MSL and full flood pool at 950' MSL. This would create a narrow, shallow conservation pool of approximately 1000 surface acres, and a flood pool of approximately 1500 acres. We have no current data on the Squaw Creek fishery. We would, however, expect a lake fishery dominated by rough fish to develop in this reservoir similar to that for Alternatives 1 and 2.

The impact to wildlife resources will be moderate, due to the pasturing of the majority of the timber in the flood plain. As with the reservoirs proposed in Alternative 1 and Alternative 2, we would anticipate a transition type of habitat to develop on the land affected by the flood pool, depending on the extent and duration of flooding events.

Alternative 5

A small reservoir has been proposed on Onion Creek just upstream of the confluence with Squaw Creek. This reservoir was proposed for water supply augmentation for the City of Ames, with a conservation pool at 950' MSL and a surface area of 200 acres.

No fishery data is available for Onion Creek. We would expect that Onion Creek does not support diverse fishery largely due to the small size of the watershed. We would expect the fishery of this reservoir to be comparable to Bear Creek Lake (Alternative 3), a managed sport fishery.

The conservation pool will flood approximately 100 acres of mixed timber which now provides habitat for a wide variety of small animals and birds. Much of the adjacent property is residential and would not be available to mitigate losses in the impoundment.

Alternative 6

A levee has been proposed [illegible] Avenue to east of Duff Avenue. The proposed levee [illegible] protect 122 acres from flooding.

Squaw Creek in this area is a meandering stream. It is severely disturbed only at the South Duff Street/Highway 69 bridge. It is tree-lined with a park in the west and commercial development along South Duff Avenue.

We anticipate little impact to the fishery and wildlife resources in the proposed project area if the tentative alignment is utilized and no clearing of the floodplain is done. The indicated setback from the creek bank will preclude removal of all but a very few trees along the creek. This will maintain the fishery at its current level, and seeding of the levee slopes and top with species valuable to wildlife will increase habitat values in the levee area.

Alternative 7

This is an agricultural flood control levee [illegible], located at River mile 2.7. This levee will run approximately [illegible] feet along the west bank of the Skunk River with [illegible] feet of [illegible] required.

The Skunk River in this reach is a channelized stream with spoil bank levees which are now perennially lined with a single row of trees. Preliminary specifications for the levee call for levee offsets from [illegible] of bank from 75 to 195 feet depending on the protection level selected. We anticipate temporary impacts to the [illegible] and an unknown amount to the wildlife resource resulting from trees and [illegible] from the present river bank, and that levee top and slopes are planted to a mix of grass and legume immaterial to wildlife. No information has been provided on borrow sites for material to construct the levees.

Mitigation

A. Policy

No specific mitigation measures have been identified in the proposed plan. In accordance with the U.S. Fish and Wildlife Service Mitigation Policy (46 FR 7644-7663), the habitats to be impacted by the proposed project have been evaluated to determine their resource categories and proper Mitigation Goals. The Resource Categories and their Mitigation Goals are as follows:

Resource Category 1 - Habitat is of high value and is unique and irreplaceable in the nation or ecoregion. Goal - no loss of existing habitat value. Guideline - the Service will recommend that all losses of existing habitat be prevented as these one-of-kind areas cannot be replaced. Insignificant changes are acceptable provided they will have no cumulative impact.

Resource Category 2 - Habitat is of high [illegible] or becoming scarce in the nation or in the region. Goal - no net loss of in-kind habitat value. Guideline - impacts that cannot be avoided, minimized, rectified or eliminated over time will be compensated by replacement with the same kind of habitat so that the habitat unit loss is zero.

Resource Category 3 - Habitat is of high to medium value and is relatively abundant in the nation. Goal - no net loss of habitat value while minimizing loss of in-kind habitat value. Guideline - impacts that cannot be otherwise avoided, minimized, rectified, eliminated over time or compensated by in-kind replacement can be compensated by replacement with other habitat types so that the total habitat unit loss is zero.

Resource Category 4 - Habitat is of medium to low quality. Goal - minimize loss of habitat value. Guideline - the Service will make recommendations to avoid, minimize, rectify or eliminate losses over time depending on the significance of the potential loss. Such areas are good candidates for mitigation of Resource Category 2 or 3 losses by management or enhancement to increase their habitat value.

