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Hydrologic Engineering Center

Opportunities for Reservoir Storage Reallocation

July 1988

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US Army Corps of Engineers
Institute for Water Resources
Hydrologic Engineering Center (HEC)
609 Second Street
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14. ABSTRACT
This report documents research on reallocation of reservoir storage for municipal and industrial water supply. The purpose of this research is to identify opportunities for reallocation of storage at Corps reservoirs by examining specific studies, projects and Federal-State partnerships where reallocation has been considered.

15. SUBJECT TERMS
reallocation, reservoir storage, municipal, industrial, water supply, Corps, projects, studies, partnership, investigation, database, data, statistical, conservation, sediment, storage, seasonal, flood control space, dry season, water control plan, dam, regulation, non-Corps, investment, O&M costs, marketing, assurance, excess storage

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Prepared for:
US Army Corps of Engineers
Institute for Water Resources
Casey Building
7701 Telegraph Road
Alexandria, VA 22315-3868

Prepared by:
US Army Corps of Engineers
Institute for Water Resources
Hydrologic Engineering Center
609 Second Street
Davis, CA 95616

(530) 756-1104
(530) 756-8250 FAX
www.hec.usace.army.mil

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OPPORTUNITIES FOR RESERVOIR STORAGE REALLOCATION

Contents

INTRODUCTION

Authority and Purpose

In recent years several policy studies have been conducted by the Institute for Water Resources, Corps of Engineers on reallocation of reservoir storage for municipal and industrial water supply. This investigation is a continuation of that effort. Its purpose is to identify opportunities for reallocation of storage at Corps reservoirs by examining specific studies, projects and Federal-State partnerships where reallocation has been considered. Sixteen study reports were examined and are reported here. In addition, discussions were held with Corps engineers in district and division offices on other projects where reallocation has been or is being considered. Together, the reports and discussions identified eight general opportunities for reallocation. The applicability of these general cases to Corps' reservoirs nationwide will depend upon the conditions at each individual site and must be evaluated on a site by site basis. A Memorandum of Understanding (MOU) between the State of Kansas and the Department of the Army is discussed as an example partnership where innovative opportunities can be developed.

Method of Investigation

Initial efforts in researching the project were made by contacting various Corps personnel and obtaining existing reservoir reallocation studies from the districts. Sixteen such studies were examined and are reported in Appendix A.

A visit was made to Washington, D.C. to speak with Corps personnel at the Office, Chief of Engineers (HQUSACE) and the Institute for Water Resources (IWR). The information gathered on this trip proved especially useful to help identify the particular aspects of reallocation which are of concern to the Corps and that should be addressed in this report.

Corps personnel at the various field offices were also visited. The Fort Worth District provided information on the background and work-to-date on creating a concept paper for a Memorandum of Understanding (MOU) in Texas. This information was supplemented by the Southwestern Division (SWD) in Dallas who provided information on reallocation and a reservoir yield simulation model used in conjunction with the Kansas MOU.

Valuable insight and background to understanding the Kansas MOU were provided by both the Tulsa and Kansas City Districts. Questions which had arisen from the trip to Washington, D.C. and previous research were answered and clarified. The Missouri River Division (MRD) in Omaha further supplemented information pertaining to the Kansas MOU and specific projects in their region.

A two-day workshop on "Reservoir Storage Reallocations for Water Supply" was held in Kansas City, 28-29 September 1987. This workshop brought together sixty Corps personnel from various Corps' offices to discuss a wide-range of topics related to reallocation of reservoir storage. This included both specific projects and policy agreements such as the Kansas MOU.

Another source of information was a "A Database to Assess Reservoir Storage Reallocation Opportunities" developed by The Hydrologic Engineering Center (1987). This provided data on nearly 600 Corps of Engineers reservoir projects and 181 water supply contracts with non-federal interests. Various statistical tabulations were developed from these data.

A comprehensive view of reservoir reallocation was developed from talking with various Corps personnel, from the workshop and from studying numerous project and policy documents. This led to the selection of the four principal topics discussed in this report. These include: a profile of existing Corps projects, a summary of sixteen existing reservoir reallocation studies, a

discussion of innovative agreements such as the Kansas MOU and an assessment of opportunities for reservoir reallocation.

Principal Findings

1. Reallocation of storage to municipal and industrial water supply at Corps of Engineers reservoirs has been considered in a variety of ways. Eight general cases have been documented in this study based upon an examination of Corps reallocation studies and projects. These cases illustrate the types of opportunities available for reallocation.

(1) Use of water supply storage not under contract
(2) Temporary use of storage allocated for future conservation purposes and sediment
(3) Storage made available by change in conservation demand or purpose
(4) Seasonal use of flood control space during dry season
(5) Reallocation of flood control space
(6) Modification of reservoir water control plan and method of regulation
(7) Raising existing dam
(8) System regulation of Corps and Non-Corps reservoirs

2. Opportunities for reallocation can also be created through new partnerships with states and other water agencies. The Memorandum of Understanding between the State of Kansas and Department of Army is the principal example. Such partnerships occur where careful planning and analyses precede cooperative discussions which develop partnerships in which all parties benefit.

Acknowledgements

The splendid cooperation of professionals in Corps district, division and headquarters offices made this study possible. They took time to discuss, at length, questions and studies on reallocation, they provided numerous policy and project documents, and when asked, they reviewed draft sections of this report. Their help is greatly appreciated. A special thanks to the Kansas Water Office for their assistance in reviewing the section of the report on the Kansas MOU. Jean Beegle, civil engineer with the Hydrologic Engineering Center (HEC) during the summer of 1987 participated in the discussions and corresponded with the various Corps offices, prepared the sixteen summaries of reallocation studies and drafted the final report. Typing of both the drafts and final report was the good work of Chris Ayala. Bill Johnson, HEC, provided supervision and final editing. Darryl Davis, Chief, Planning Division and Bill Eichert, Director, HEC, provided general guidance. Jim Comisky, Institute for Water Resources (IWR) was especially helpful in getting this study launched in its early stages. He provided much good counsel from his own earlier research on reallocation and made available many important documents. Funding for the study was provided by, Kyle Schilling, Chief, Policy Division and Randy Hanchey, Director, Institute for Water Resources.

PROFILE OF EXISTING CORPS RESERVOIRS

The Corps of Engineers owns approximately 600 reservoirs including navigation locks and dams. They are regulated and maintained through ten Division and thirty-six District offices located throughout the continental United States. Data describing the geographical, physical, economic, environmental, social, institutional and legal features of these reservoirs are available from a variety of documents and computer databases. To assist in assessing the opportunities for reservoir storage reallocation for municipal and industrial water supply a database was developed from three existing databases and includes data of interest in reallocation. It is the purpose of this section to present a brief profile of Corps reservoirs using these data. It is intended to provide a thumbnail sketch of Corps reservoir storage nationwide as a preface to the specific project considerations discussed later.

Reservoir Storage and Project Distribution

There is approximately 215 million acre-feet of single and multiple-purpose storage in Corps of Engineers reservoirs. Table 1 summarizes this storage for all projects. Ninety percent of the single-purpose storage is for flood control. There is approximately 109 million acre-feet of storage serving multiple-purposes with approximately 74 million acre-feet having municipal and industrial water supply as one of those purposes.

Table 2 shows the geographical distribution of Corps Division and District offices together with their three-letter code abbreviations. The single- and multiple-purpose storages presented in Table 1 are represented by projects in Tables 3 and 4. The predominance of projects with single-purpose flood control and navigation storage is clearly indicated in Table 3.

Table 4 shows that there are approximately 275 projects with multiple-purpose storage. The combinations of purposes are

numerous. Municipal and industrial (M&I) water supply is a purpose in approximately 109 projects. Over half of these projects are in the Southwestern Division (SWD).

Water Supply Storage

Corps' reservoir storage for M & I water supply can be examined separate from other purposes because data are collected as part of the Corps water supply program. This is not true for most other purposes. Table 5 shows that there is presently a little over 6 million acre-feet of storage used for M & I water supply. There is an additional 3.3 million acre-feet allocated for future M & I water supply and approximately 0.94 million acre-feet that is not under contract. This means there is nearly a million acre-feet of future storage not under contract which is available for M & I water supply. The geographic distribution of this storage by Corps Division offices is shown in Table 6. Sixty-five percent of the storage not under contract is available in the southwest (SWD). Another 20% is available in the Lower Mississippi Valley Division (LMV). The distribution of storage not under contract by reservoir is presented in Table 7.

The number of current M & I water supply contracts is 161. Sixty-two percent of these are with the Fort Worth and Tulsa Districts. The distribution of contracts by District is presented in Table 8.

This brief profile of Corps reservoir projects, their storage, purpose, M & I water supply and geographical distribution provides an introduction to the potential of Corps reservoirs and current M & I water supplies nationwide. In the sections which follow the opportunities for reallocation will be investigated by examining individual reservoirs and systems of reservoirs. These individual reservoirs are part of the larger picture summarized in this section.

TABLE 1

CORPS OF ENGINEERS
TOTAL RESERVOIR STORAGE

Purpose	Storage (acre-feet)
Single-Purpose Storage[1]	
Single-Purpose Flood Control Storage	95,534,000
Single-Purpose Navigation Storage	2,698,000
Single-Purpose Storage-Other	7,995,000
Sub-total	106,227,000
Multiple-Purpose Storage[2]	
Multiple-Purpose Storage with M & I[3]	74,390,000
Multiple-Purpose Storage-Other	34,633,000
Sub-total	109,023,000
Total	215,250,000

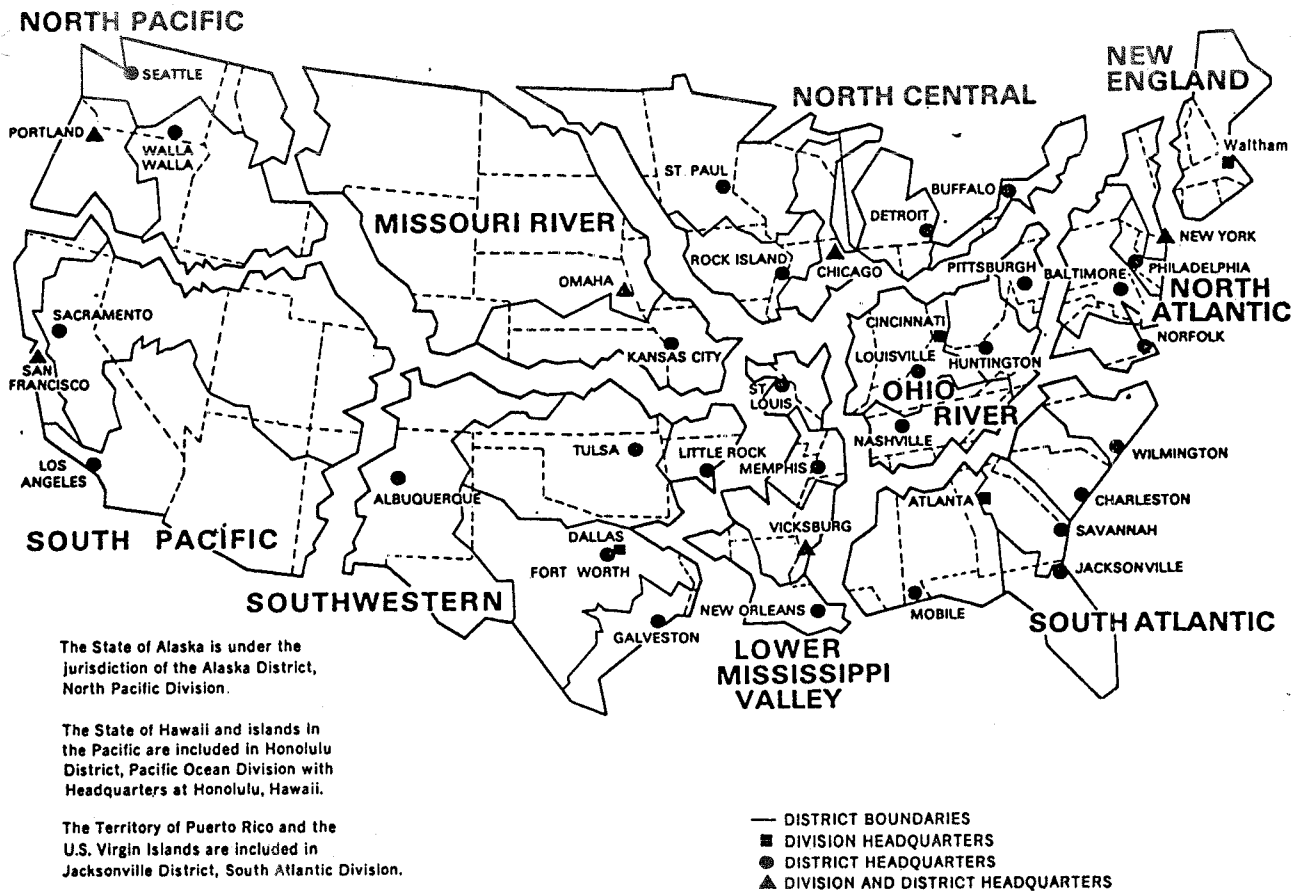
[1] Single-purpose storage refers to storage serving a single purpose. Flood control is the predominate single purpose.

[2] Multiple-purpose storage refers to storage serving two or more purposes.

[3] Multiple-purpose storage where one purpose is M & I water supply.

TABLE 2

CORPS OF ENGINEERS DIVISION
AND DISTRICTS FOR CIVIL WORKS ACTIVITIES



DIVISION	CODE
LOWER MISSISSIPPI VALLEY DIVISION	LMV
MISSOURI RIVER DIVISION	MRD
NEW ENGLAND DIVISION	NED
NORTH ATLANTIC DIVISION	NAD
NORTH CENTRAL DIVISION	NCD
NORTH PACIFIC DIVISION	NPD
OHIO RIVER DIVISION	ORD
PACIFIC OCEAN DIVISION	POD
SOUTH ATLANTIC DIVISION	SAD
SOUTH PACIFIC DIVISION	SPD
SOUTHWESTERN DIVISION	SWD

LMVD	
MEMPHIS DISTRICT	LMM
NEW ORLEANS DISTRICT	LMN
ST. LOUIS DISTRICT	LMS
VICKSBURG DISTRICT	LMK
MRD	
KANSAS CITY DISTRICT	MRK
OMAHA DISTRICT	MRO
NED	
NAD	
BALTIMORE DISTRICT	NAB
NEW YORK DISTRICT	NAN
NORFOLK DISTRICT	NAO
PHILADELPHIA DISTRICT	NAP
NCD	
BUFFALO DISTRICT	NCB
CHICAGO DISTRICT	NCC
DETROIT DISTRICT	NCE
ROCK ISLAND DISTRICT	NCR
ST PAUL DISTRICT	NCS
NPD	
ALASKA DISTRICT	NPA
PORTLAND DISTRICT	NPP
SEATTLE DISTRICT	NPS
WALLA WALLA DISTRICT	NPW
ORD	
HUNTINGTON DISTRICT	ORH
LOUISVILLE DISTRICT	ORL
NASHVILLE DISTRICT	ORN
PITTSBURG DISTRICT	ORP
POD	
SAD	
CHARLESTON DISTRICT (SAN)	SAC
JACKSONVILLE DISTRICT	SAJ
MOBILE DISTRICT	SAM
SAVANNAH DISTRICT	SAS
WILMINGTON DISTRICT	SAW
SPD	
LOS ANGELES DISTRICT	SPL
SACRAMENTO DISTRICT	SPK
SAN FRANCISCO DISTRICT	SPN
SWD	
ALBUQUERQUE DISTRICT	SWA
FT WORTH DISTRICT	SWF
GALVESTON DISTRICT	SWG
LITTLE ROCK DISTRICT	SWL
TULSA DISTRICT	SWT

TABLE 3

CORPS OF ENGINEERS
DISTRIBUTION OF PROJECTS WITH SINGLE-PURPOSE STORAGE

Division	All Single-Purposes	Flood Control	Number of Projects with Single-Purpose Storage Indicated					
			M&I	Navigation	Power	Recreation	Fish and Wildlife	Irrigation
LMV	76	45		18	2	1	6	4
MRD	49	49						
NAD	21	21						
NCD	55	6		46	1	1	1	
NED	33	33						
NPD	23	18			5			
ORD	129	72		49	6	2		
SAD	33	15		18				
SPD	27	27						
SWD	89	78		11				
TOTAL	535	364		142	14	4	7	4

TABLE 4

CORPS OF ENGINEERS
DISTRIBUTION OF PROJECTS WITH MULTIPLE-PURPOSE STORAGE

Division	All Multiple-Purposes	Number of Projects with Multiple-Purpose Storage Indicated						
		Flood Control	M&I	Low-Flow	Hydro-Power	Irrigation	Fish and Wildlife	Recreation
LMV	17	9	7	7	4	3	8	8
MRD	45	45	13	19	9	8	34	38
NAD	5	4	3	4				2
NCD	11	11	2	1	1		6	1
NED								
NPD	27	20	1	2	19	15	1	2
ORD	63	59	15	27	6		41	59
SAD	23	12	11	6	15	4	6	7
SPD	10	8	2			9		1
SWD	74	47	55	16	17	6	21	21
TOTAL	275	215	109	82	71	45	117	139

TABLE 5

CORPS OF ENGINEERS
M & I WATER SUPPLY STORAGE

Type of Storage	Storage (acre-feet)
Present Storage	6,086,000
Future Storage	3,330,000
Future Storage (not under contract) see Table 6	945,000

TABLE 6

CORPS OF ENGINEERS
FUTURE M&I WATER SUPPLY STORAGE
NOT UNDER CONTRACT

Division	Storage (acre-feet)
Lower Mississippi Valley (LMV)	187,750
Missouri River (MRD)	81,900
North Pacific (NPD)	9,600
Ohio River (ORD)	2,200
South Atlantic (SAD)	45,800
Southwestern (SWD)	617,750
Total	945,000

TABLE 7

CORPS OF ENGINEERS
NUMBER OF RESERVOIRS WITH
FUTURE M&I STORAGE NOT UNDER CONTRACT

District		Number of Reservoirs
Vicksburg	(LMK)	1
St. Louis	(LMS)	1
Kansas City	(MRK)	2
Portland	(NPP)	1
Pittsburgh	(ORP)	1
Wilmington	(SAW)	1
Little Rock	(SWL)	1
Tulsa	(SWT)	15
	Total	23

TABLE 8

CORPS OF ENGINEERS
NUMBER OF WATER SUPPLY CONTRACTS
BY DISTRICT

District		Number of Contracts
Rock Island	(NCR)	1
New England	(NED)	3
Portland	(NPP)	1
Seattle	(NPS)	1
Huntington	(ORH)	5
Louisville	(ORL)	9
Pittsburgh	(ORP)	4
Jacksonville	(SAJ)	1
Mobile	(SAM)	3
Savannah	(SAS)	3
Wilmington	(SAW)	3
Sacramento	(SPK)	3
Albuquerque	(SWA)	1
Fort Worth	(SWF)	40
Galveston	(SWG)	1
Little Rock	(SWL)	9
Tulsa	(SWT)	73
	Total	161

STUDIES AND PROJECTS WHICH HAVE CONSIDERED REALLOCATION

Selected Reallocation Studies and Projects

Corps of Engineer field offices have studied possible reallocation of existing reservoir storage for municipal and industrial water supply for a number of years. Many of these studies are documented in study reports which specifically address the question of reallocation. Sometimes an office will have examined reallocation but will not produce a specific study report either because the study was part of a larger investigation or because the study was not of the scope to justify a formal document. Such studies, whether reported formally or not, are an important source of examples of the types of opportunities available for storage reallocation. While many of these studies did not result in reallocation of storage they do illustrate the potential for reallocation. Sometimes economic, legal and institutional considerations prevent reallocation, however, these conditions can and do change, and therefore a potential for reallocation exists.

Table 9 is a summary which lists sixteen Corps reservoir projects that were studied for possible water supply reallocation possibilities. Their location, district, and date of the reallocation study report are also shown in the Table. A project summary and a reservoir profile are provided later in this section for each study. The summaries provide descriptive information on each reservoir including current project status and specific project cost information. The physical characteristics of the reservoir storage, including the storage considered for reallocation, are detailed in the reservoir profiles.

Table 10 is a summary of storages in the sixteen reservoirs including: the storage zone of the proposed reallocation, the total reservoir storage, the proposed reallocated storage, and the percent of total storage considered for reallocation. The amount of storage considered for reallocation to water supply varies from 270 A.F. to 77,400 A.F. The percent of total storage proposed for reallocation varies from 0.08 % to 33.0 %.

TABLE 9
RESERVOIR REALLOCATION STUDY REPORTS

Reservoir/Location	District	Date
Bardwell Lake Trinity River, TX	Fort Worth	Dec 1985
Barren River Lake Barren River, KY	Louisville	Aug 1965
Bear Creek Reservoir South Platte River, CO	Omaha	Nov 1984
Bloomington Lake Potomac River, MD	Baltimore	Sep 1983
Chatfield Reservoir South Platte River, CO	Omaha	Nov 1984
Cowanesque Lake Reformulation Study Tioga County, Susquehanna River Basin, PA	Baltimore	Jan 1985
Denison Dam (Lake Texoma) Red River, OK & TX	Tulsa	1985
Granger Lake San Gabriel River, TX	Fort Worth	Oct 1986
Lake O' The Pines Cypress Bayou Basin, TX	Fort Worth	Feb 1987
Rathbun Lake Chariton River, Iowa	Kansas City	May 1985
Rough River Lake Rough River, Kentucky	Louisville	Apr 1966 Dec 1978
Sam Rayburn Reservoir Angelina River, Neches River Basin, TX	Fort Worth	Jun 1986
Saylorville Lake Des Moines River, Iowa	Rock Island	Dec 1981 Apr 1982
Waco Lake Brazos River, TX	Fort Worth	Oct 1982
White River Lake White River Lakes, Ark. & MO	Little Rock	Oct 1983
Wister Lake Poteau River, Oklahoma	Tulsa	Feb 1987

Table 10

Reallocation Studies Storage

Project	Reallocation Purposes	Total Storage (A-F)	Proposed Reallocation (A-F)	Percent of Total Storage (%)
Bardnell Lake Trinity River, Texas	Flood Control Storage to Water Supply Storage	122,392	19,329	15.8
Barren River Lake Barren River, Kentucky	Permanent Pool Storage to Water Supply Storage	815,150	681	0.08
Bear Creek Reservoir South Platte River, CO	Flood Control Storage to Water Supply Storage	58,400	18,400	31.5
Bloomington Lake North Branch Potomoc River, Maryland	None to date	128,200	-----	-----
Chatfield Reservoir South Platte River, CO	Flood Control Storage to Water Supply Storage	231,400	22,700	9.8
Cowanesque Lake Cowanesque River, PA	Flood Control Storage to Water Supply Storage	86,700	24,335	28.1
Denison Dam (Lake Texoma) Red River, Oklahoma & Texas	Power Storage to Water Supply Storage	4,281,000	77,400	1.8
Granger Lake San Gabriel River, Texas	Flood Control Storage to Water Supply Storage	200,100	65,950	33.0
Lake O' The Pines Cypress Bayou Basin, TX	Flood Control Storage to Water Supply Storage	838,300	50,000	6.0
Rathbun Lake Chariton River, Iowa	Recreation Storage to Water Supply Storage	528,000	3,340	0.6
Rough River Lake Rough River, Kentucky	Conservation Storage to Water Supply Storage	334,380	270	0.08
Sam Rayburn Reservoir Angelina River, Texas	Hydropower Storage to Water Supply Storage	3,997,600	2,588	0.2
Saylorville Lake Des Moines River, Iowa	Flood Control Storage to Water Supply Storage	676,000	14,900	2.2
Waco Lake Brazos River, Texas	Flood Control Storage to Water Supply Storage	657,400	47,500	7.2
White River Basin Reservoirs White River Basin, Arkansas & Missouri	None to date	-----	-----	-----
Wister Lake Poteau River, Oklahoma	Conservation Storage to Water Supply Storage	410,640	4,400	1.1

General Cases Derived from Existing Studies and Projects

A review of the sixteen studies and subsequent discussions with Corps personnel on other projects resulted in the development of eight general cases to describe the various opportunities which exist for reallocation of storage for municipal and industrial water supply in Corps of Engineers reservoirs. The eight cases are illustrated in Figures 1 through 8 and are discussed below.

Case 1: Use of Water Supply Storage not under Contract

Some Corps' reservoirs include storage for future water supply based on a user's reasonable assurance for a need sometime in the future. Investigations have shown that some of these users no longer exist or had forgotten about their assurance since they no longer need the water. Examples include a manufacturing plant that has relocated or a municipality that has chosen to develop another source of water. These changes make water available for other water supply users.

Corps-wide there are 23 projects with 945,000 acre-feet of municipal and industrial water supply storage not under contract. The specific projects and storage available may be found in the Water Supply Program (WSP) database maintained in the Office Chief of Engineers, Civil Works, Planning Division.

Case 2: Temporary Use of Storage Allocated for Future Conservation Purposes and Sediment

Temporary use of storage authorized for conservation purposes and sediment until it is needed for those purposes provides an opportunity for temporary reallocation. Such use can include not only water supply but recreation, fish and wildlife, hydropower and other conservation purposes. This type of arrangement allows a purpose to use the water until it is needed for the original purpose, or until a permanent reallocation can be arranged. Storage space set aside for sediment is sometimes

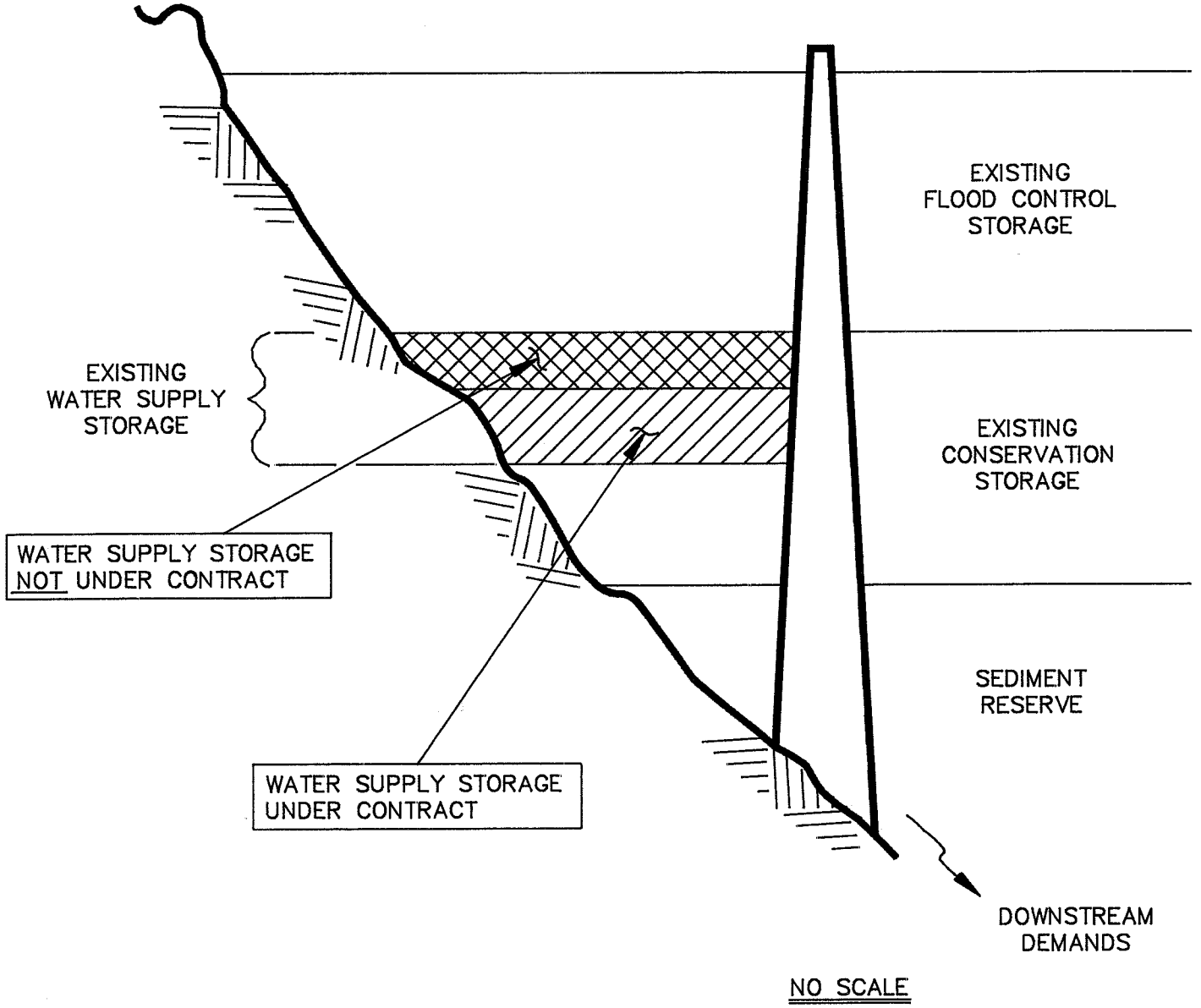


FIGURE 1: Use of Water Supply Storage not under Contract.