B. Assignment of Resource Categories

We have assigned Resource Category 2 to all forested, prairie, wetland, and riverine habitats, Resource Category 3 to wooded pasture and grassland habitats, and Resource Category 4 to pasture, cropland, and other disturbed areas.

Based on these assignments and the alternative plans, the [illegible] alternatives will avoid most of the impacts to fish and wildlife resources and will require minimal compensation. Of the three of alternatives, Bear Creek appears to have lesser impacts due to the extent of pasture and wooded pasture in the impounded area. Alternatives 3, 4 and 5 will involve significant losses of forested habitat which is difficult to compensate for. In particular, any of the Skunk River Greenbelt should be avoided since the environmental, recreational, and wildlife values of this area may preclude adequate mitigation alternatives.

[illegible] and Recommendations

Based on the preceding discussion of alternative plans, [illegible] Creek Impoundment Alternative 3 and the proposed levee will meet the project objectives and have the least impacts to fish and wildlife resources. Due to extensive impacts to the Skunk River Greenbelt, we [illegible] favorably upon Alternatives 4 and 5. In addition, we recommend that several other alternatives be considered. Serious consideration should be given to the Soil Conservation Service's Resource Protection Plan (RPP) and Maximum Infiltration Plan (MIP) for reducing peak flood flows as outlined in their recent input to this reevaluation study. Also, alternative water supplies for Ames, such as reallocation of Saylorville Lake water supply, etc., should be investigated.

In order to complete a Fish and Wildlife Coordination Act report for this project, we will need the following information:

1. A description and map of all feasible alternatives being considered for detailed planning.

2. Complete a habitat inventory of the feasible alternatives.

3. Survey the area to determine if suitable habitat may exist in the study area for federal endangered and threatened species.

4. Survey the study area for state of Iowa threatened or endangered species. This survey should include sampling periods in spring, summer, fall, and winter.

5. Fisheries and "in stream" surveys, including, spring, summer, and fall sampling periods, should be conducted to update data on the Skunk River, and establish baseline data on the tributary streams.

6. Expected flow rates from each of the reservoir alternatives.

7. Water quality data for the Skunk River and Bear Creek.

Once feasible alternatives are selected, we recommended completion of the habitat inventory and surveys as soon as possible, so that the impact analyses can be completed concurrently with project planning.

We look forward to participating in planning on this project. If you have any questions, please contact Wayne Bissell or myself. We recommend using the Service's Habitat Evaluation Procedures (HEP) for any site selected for future study. The HEP analysis will assist in understanding the relative impacts of each of the alternatives and in determining mitigation requirements. Furthermore, mitigation for low flow regimes and potential impacts to aquatic resources need to be conducted. If potential adverse impacts are identified, the Service's Instream Flow Methodology (IFM) may be appropriate to determine flow regimes to minimize impacts. In addition, we would like to assist in preparation of any scopes of work to obtain fish and wildlife information.

Sincerely,

Richard C. Nelson
Field Supervisor

cc: IDC (Wilson, Hayes, Jones, Putnam)
Story County Conservation Board
IDWAM (Pinnoha)
U.S. EPA (Kreig)

References

Coon, David Max. 1971. A fisheries survey of the Upper Skunk River, IA. M.S. Theisis, Iowa State University, Ames, Iowa. 96pp.

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Larry J. Wilson — Director
Wallace State Office Building, Des Moines, Iowa 50319-0034
515/281-5145

August 27, 1986

Colonel William C. Burns
Rock Island Corps of Engineers
Clock Tower Building, P. O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Burns:

I have reviewed the scaled-down Ames Lake project proposals. The Iowa Department of Natural Resources does not support the proposal and does not have any interest in cost-sharing the lake's development nor its operation and maintenance.

Our primary reason for opposing the project is the lake's large drainage area relative to lake size (108:1). The preferred ratio for that area of the state is 15:1 for a good quality multi-purpose recreation lake.