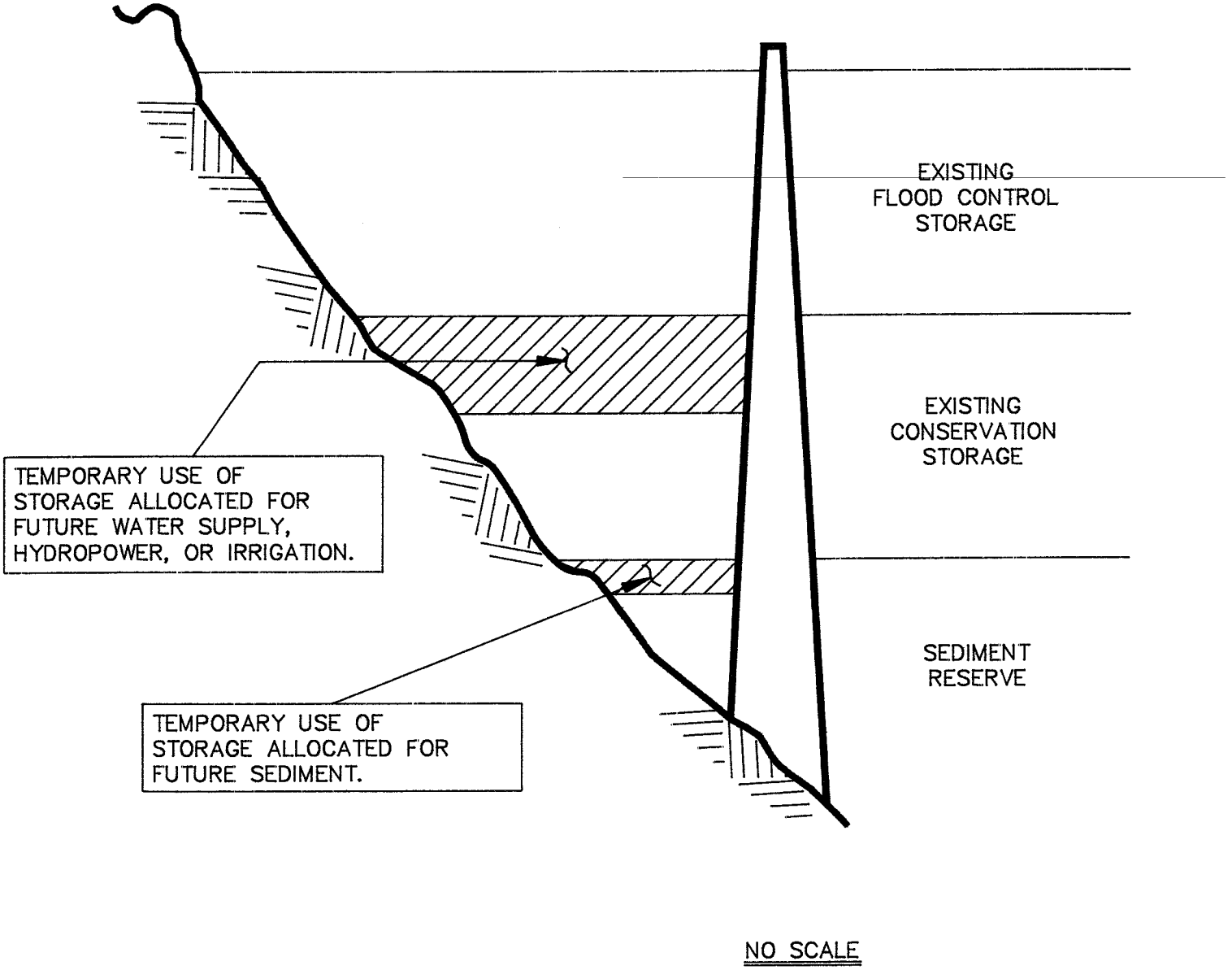


FIGURE 2: Temporary Use of Storage Allocated for Future Conservation Purposes and Sediment.

used temporarily for fish and wildlife, hydropower and recreation. During water shortage conditions, sediment space is sometimes used as a temporary source of water supply. Some reservoirs have only sediment as a purpose and are used for other purposes until the space is needed to store sediment.

Case 3: Storage made available by Change in Conservation Demand or Purpose

Originally authorized project purposes may no longer be required to meet present needs or may be available for some new equal or higher purpose. The opportunity then exists to modify or update the authorized project purposes through reallocation. For example, changes in a reservoir's upstream conditions may provide an opportunity to consider whether to extend the period that sediment could be collected without encroachment on other storage, or allow a portion of the storage initially reserved for sediment to be reallocated to water supply. Hydropower storage can sometimes be reallocated to water supply when the benefits gained by the reallocation are positive. Denison Dam (Lake Texoma), Texas, is one example of this case. Another case is where water quality storage originally provided to dilute pollutants may no longer be needed if pollutants are now being removed before being discharged into a stream or river. An example is reservoirs in the Kansas, Neosho, Marais des Cygnes and Verdigris River Basins in Kansas which are being studied for reallocation under the Kansas MOU.

Case 4: Seasonal Use of Flood Control Space During Dry Season

In some regions of the country, the probability of flooding during the dry season is very low. Where this condition exists, some reservoirs have operating procedures which allow conservation water to be stored in flood control space. Also rule curves, which vary seasonally, have been developed to vary the use of reservoir storage during the year. At some locations the storage needed is small and can easily be accommodated. In

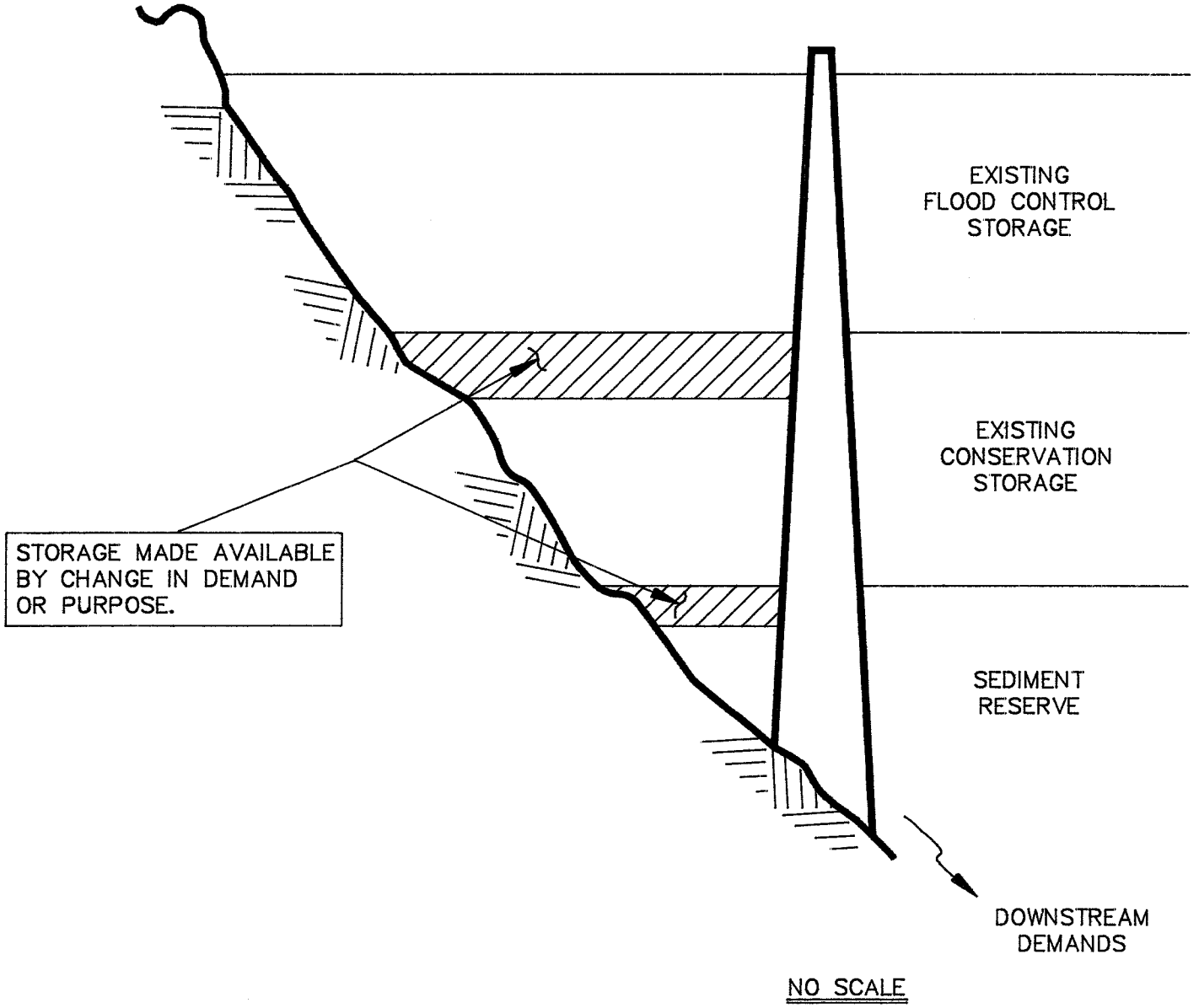


FIGURE 3: Storage Made Available by Change in Conservation Demand or Purpose.

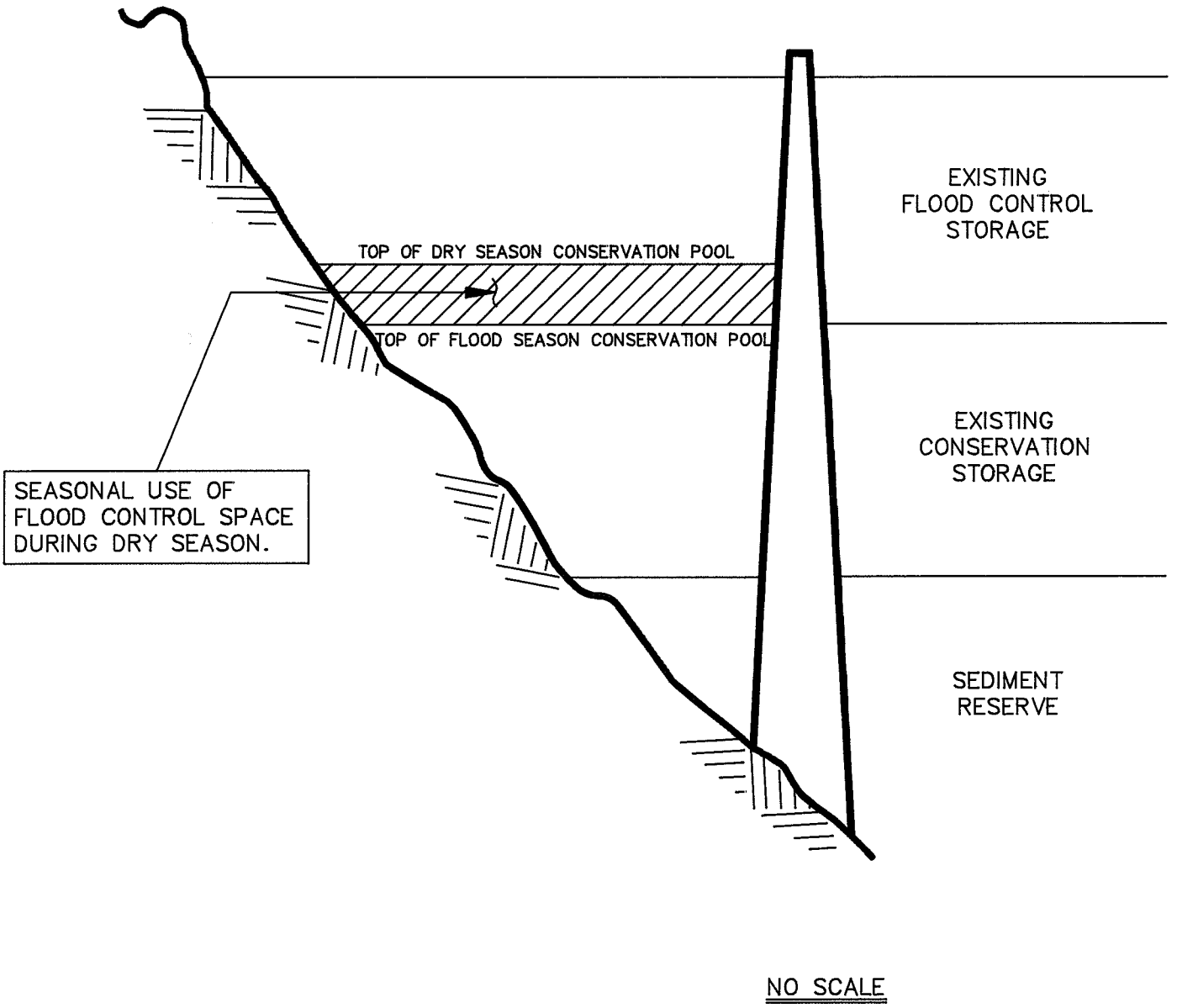


FIGURE 4: Seasonal Use of Flood Control Space During Dry Season.

others the need may be large, in which case the possible increased risk to flooding from using the flood pool, is carefully evaluated. Howard A. Hanson Dam, Washington, has 80,000 acre-feet of flood control space which is being considered for seasonal reallocation to provide water supply for the City of Tacoma. The City presently has 26,000 acre-feet of permanent water supply storage. Where flood control space is used for snowmelt floods it is sometimes possible to increase downstream diversion capability and thereby lessen the need for the flood space and use it seasonally for water supply.

Case 5: Reallocation of Flood Control Space

Three conditions which create an opportunity to reallocate flood control storage to water supply storage are:

1. Where reallocation of flood control storage volumes are small and have little or no affect on flood protection, reallocation has been considered. In a reallocation study for Sam Rayburn Reservoir, Texas it was found that raising the conservation pool 0.1 ft. provided 11,467 acre-feet of water supply storage. While this alternative was not ultimately adopted, it illustrates the potential in some reservoirs for reallocating small amounts of flood control storage.

2. Where the downstream floodplain has changed or supplemental protection has been provided, reallocation of flood control space may be a possibility. Ex post facto studies to document this case are not usually conducted by the Corps of Engineers. However, it is believed that such conditions do exist and provide an opportunity for reallocation.

3. Where reservoirs have been designed to a maximum site capacity which is larger than that required by hydrologic analysis, flood control storage is created which could be utilized for other purposes. Chatfield

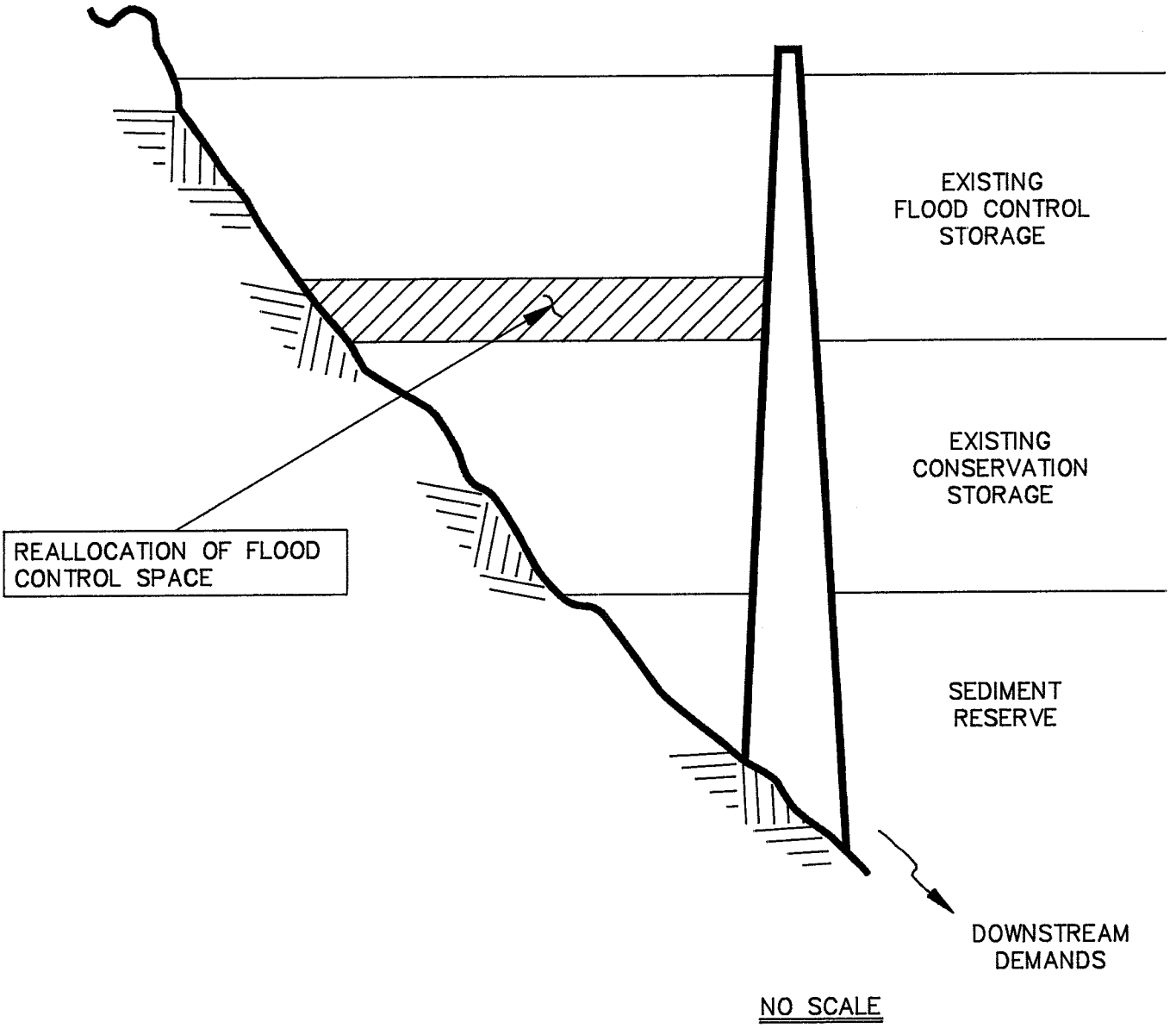


FIGURE 5: Reallocation of Flood Control Space.

Reservoir, South Platte River, Colorado has the potential to reallocate up to 22,700 acre-feet of flood control storage to water supply.

Case 6: Modification of Reservoir Water Control Plan and Method of Regulation

An opportunity exists to make additional water supply available by changing reservoir regulation for conservation purposes. Purposes such as hydroelectric power, water quality, water supply, fish and wildlife and recreation use water in both competing and complementary ways. Changing project regulation for one or several purposes can sometimes result in additional water supply without affecting the other purposes. While storage is not reallocated in a direct sense, the result is similar to a reallocation. In the southeast, during the 1986 drought, two reservoirs whose water control plan and method of regulation had been modified several years earlier stored additional water which would not have been available had the operation not been modified. An increase in dependable capacity for hydropower and modification of the water control plan at John H. Kerr and Philpott Reservoirs in the Roanoke River Basin resulted in both reservoirs having more water in storage at the end of the 1986 drought than without the rule curve modifications. Changes in water control plans for W. Kerr Scott resulted in a similar effect.

Case 7: Raising Existing Dam

Flood control space is sometimes reallocated to water supply when replacement space is provided by raising the dam. In such cases the flood pool is equal, if not greater, with the raised structure and the conservation pool is greater because of the additional water supply storage. While raising the dam may be more costly than working with existing storages as illustrated by the other cases considered here, it may be the least cost source

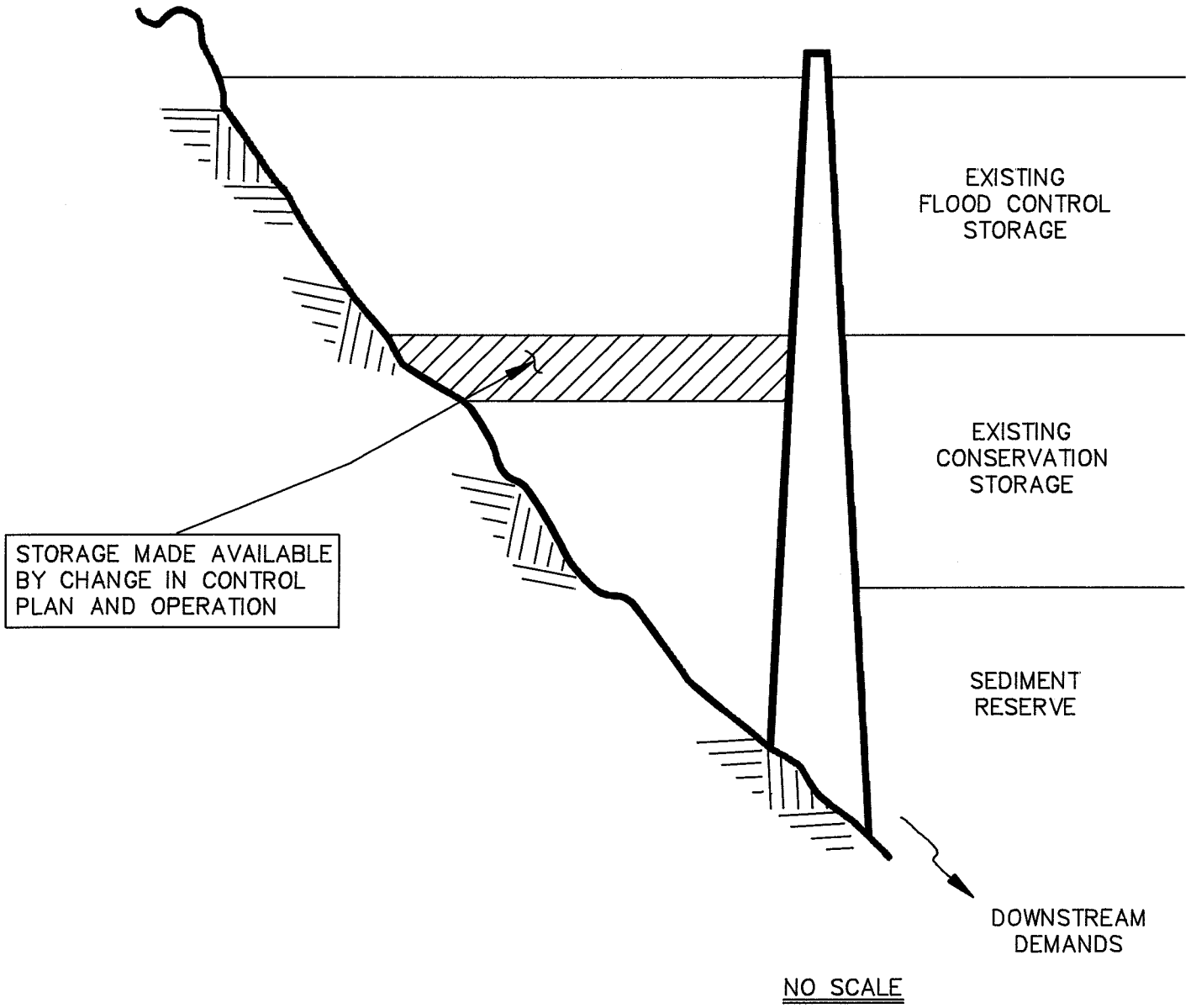


FIGURE 6: Modification of Reservoir Water Control Plan and Method of Regulation

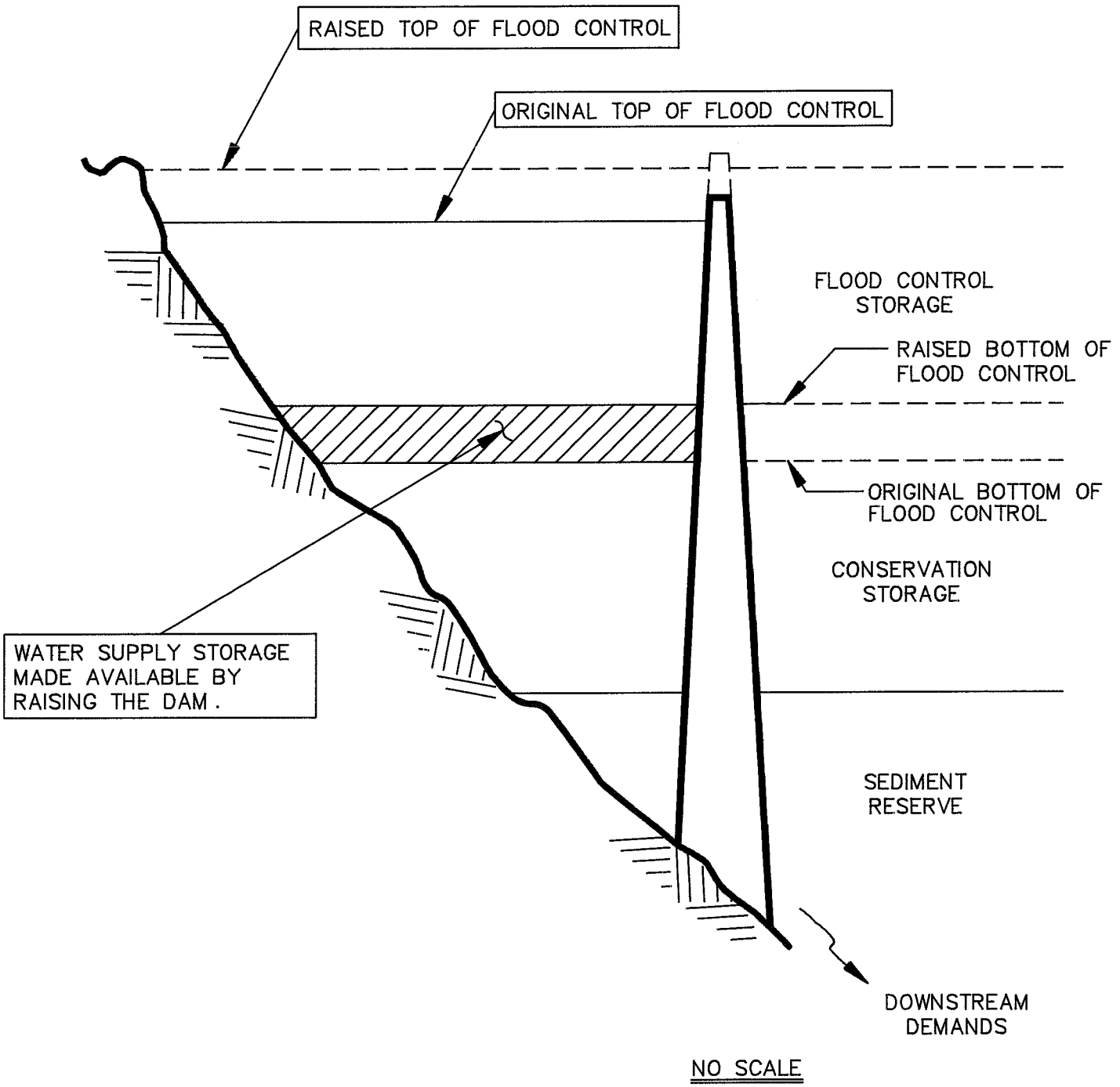


FIGURE 7: Raising Existing Dam.

of water available. F. E. Walters Reservoir, Pennsylvania, is an example of this case. The study report recommended raising the dam 30 feet to create 70,000 acre-feet of additional storage.