I met with Ames city officials to discuss the proposed project and their long-term water supply needs. We mutually agreed that an impoundment on a tributary to the Skunk River may warrant further exploration. I informed the city that Iowa DNR staff will provide comments and information from environmental and recreation perspectives on any proposed tributary sites and impoundment sizes.

Thank you for the advanced opportunity to review the Upper Skunk River Basin Reevaluation Study.

Sincerely,

LARRY J. WILSON, DIRECTOR
DEPARTMENT OF NATURAL RESOURCES

rlt:L32

cc: Harris Seidel, City of Ames

ALL-AMERICA CITY
1982-1983

CITY OF AMES, IOWA 50010

City Administration Building
621 Main Street
Ames, Iowa 50010
515-239-5105

F. PAUL GOODLAND
MAYOR

September 9, 1986

Col. William C. Burns
Rock Island Corps of Engineers
Clock Tower Building
P. O. Box 2004
Rock Island, Illinois 61201

Dear Col. Burns:

The City of Ames has received most of the relevant material regarding the proposed scaled-down Upper Skunk River Lake Project. At their August 26, 1986, meeting the City Council passed a motion requesting that the Mayor inform the Corps of Engineers that the City of Ames is not interested in sponsoring the proposed scaled-down dam project. While the City of Ames is interested in identifying additional water supplies, it is difficult to justify during these harsh economic times such a significant expenditure in capital and operating costs for this facility, when our actual need for additional water capacity is not expected for the next 20 years.

It is our understanding that the Corps examined other smaller impoundment areas, but determined that the cost benefit ratio for these facilities did not warrant further consideration. It may be helpful if you would share your analysis of these smaller impoundment facilities with us. Perhaps in the future we could discuss a joint effort with the Corps of Engineers and the Department of Natural Resources regarding impoundments on certain tributaries to the Skunk River or low head dams such as the one we recently constructed in Ames.

We would like to thank you very much for your extensive analysis on the Upper Skunk River Basin Reevaluation Study. We hope that in the future we will be

able to work together on a similar project which will meet both of our needs and, at the same time, minimize the negative effects on the county's greenbelt.

While I am personally in favor of the Upper Skunk River Lake Project, the Council has consistently been opposed. Therefore, I must communicate the final decision to you.

Respectfully,

F. Paul Goodland
Mayor, City of Ames

FPG/nd

c: Ames City Council
Steven Schainker, City Manager
Harris Seidel, Director of Water and WPC
Congressman Neal Smith

The following resolution was offered by Councilmember Nelson, who moved its adoption.

RESOLUTION NO. 86-14

WHEREAS, the Ames Lake Project proposed by the United States Corps of Engineers and the scaled down version of this same project proposed by the United States Corps of Engineers is hereby on the agenda for consideration by the City Council of the Incorporated City of Story City, Iowa, and

WHEREAS, the City Council of the Incorporated City of Story City, Iowa, is already on record as being in opposition to the Ames Lake Project proposed by the U. S. Corps of Engineers, and

WHEREAS, the U. S. Corps of Engineers admits that the original Ames Lake Project is impractical and that the scaled down version of the original Ames Lake Project has a very poor cost to benefit ratio, and

WHEREAS, the U. S. Army Corps of Engineers can find no sponsor for the cost sharing plan for the Ames Lake Project, and

WHEREAS, the City of Ames, Iowa and Story County, Iowa and the State of Iowa all refuse to endorse the project.

Now, therefore, BE IT RESOLVED by the City Council of the Incorporated City of Story City, Iowa that this City Council of the Incorporated City of Story City, Iowa is still opposed to the Ames Lake Project proposed by the U. S. Corps of Engineers and desires that the Ames Lake Project be completely and finally deauthorized so that the citizens of

Story City, Iowa and their friends and their neighbors might go on about their business without the fear of another Feasibility Study. and

Now, therefore BE IT FURTHER RESOLVED by the City Council of the Incorporated City of Story City, Iowa that this resolution passed this day be brought to the attention of the Congress of the United States of America by delivery to the representative from this district to the Congress of the United States of America.