Case 8: System Regulation of Corps and Non-Corps Reservoirs

System regulation and coordination of reservoirs, whether Corps or non-Corps, has the potential for conserving additional water which would not be available if the reservoirs were operated individually. Typically, Corps water control plans for flood control regulation are developed on a system-wide basis because the Corps has the authority to regulate all reservoirs for flood control. Since water supply releases are commonly made at the request of different owners, the Corps authority for low-flow regulation of a reservoir system is often limited. However, an opportunity exists to work in partnership with states and other authorities to develop system regulation for water supply. The Memorandum of Understanding (MOU) between the State of Kansas and the Department of the Army, is an example of an effort to take advantage of this opportunity. Another example of Corps and non-Corps coordination occurred during the 1986 drought in the southeast where water was stored in the flood pool of Smith Reservoir, owned by Alabama Power Company, to enable the Corps reservoirs in the Apalachicola-Chattahoochee-Flint River Basin to meet low-flow needs.

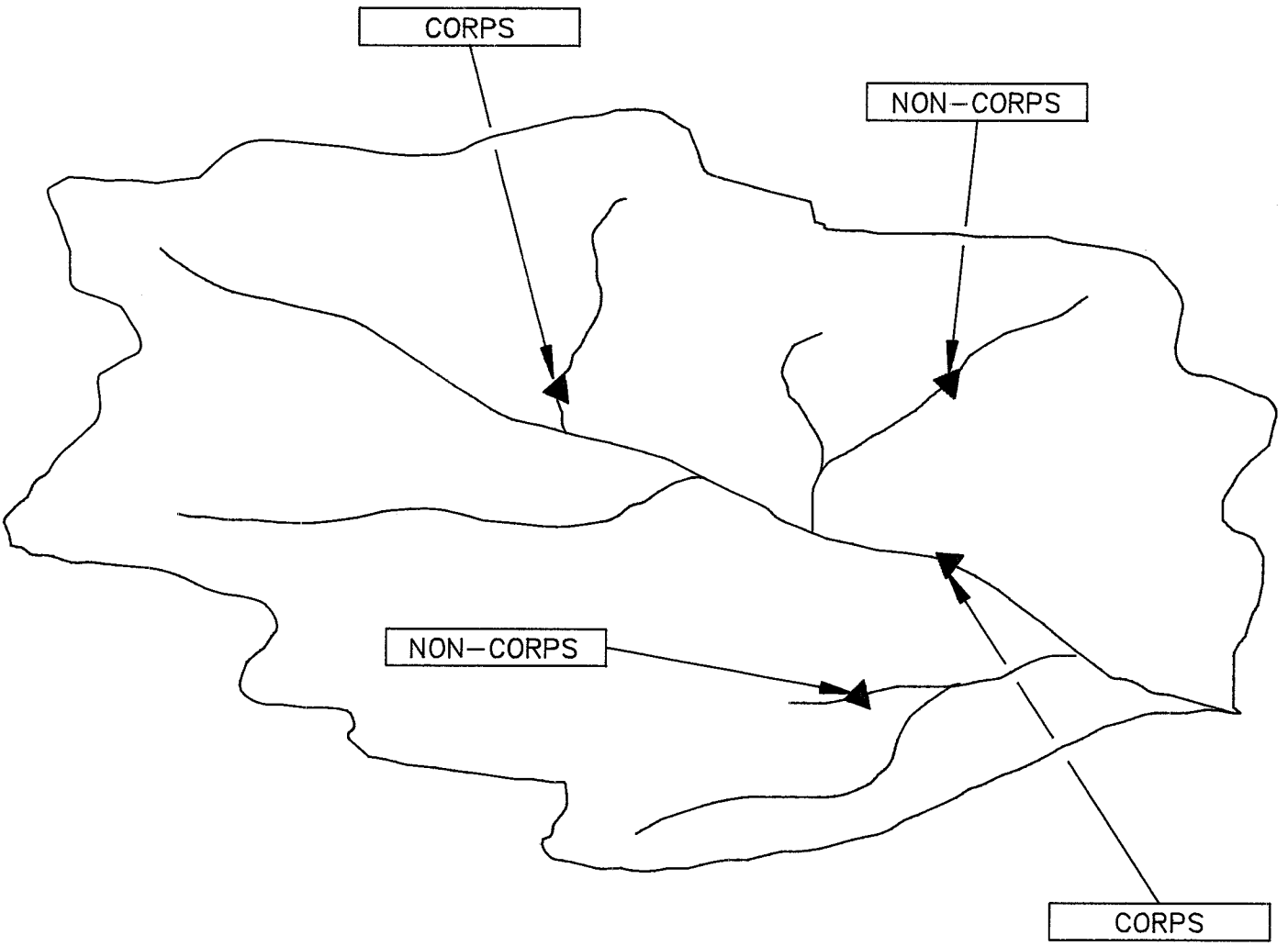


FIGURE 8: System Regulation of Corps and Non–Corps Reservoirs.

INNOVATIVE AGREEMENTS WITH STATES: STATE OF KANSAS MOU

History and Background

In the 1950's, one method of wastewater management was dilution of waste discharge with better quality water. As a result, water quality storage was authorized in reservoir projects and low-flow requirements were established. The State of Kansas played an active role in obtaining water quality storage as an authorized purpose in flood control lakes during this period. With the passage of the Federal Water Pollution Control Act Amendments of 1972, the emphasis in wastewater management shifted from dilution to point-source treatment and prevention. This created the opportunity to reallocate some of the existing water quality storage to other purposes.

On 24 March 1977, the Governor of Kansas issued Executive Order No. 77-21 establishing a task force on water resources to: (Kelly, 1984)

1. determine the water supply problems of the State for the present and in the future;
2. examine the underlying causes of the water supply problems; and
3. identify the available options the State has for resolving such problems.

To achieve these goals, the task force was to develop recommendations for any necessary changes in the existing water resources laws, policies, and programs; and for the need to develop additional conservation storage in the lakes and the transfer of this water to the users.

The final task force report, issued to the Governor in December 1978, had a number of major findings (Kelly, 1984). It recommended that the maintenance of minimum streamflows be accomplished through formalized agreements by either establishing

agreements with Federal agencies or by State purchase of storage in the Federal reservoirs on regulated streams. The report also found that under the Water Supply Act of 1958 and with the purchase of water storage, the State would have an important role in developing and controlling the uses of these resources by its citizens.

About the same time as the State's task force review, the Corps of Engineers began a comprehensive study of the Federally regulated reservoirs within the State of Kansas pursuant to both the House and Senate resolutions, dated 10 May 1977 and 2 February 1977, respectively (Kelly, 1984). The Corps investigated storage allocations in the Kansas river basins and their effects on present and future uses for water in Kansas. During this parallel planning process, several questions arose regarding the storage in the lakes. These included:

1. How much storage exists in the Federally authorized and operated lakes in Kansas?
2. For what purpose(s) is this storage included in the Federal lakes in Kansas?
3. Under what terms is this storage available for use within Kansas? and
4. What methods should be used in finding the answers to the above questions?

In 1983, the Governor of Kansas, John Carlin, wrote a letter dated 30 December to William R. Gianelli, Assistant Secretary of the Army (Civil Works) (ASA(CW)). The letter included an explanation of the State Water Plan objectives and questions regarding Corps policy. The Governor recognized the State's water resources problems and the importance of developing a comprehensive Water Plan to meet these problems. Joseph F. Harkins, Director of the Kansas Water Office (KWO), developed the first draft of a Memorandum of Agreement in July 1985. The proposal was reviewed by Corps personnel in the Planning and

Engineering Branches at the Kansas City District, Tulsa District, Missouri River Division (MRD), and Southwestern Division (SWD) offices in addition to the staff of the Office of Counsel and OCE. Suggestions were offered to clarify certain issues and to demonstrate that benefits would accrue to both parties even though the proposal varied from current Corps policy.

Following revisions to the draft Agreements and negotiations with ASA(CW), a Memorandum of Understanding (MOU) with the State of Kansas was signed on 11 December 1985 establishing a cooperative partnership between the two agencies. The MOU was an effort to realize the highest level of benefits possible in existing Corps regulated reservoirs. It was also a unique opportunity to:

1. Solve the State's water supply problems regarding availability and dependability;
2. Increase the recovery of Federal investments occurring in the State's water resources developments;
3. Shift a greater portion of operation and maintenance costs from the Federal government to the State; and
4. Establish a water resource management plan.

A copy of the MOU signed by the State of Kansas and the Department of the Army is included in Appendix B.

Innovations which made the MOU Unique

In addition to the Reagan Administration's encouragement of new partnerships with non-Federal interests, several other conditions existed which made the MOU timely and acceptable. Of particular importance was the creation of new storage and cost recovery opportunities made possible by the partnership that the Federal government would not have been capable of achieving alone. The rationale behind this was the determination that the unused water quality storage had no potential for reallocation now or in the future and, therefore, no possibility for reimbursing Federal costs. This determination was especially

true under current federal pricing policy. Also, the establishment of a system-wide conjunctive regulation of reservoirs utilized storage to provide additional water at no additional cost to the Federal government.

The major benefits of the MOU to the State of Kansas include:

1. Creating a dependable water supply since the users never controlled when the water quality releases would take place or the quantity which would be released under the old system;
2. Determining the availability of excess water storage which would be made available through the studies performed under the agreement;
3. Gaining control over the lake regulation as a means of enhancing their water management program; and
4. Paying moderately updated costs for the water supply storage rather than the more expensive updated costs required in ER 1105-2-10.

Not only did the MOU benefit the State of Kansas, but it also benefited the Corps and, therefore, the Nation. These benefits include:

1. Reimbursing Federal investment and operation and maintenance (O & M) costs from the State acquisition of water supply storage in the reservoirs;
2. The State's protection of the water quality inflows and releases which would make it possible to meet the Federal government's water quality objectives; and
3. The State's making up-front payments to secure their commitment and responsibility within the agreement.

Recovery of Investment and O & M costs

Under the MOU, the Corps agreed to offer the State of Kansas a 10-year right of first refusal option on all storage found to be capable of reallocation. If the State accepts a segment of available storage, the purchase price of the storage will be as if it were originally authorized as municipal and industrial water supply. Under the Water Supply Act of 1958, this enables the State to pay an updated cost equal to the original cost for the storage with a 10-year interest-free period which is updated at the original project interest rate. This method is a variation to the present Corps policy of using the updated cost of storage as detailed in ER 1105-2-20 (Modified 20 Feb 1987 in EC 1105-2-169 which expires 31 Dec 1987).

As confusion could arise over the basis for using different methods of cost recovery, an explanation was prepared by the office, Assistant Secretary of the Army, Civil Works (Appendix B).

State Water Marketing and Assurance Programs

Under the terms of the MOU the State of Kansas Legislature adopted the Kansas Water Assurance Program Act in 1986 as a means of assuring reliable municipal and industrial water supply and strengthening its comprehensive water management program. The Act allows the establishment of water assurance districts in the State as a means of managing the water in a basin.

The Water Assurance Program is an alternative to the State's Water Marketing Program which evolved from the 1958 Amendment to the Kansas Constitution allowing the State to take advantage of the Federal Water Supply Act of 1958's provision to include municipal and industrial water supply in Federal reservoir projects. In 1965, the Kansas Water Resources Board (presently the Kansas Water Office (KWO)) was authorized by State legislature to contract with the Federal government for municipal and industrial water supply in Federal reservoirs. Water

marketing legislation was later adopted in 1974 which allowed the State to sell water from its contracted water supply storage (US Army Corps of Engineers, 1987). Following the procedure to buy water, a prospective water purchaser must file an application with KWO to obtain the water (Kansas Water Office, 1984). Guidelines detailing the present application process are available from the KWO.

The first water assurance district in the State of Kansas was voted into existence on Wednesday 22 July 1987 to assure municipal and industrial users of a dependable water supply during times of drought.

As part of the State's Water Assurance Program, KWO is making an effort to develop modified operating criteria, rules, and procedures for storage in the nine reservoirs listed in the MOU as well as storage currently under contract. To accomplish this, KWO is conducting a drought exercise in each river basin to simulate a reoccurrence of the 1950's drought conditions with present day demands. The exercise will increase all involved parties' knowledge on experiencing a real drought and establish a basis for evaluating any proposed changes.