This motion was seconded by Councilmember Clayberg and on roll call, carried by an aye and nay vote as follows:

AYE: Longseth, Jensen, Nelson, Clayberg, Erickson

NAY: None

ABSENT: None

WHEREUPON, the Mayor declared the motion duly passed this 6th day of October, A.D., 19 86

Mayor

ATTEST:

City Clerk

STORY COUNTY BOARD OF SUPERVISORS

RESOLUTION 86-40

WHEREAS, studies and debate have gone on since the 1930's concerning the Army Corp of Engineers' proposed projects on the Skunk River Basin, and during this elasped time, no definite action has been taken by the Corp of Engineers due to the vast amount of controversy associated with any proposed project; and

WHEREAS, complete and final deauthorization of the Skunk River Basin project is indicated by the following negative consequences of this project:

1. Increased tax burden placed on landowners, i.e., the reduced ag land tax base which would affect local government and school districts;
2. Increased tax to residents of Iowa to pay for the project, i.e., local-requirement current-cost estimated at $18.75 million, non-federal-sponsor estimated annual cost of $1.75 million for operation and maintenance, and increased costs as a result of inflation;
3. Detrimental effects to farm drainage systems vital to ag production above the normal flood pool area;
4. Severe siltation problems associated with a project of this type in an intensively tilled rural agricultural area;
5. The $44 million cost of the Ames Lake dam could better be directed toward soil conservation practices within Iowa;
6. The elimination of one of the area's only natural habitat greenbelt areas.
7. Restudy of the project every eight years unless deauthorized by Congress; i.e., cost of the last study was $250,000; and

WHEREAS, the Corp of Engineers' study showed that the cost benefit ratios are unfavorable for a project of this type and no sponsor has been found for the Corps' cost-sharing plan nor has there been any endorsement for the project by any municipality, county or the State of Iowa; and

WHEREAS, if funding were used for soil conservation practices in the upstream watershed instead of construction, maintenance and siltation impoundments for the dam on the Skunk River, the benefits would far exceed those associated with the dam; and

WHEREAS, we believe that benefits derived from flood control and water supply retention do not outweigh the economic damage to the farmland that drains into the Skunk River and its tributaries;

BE IT THEREFORE RESOLVED that the Story County Board of Supervisors request the complete and final deauthorization by Congress of the Army Corps of Engineers' proposed projects on the Skunk River Basin.

Moved for adoption by Donald E. Nelson, seconded by Fred L. Mathison.

Voting aye: Nelson, Mathison, W. G. Stucky

Voting nay: none

Not voting: none

Absent: none

Passed this 4th day of November, 1986.

Attest:

Donald E. Nelson
Chair, Board of Supervisors

Alvina M. Mathison
County Auditor

Association of Soil Conservation District

Route 1, Box 66
Casey, IA 50048
January 26, 1987

TO: Colonel Bernard Slofer, Corps of Engineers

FROM: Norman Kading, Chairman of Resolutions Committee, Iowa Association of Soil Conservation District Commissioners

RE: Resolutions Passed at 1986 Annual Conference

During the Annual Conference for Soil Conservation District Commissioners held in Des Moines on December 1 and 2, 1986, the commissioners of Iowa expressed their opinions on various issues regarding conservation of soil and water resources and problems that arise in the operation of soil conservation districts. Those opinions were expressed through various (12) resolutions presented and voted upon at the conference.

Enclosed is a resolution acted upon by the IASCDC and supported by a vote of 272 yes and 7 no. The intent of the resolution was aimed at permanent deauthorization of the Skunk River Dam project north of Ames, Iowa.

I thought that this information would be of interest to you and would be of value in determining future course of action on that project.

NK/maf
Enclosure

Annual Conference for
Soil Conservation District Commissioners
December 1-2, 1986

Resolution

#6 Skunk River Dam Project Deauthorization (272 yes, 7 no)

BE IT RESOLVED, that the IASCDC support the immediate deauthorization of the U.S. Army Corps of Engineers proposed Skunk River Dam north of Ames.

APPENDIX D

COST ESTIMATES

GENERAL REEVALUATION REPORT

UPPER SKUNK RIVER BASIN, IOWA
(AMES LAKE)

APPENDIX D
COST ESTIMATES

Authorized Ames Dam and Reservoir
Cost Estimate

Real Estate		$19,000,000
Administration Center	$ 527,000	
Overlook	264,000	
Reservoir Clearing	1,237,000	
Boundary Surveys & Marking	230,000	
Recreation Facilities	4,906,000	
Dam Embankment	6,313,000	
Outlet Works	6,390,000	
Spillway	6,523,000	
Relocations	12,007,000	
O&M During Construction	220,000	
Subimpoundments		
Bear Creek	1,441,000	
Dam Site	287,000	
Subtotal	$40,345,000	
Contingencies (15% ±)	6,055,000	
Subtotal	$46,400,000	
E&D and S&A	6,495,000	
	$52,895,000	$52,895,000
	Total Cost	$71,895,000

Downsized Ames Dam and Reservoir
(3.0 inches flood storage)

Cost Estimate

Real Estate		$7,600,000
Administration Center	$ 527,000	
Overlook	264,000	
Reservoir Clearing	604,000	
Boundary Surveys & Marking	158,000	
Recreation Facilities	2,250,000	
Dam Embankment	4,585,000	
Outlet Works	3,000,000	
Spillway	8,170,000	
Relocations	5,415,000	
O&M During Construction	210,000	
Subtotal	$25,183,000	
Contingencies (20%)	5,037,000	
Subtotal	$30,220,000	
E&D and S&A	4,180,000	
	$34,400,000	$34,400,000
	Total Cost	$42,000,000

Squaw Creek Detention Dam
(Dry Reservoir)

Cost Estimate

Real Estate		$9,[illegible]
Clearing & Grubbing (Dam & Spillway	$ 84,[illegible]	
Boundary Surveys & Marking	[illegible],000	
Dam Embankment	3,750,000	
Outlet Works	[illegible],000	
Spillway	3,200,000	
Relocations	2,500,000	
O&M During Construction	165,000	
Subtotal	$11,[illegible],000	
Contingencies (20%)	2,221,000	
Subtotal	$13,300,000	
E&D and S&A	1,870,000	
	$15,170,000	$15,170,000
	Total Cost	$24,670,000

Bear Creek Water Supply Dam and Reservoir
Cost Estimate

Real Estate		$1,500,000
Reservoir Clearing	$ 61,000	
Dam Embankment	480,000	
Outlet Works	61,000	
Spillway	695,000	
Subtotal	$1,297,000	
Contingencies (15%)	193,000	
Subtotal	$1,490,000	
E&D and S&A	210,000	
	$1,700,000	$1,700,000
	Total Cost	$3,200,000

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WASHINGTON, DC 20510

HONORABLE TOM HARKIN, UNITED STATES SENATE
WASHINGTON DC 20510

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721 FEDERAL BUILDING, 210 WALNUT STREET
DES MOINES, IA 5030

HONORABLE TOM HARKIN, UNITED STATES SENATOR
733 FEDERAL BUILDING, 210 WALNUT STREET
DES MOINES, IA 5

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DES MOINES, IA 50309-2317

HONORABLE NEAL SMITH, REPRESENTATIVE IN CONGRESS
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DES MOINES, IA 50310-1744

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OLD POST OFFICE BLDG., SUITE 809, 1100 PENNSYLVANIA AVENUE NW
WASHINGTON DC 20004

DIRECTOR, OFFICE OF POLICY & PROGRAM CONSERVATION
DEPT OF COMMERCE, RM 5131 (PP/EC), 14TH & CONSTITUTION AVE., NW
WASHINGTON, DC 20230

DR ALLAN HIRSCH, DIRECTOR, OFFICE OF FEDERAL ACTIVITIES (A-104)
US ENVIRONMENTAL PROTECTION AGENCY, 401 M STREET SW
WASHINGTON DC 20460

FEDERAL EMERGENCY MANAGEMENT ADMIN, 500 C STREET S.
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WASHINGTON DC 20235