Determination of Excess Storage made available for Water Supply

Prior to the MOU, the State of Kansas was interested in the Corps' assistance in developing a computer program which would perform yield studies for the Kansas river basins. In 1982, Kansas City District conducted yield studies for the Kansas and Osage River basins. In a report for the Kansas River Alliance, Black and Veatch, consulting engineers, found that the basin yields were much lower than what the Kansas City District or KWO had computed due to the neglecting of the effects of water rights and other depletions. Tulsa District conducted yield studies for Neosho and Verdigris under a different methodology than Kansas City District. In early 1985 at the request of KWO, Tulsa and Kansas City Districts began the joint preparation of a new method

for yield computations. Further, SWD requested Mr. Leo R. Beard, Consulting Engineer, to assist in the development of a modified computer model. Mr. Beard modified the 1971 version of the Hydrologic Engineering Center's HEC-3 computer program for use in determination of yields in the Corps' lakes.

Although the program requires a large amount of input data and computer capability, it does take into account all the significant factors necessary in determining basin-wide yields

and streamflows. The modified program features include the consideration of water rights.

As part of the process to review the technical details of the model, a committee was established to study the model and test the results. The Committee consisted of:

1. Professor Robert Smith, Department of Civil Engineering, University of Kansas,
2. Mr. Robert Crawford, Wilson and Company,
3. Mr. Les Lampe, Black and Veatch,
4. Dr. James Koelliker, Kansas State University.

Following acceptance of the model by the Committee and KWO, applications of the model were begun by the two districts. The districts are in the process of completing or have completed the work on the basins mentioned previously.

In the MOU, the State agreed to cooperate with the Corps in completing reallocation studies to determine if there is available excess storage. The modified HEC-3 computer model will be used to perform the analyses for the reservoirs according to the schedule indicated in the MOU.

ASSESSING OPPORTUNITIES FOR REALLOCATION

In this report, opportunities for reallocation have been assessed by looking at individual reservoirs and through Federal-State partnerships such as in the State of Kansas MOU. To convert an opportunity to a reality requires addressing engineering, economic, institutional and legal considerations. Comisky (1986) has discussed many of these in his study on "Generic Considerations in Reallocation of Water Storage at Corps of Engineers Reservoirs". Both the opportunities documented in this report and the considerations identified by Comisky are important when assessing reallocation. It still remains, however, to investigate the feasibility of reallocation site-by-site. Many considerations depend upon the specific details of each site. As an example, a need for water supply storage must exist and this depends upon the users served by non-Federal interests. In those cases where reallocation has taken place, and where it has been or is being considered, there was and is a need for water supply by non-Federal interests. The intensity of interest will always be tied to the intensity of need, the features of other alternatives available to non-Federal interests, and the features of reallocation at the Corps' reservoir. Even where a need exists there may also be issues to be resolved. However, the institutional means exist to address many of these issues. The Corps of Engineers, for example, has the authority to contract for water supply not under contract. Also, the Chief of Engineers has a discretionary authority in cases where no significant impact will result from a reallocation. In addition, the Assistant Secretary of the Army (ASA) has authority, as exercised in creating the Memorandum of Understanding with the State of Kansas. Lastly, the Congress has authority to make changes to reservoir storage and its purposes. These are examples of the authorities which may be used to resolve various engineering, economic, institutional and legal issues. All this is to say that opportunities for reallocation exist, other considerations are important and must be addressed and resolved, and the institutional authorities exist to do much of that.

APPENDIX A

REALLOCATION-STUDIES PROFILES

Reservoir: Bardwell Lake

General Location: Waxahachie Creek, Trinity River Basin

District: Fort Worth District

Report: Bardwell Lake Review of Completed Projects
December 1985

Purpose: To determine the feasibility of modifying existing storage allocations in Bardwell Lake to provide additional water supply for the cities of Ennis and Waxahachie, Texas.

Sponsor: City of Ennis

Recommendations: That funds be approved to conduct further studies and to make a final recommendation to determine which alternative, embankment raising or storage reallocation, is better.

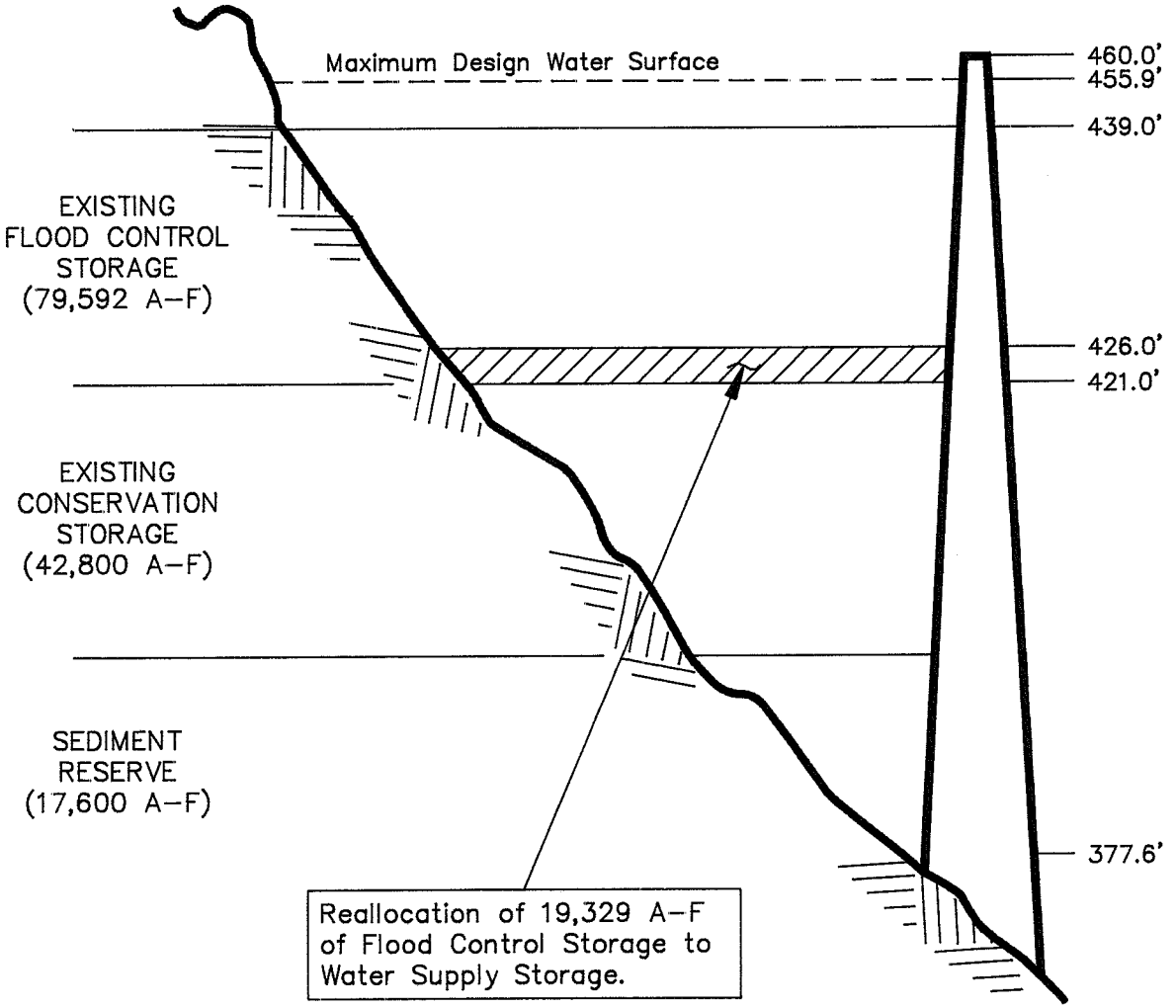
Aug 1987 Status: Awaiting funds to do a full section 216 reconnaissance and feasibility study.

Storage Reallocation:

Total Storage =	122,392 A-F
Flood Control Storage =	79,592 A-F
Proposed Reallocation =	19,329 A-F
Percent of Total Storage =	15.8%

Original Total Cost: $9,649,322.57 (Apr 77)

Original Reallocated Cost: $1,424,818.97 (Apr 77)



BARDWELL LAKE (122,392 A-F)

Trinity River, Texas

Fort Worth District

Reservoir: Barren River Lake

General Location: Barren River, KY

District: Louisville District

Report: Contract between the United States of America and City of Glasgow, Kentucky for Water Storage Space in Barren River Reservoir, Kentucky, 18 August 1965

Purpose: To study the feasibility of modifying the project to include provisions for municipal water supply from Barren River Reservoir.

Sponsor: City of Glasgow, Kentucky

Recommendation: That the existing project be revised to incorporate 681 acre-feet of storage for municipal water supply from the permanent storage for the City of Glasgow, Kentucky.

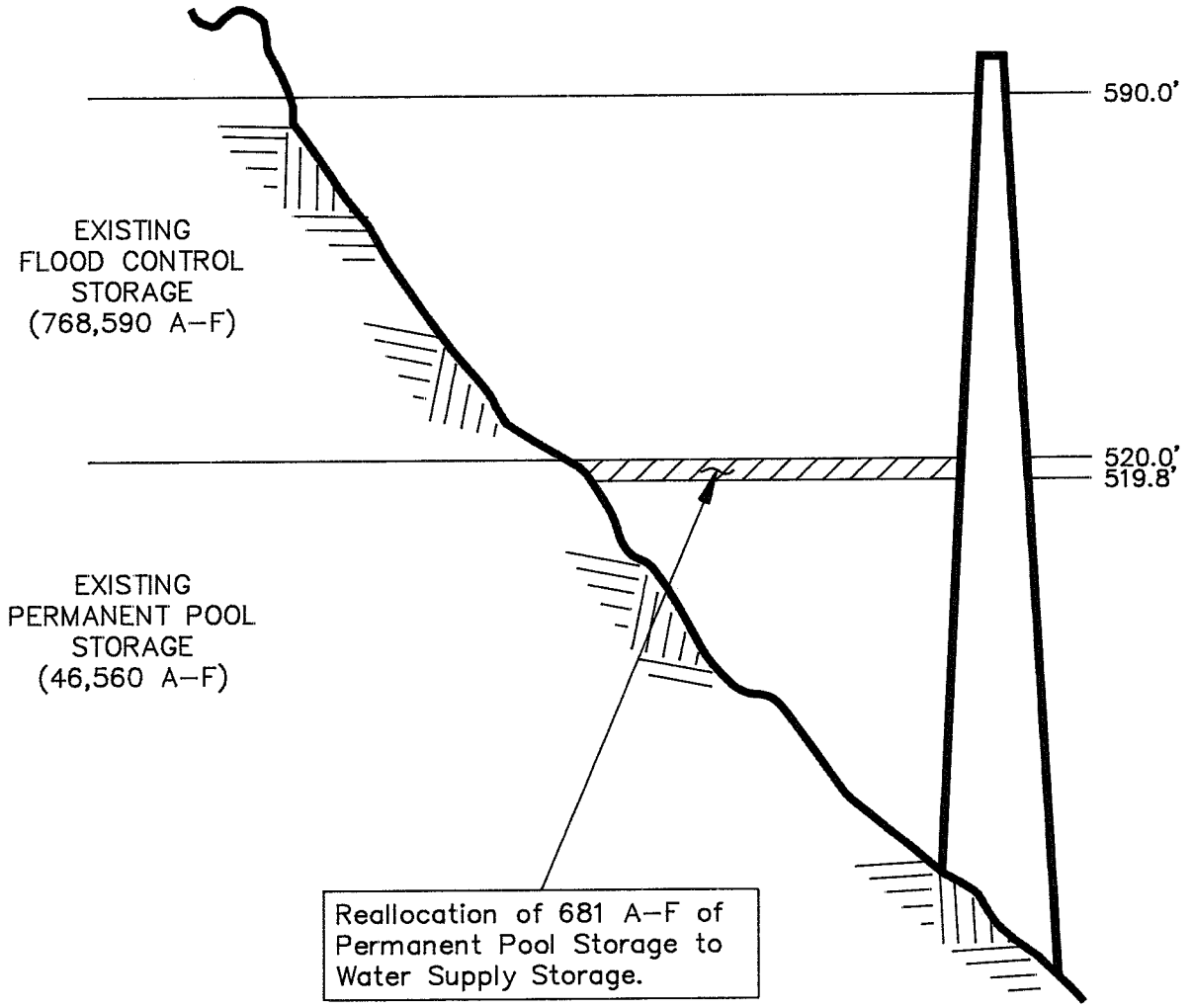
Aug 1987 Status: Contract approved 4 October 1965 and in force.

Storage Reallocation:

Total Storage =	815,150 A-F
Permanent Storage =	46,560 A-F
Proposed Reallocation =	681 A-F
Percent of Total Storage =	0.084%

Original Total Cost: $23,822,000 (Jul 62)

Original Reallocated Cost: $22,300 (Jul 62)



BARREN LAKE (815,150 A–F)

Barren River, Kentucky

Louisville District

Reservoir: Bear Creek Reservoir

General Location: South Platte River, Colorado

District: Omaha District

Report: No report to date.

Purpose: N/A

Sponsor: Colorado Water Conservation Board or individual users (not yet committed)

Recommendations: Make 18,400 A-F of flood control storage available for water supply.

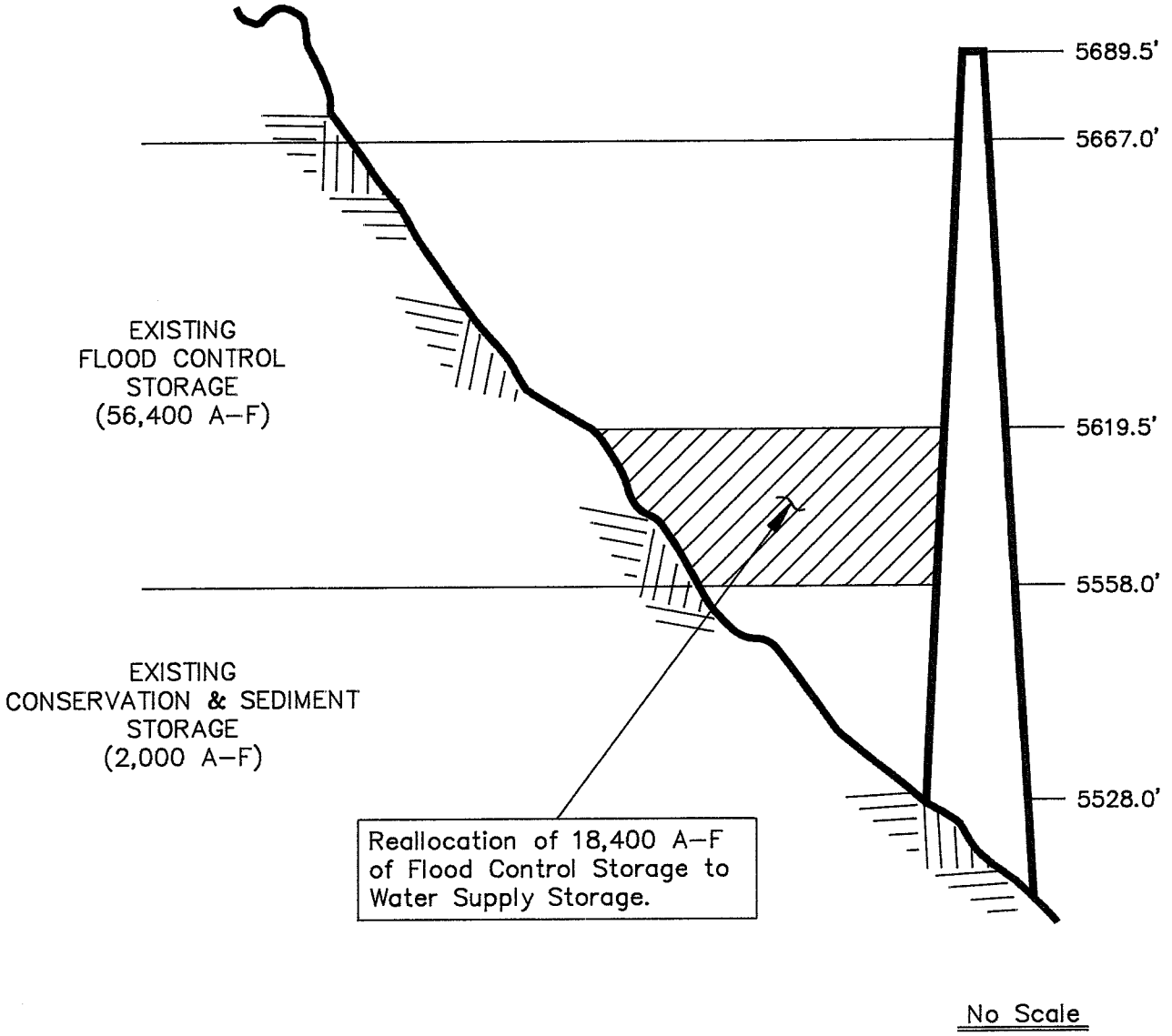
Aug 1987 Status: No actions have taken place towards implementing the reallocation.

Storage Reallocation:

Total Storage = 58,400 A-F
Flood Control Storage = 56,400 A-F
Proposed Reallocation = 18,400 A-F
Percent of Total Storage = 31.5%

Original Total Cost: $61,422,987 (1982)

Original Reallocated Cost: N/A



BEAR CREEK RESERVOIR (58,400 A-F)

South Platte River, Colorado
Omaha District

Reservoir:	Bloomington Lake (Now called Jennings Randolph Lake)
General Location:	North Branch Potomac River, Maryland
District:	Baltimore District
Report:	Bloomington Lake Reformulation Study September 1983
Purpose:	(1) To investigate operation of Bloomington Lake project in conjunction with other resources and using the authorized storage allocation to provide optimum increase in flow for alleviating water supply shortages projected to 2030. (2) To investigate the feasibility of project storage reallocation (transfer of water quality and flood control storages to water supply storage.) Two storage reallocation possibilities were considered for Bloomington Lake - water quality storage to water supply and flood control storage to water supply. Studies indicated that all of the existing water quality storage should be reserved for satisfying downstream water quality targets. Two levels of flood control storage were also considered (reallocation of 25 percent and 50 percent of flood control storage). Studies indicated that the reduction in flood control benefits would be minimal (less than seven percent). However, due to lack of immediate need, no recommendations were made.
Sponsor:	Metropolitan Washington Area (MWA) and Interstate Commission on the Potomac River Basin (ICPRB)
Recommendations:	As part of the comprehensive Metropolitan Washington Area Water Supply Study, a recommendation was made for no Federal action. Institutional arrangements were determined to be capable of satisfying water supply needs until at least 2030. Therefore, no recommendations were made regarding Bloomington Lake.
Aug 1987 Status:	N/A

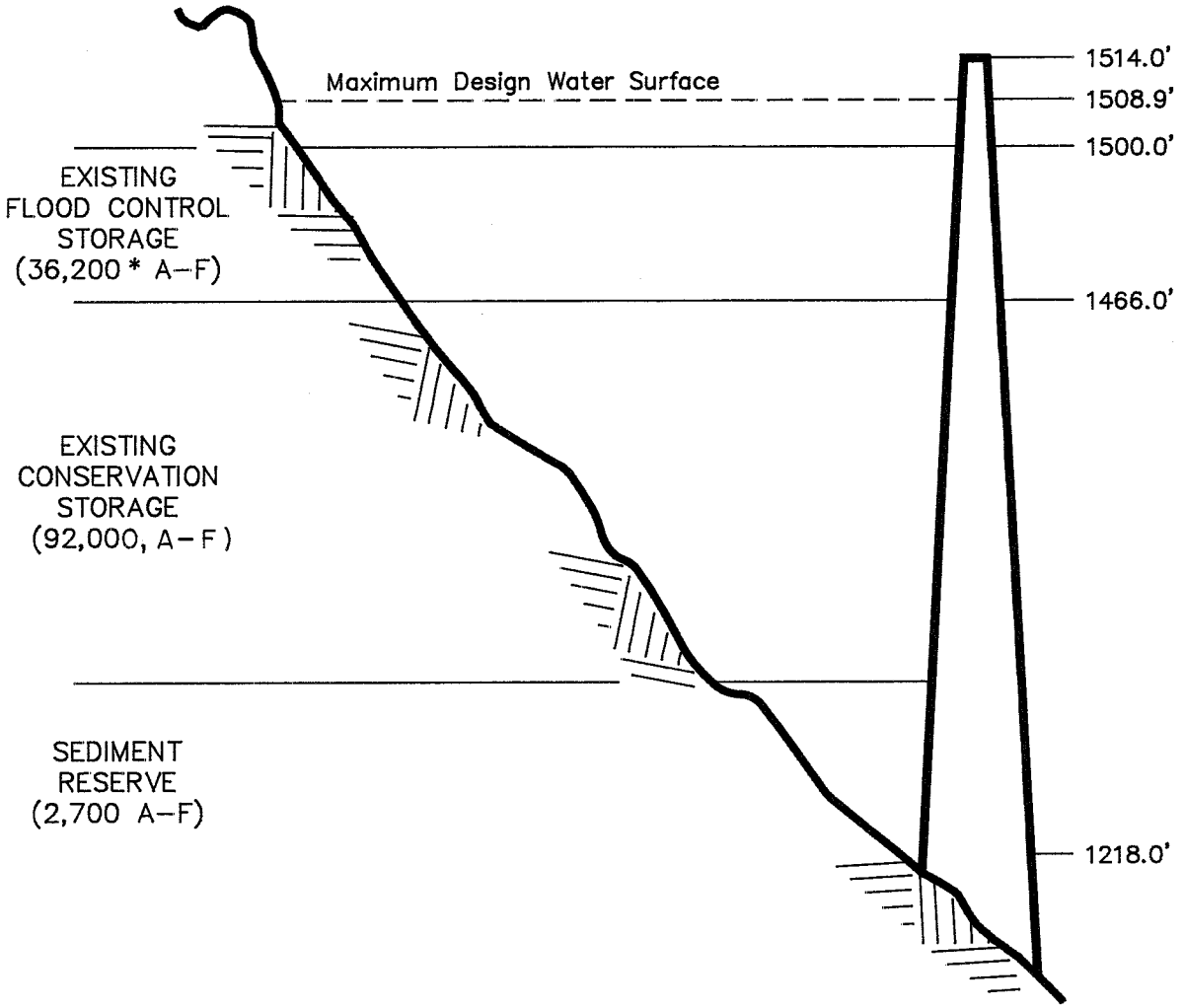
Bloomington Lake (continued)

Aug 1987: N/A

Storage Reallocations: Total Storage = 128,200 A-F
Flood Control Storage = 36,200 A-F
Proposed Reallocation = N/A
Percent of Total Storage = N/A

Original Total Cost: $174,300,000 (1983)

Original Reallocated Cost: N/A



BLOOMINGTON LAKE (128,200 A-F)

Potomac River, Maryland
Baltimore District

* In addition, a minimum of 44,400 A-F of conservation storage will be available seasonally for flood control.

Reservoir: Chatfield Reservoir

General Location: South Platte River, Colorado

District: Omaha District

Report: No report to date.

Purpose: N/A

Sponsor: None to date.

Recommendations: Make 22,700 A-F of flood control storage available for water supply.

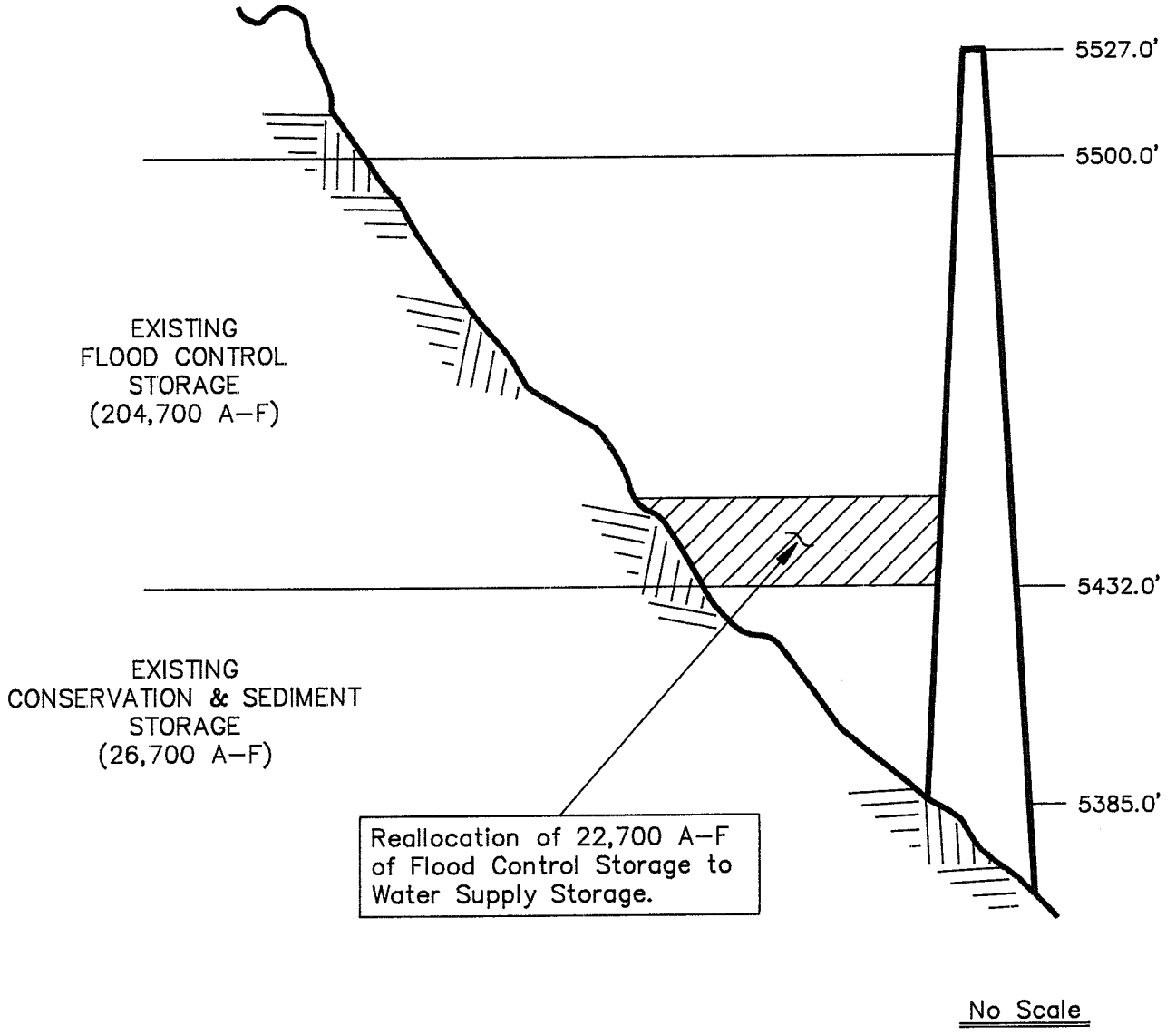
Aug 1987 Status: Have notified Colorado Water Conservation Board that 22,700 A-F of storage is available.

Storage Reallocation:

Total Storage = 231,400 A-F
Flood Control Storage = 204,700 A-F
Proposed Reallocation = 22,700 A-F
Percent of Total Storage = 9.8%

Original Total Cost: $84,199,000 (1978)

Original Reallocated Cost: N/A



CHATFIELD RESERVOIR (231,400 A–F)

South Platte River, Colorado

Omaha District

Reservoir: Denison Dam (Lake Texoma)

General Location: Red River, Oklahoma and Texas

District: Tulsa District

Report: Letter Report Denison Dam (Lake Texoma) North Texas Municipal District, 1985

Purpose: To provide necessary information to reassign 77,400 A-F of storage in Denison Dam to satisfy the municipal & industrial water supply needs of the North Texas Municipal District.