MR RICHARD NELSON - FIELD SURVEY, U.S.FISH & WILDLIFE SERVIC
1511 SECOND AVE. - 2ND FLOOR, ROCK ISLAND, IL 61201

JIM KUEL, SOIL CONSERVATION SERVICE
FEDERAL BUILDING, 210 WALNUT ST
DES MOINES IA 50309

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ROUTE 2, ST CHARLES IA 50240

JEANE S GLEN, US SOIL CONSERVATION SERVICE
693 FEDERAL BLDG, 210 WALNUT ST
DES MOINES IA 50309

STATE CONSERVATIONIST, SOIL CONSERVATION SERVICE USDA
693 FEDERAL BLDG, 210 WALNUT STREET
DES MOINES IA 50309

GEOLOGICAL SURVEY MAP AD, ENERGY AND ECOLOGICAL RESOURCES DIVI
IOWA DEPT OF NATURAL RESOURCES, 123 NORTH CAPITOL STREET
IOWA CITY IA 52241

WATER RES. RESEARCH CENTER, ATTN DR AL ALSTIN
355 TOWN ENGINEERING BUILDING, IOWA STATE UNIVERSITY
AMES IA 50010

REGIONAL DIRECTOR, REGION 3, U.S.FISH AND WILDLIFE SERVICE
FEDERAL BLDG, FORT SNELLING, TWIN CITIES MN 55111

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STATE CAPITOL, DES MOINES, IA 50319

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200 EAST GRAND AVENUE, DES MOINES IA 50319

CARROLL MCALLISTER-BUREAU CHIEF, SURFACE & GROUNDWATER PROT BUREAU-DNR
WALLACE STATE OFFICE BLDG, 900 EAST GRAND AVENUE
DES MOINES IA 50319

MR LARRY WILSON - DIRECTOR, DEPT OF NATURAL RESOURCES 2
WALLACE STATE OFFICE BLDG, 900 EAST GRAND AVENUE
DES MOINES IA 50319

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CAPITOL BUILDING, DES MOINES IA 50319

THATCHER JOHNSON, IOWA DEPT OF AGRICULTURE
CAPITOL BUILDING, DES MOINES IA 50319

DIRECTOR, IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF POLICY, 800 LINCOLN WAY
AMES, IA 50010

MR JAMES COHN, IOWA DEPT OF TRANSPORTATION
826 LINCOLN WAY, AMES IA 50010

DAN LINDQUIST, IOWA DEPT OF SOIL CONSERVATION
STATE CAPITOL COMPLEX, DES MOINES IA 50319

JERRY SHIPLER, IOWA FARM BUREAU
5400 UNIVERSITY AVE, WEST DES MOINES IA 50265

TOM PUTNAM, FISHERIES BIOLOGIST II
ROUTE 1, LEDGES ROAD
BOONE IA 50036

MR DAVID OSCOOD, STATE HISTORIC PRESERVATION OFFICER
HISTORICAL BUILDING, EAST 12TH & GRAND AVENUE
DES MOINES, IA 50319

PRESIDENT, STATE HISTORICAL SOCIETY OF IOWA
E 12TH AVE GRAND AVENUE, DES MOINES IA 50309

STATE ARCHEOLOGIST, UNIVERSITY OF IOWA
EAST LAWN BLDG, IOWA CITY IA 52240

HONORABLE CHARLES BRUNER, IOWA SENATOR
4621 WESTBEND, AMES IA 50010

HONORABLE JACK R. NYSTROM, IOWA SENATOR
115 CLINTON, BOONE, IOWA 50036

HONORABLE GENE GLANZMAN, IOWA REPRESENTATIVE
RR 1 BOX 137, SCRANTON IA 51462

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1215 MAMIE EISENHOWER AVENUE, BOONE, IA 50036

HONORABLE RALPH ROSENBERG, IOWA REPRESENTATIVE
111 STATE STREET, AMES IA 50010

PHILIP COX, CONSERVATION COUNCIL
RR 1, AMES IA 50010

ARNOLD SCHN - CHIEF, PLANNING BUREAU - DNR
WALLACE STATE OFFICE BUILDING, 900 EAST GRAND AVENUE
DES MOINES IA 50319

DAN LINDQUIST - SECRETARY, SKUNK RIVER CONSERVANCY DISTRICT
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