Sponsor: North Texas Municipal District

Recommendations: To reallocate an additional 77,400 A-F of storage between 590' and 617' from hydropower to water supply. This, in addition to the 72,600 A-F previously reallocated, will provide 150,000 A-F to meet the existing contract obligations and municipal and industrial water supply needs of the North Texas Municipal District.

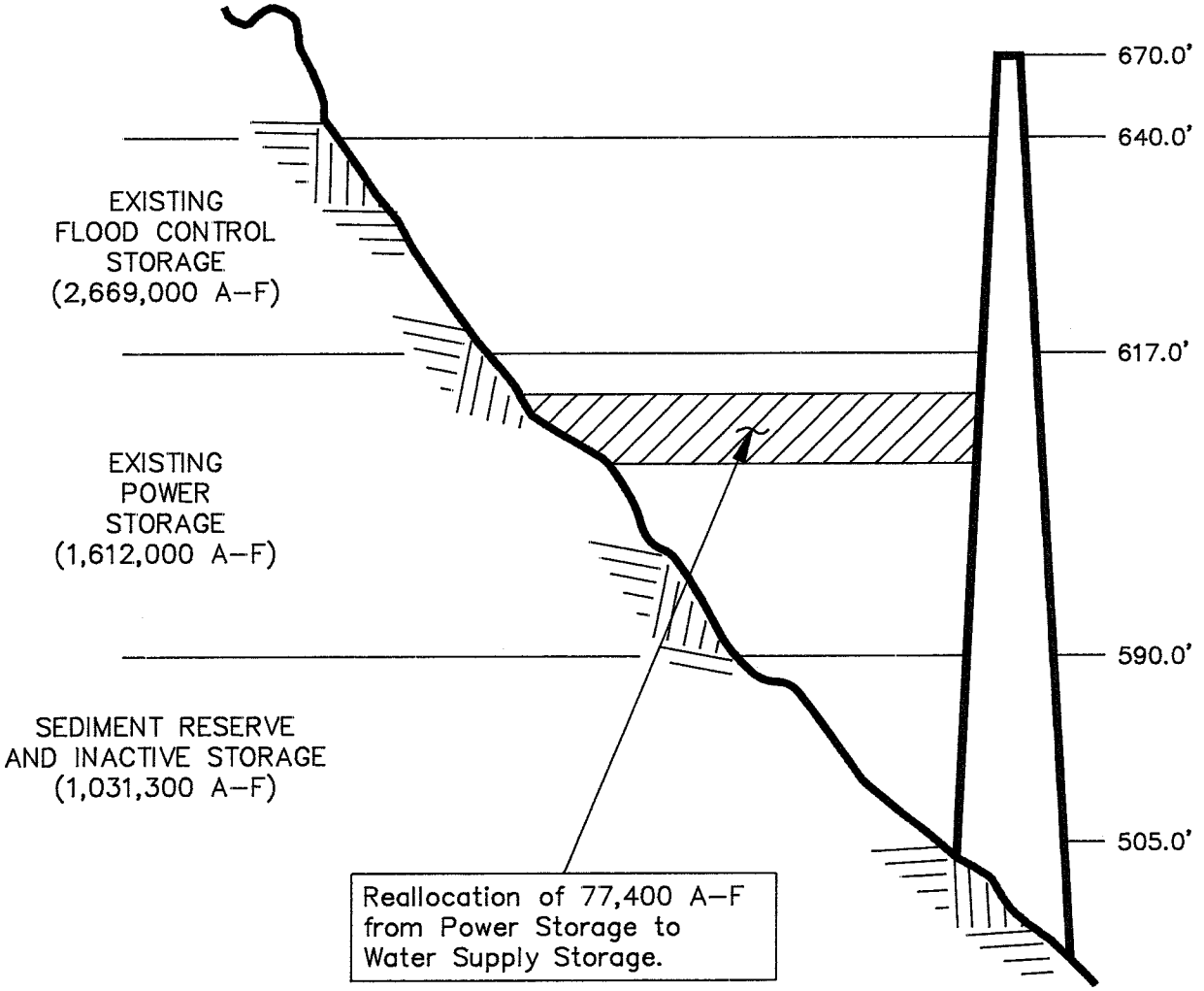
Aug 1987 Status: Reallocations are in effect.

Storage Reallocation:

Total Storage	= 4,281,000 A-F
Flood Control Storage	= 2,669,000 A-F
Power Storage	= 1,612,000 A-F
Proposed Reallocation	= 77,400 A-F
Percent of Total Storage	= 1.81%

Original Total Cost: $45,810,877 (Sep 41)

Original Reallocated Cost: $1,062,200 (Sep 41)



DENISON DAM (LAKE TEXOMA) (4,281,000 A-F)

Red River, Oklahoma & Texas

Tulsa District

Reservoir: Cowanesque Lake

General Location: Cowanesque River, Tioga County, Pennsylvania

District: Baltimore District

Report: Cowanesque Lake Reformulation Study
January 1985 - General Design Memorandum

Purpose: To examine the feasibility of reallocating some flood control storage to water supply storage.

Sponsor: Susquehanna River Basin Commission

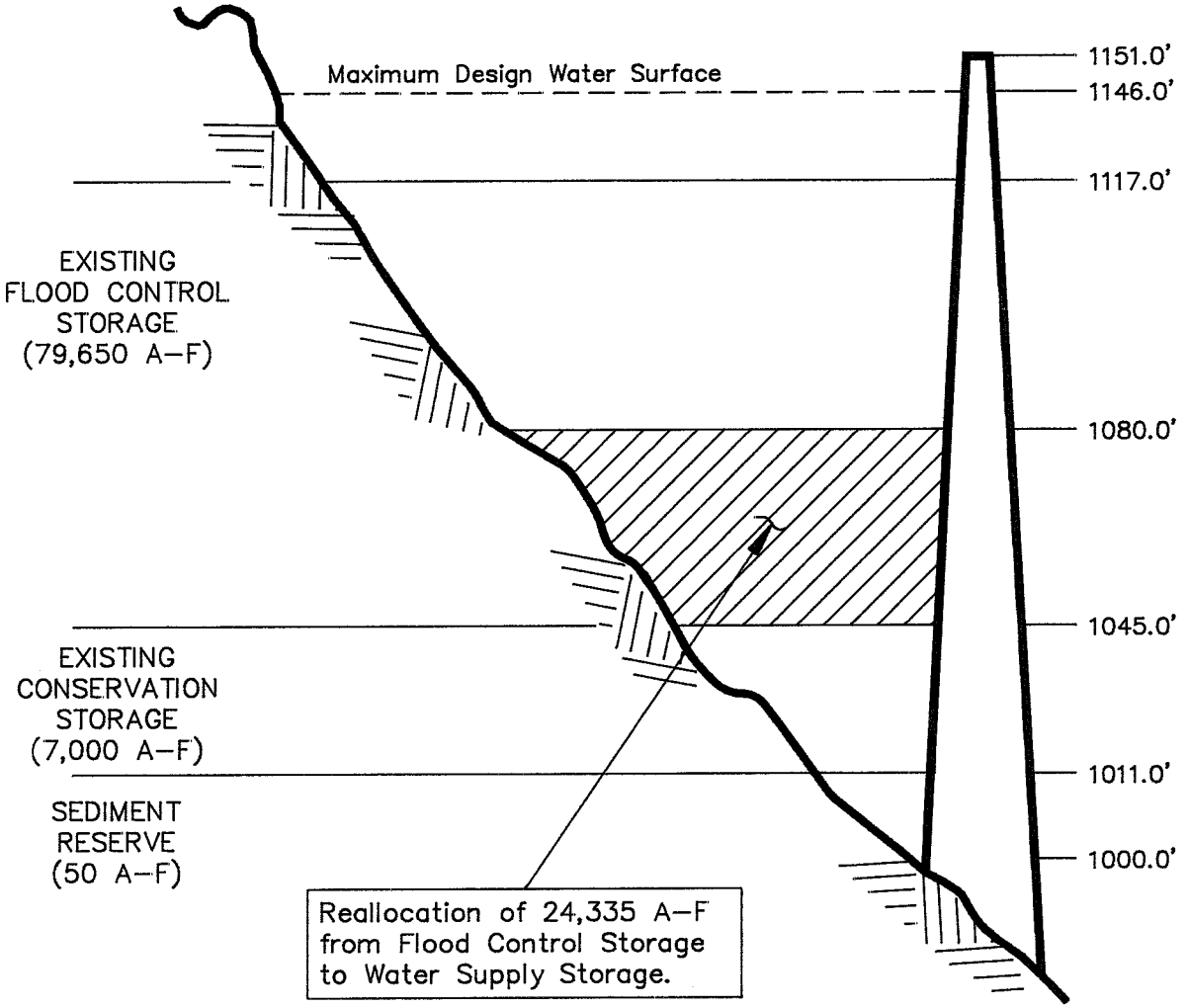
Recommendations: That the selected 1080 Plan for reallocation of 25,600 A-F of storage to water supply from flood control be approved for construction.

Aug 1987 Status: The project modification was approved 1 March 1983 by the Chief of Engineers. The finalized contracts were signed by ASA(CW) on 30 June 1986. Construction was initiated in 1987.

Storage Reallocation:
Total Storage = 86,700 A-F
Flood Control Storage = 79,650 A-F
Proposed Reallocation = 24,335 A-F
Percent of Total Storage = 28.1%

Original Total Cost: $106,000,000 (1978)

Original Reallocated Cost: $13,570,000 investment cost and $39,890,000 original project share cost (1986)



COWANESQUE LAKE (86,700 A-F)

Susquehanna River, Pennsylvania
Baltimore District

Reservoir: Granger Lake (formerly Laneport Reservoir)

General Location: San Gabriel River, Texas

District: Fort Worth

Report: South Fork Lake Reevaluation Report
October 1986

Purpose: To reevaluate the feasibility of constructing the authorized South Fork Reservoir based on the current water resources needs in the study area.

Sponsor: None identified.

Recommendations: That further studies regarding storage reallocations at Granger Lake be deferred until water supply needs develop in the study area or definite interest is expressed by a local sponsor.

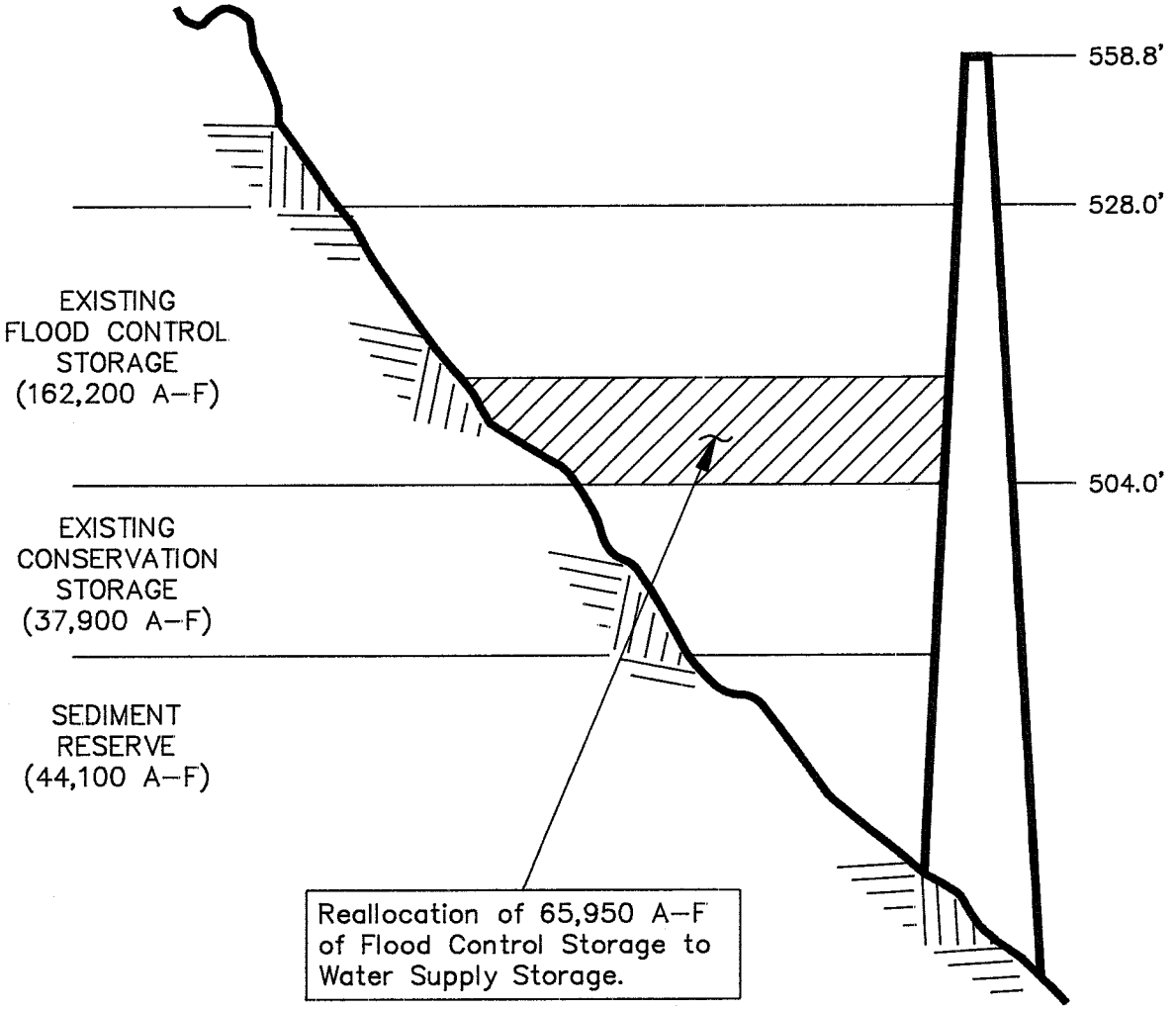
Aug 1987 Status: Studies suspended.

Storage Reallocation:

Total Storage	= 200,100 A-F
Flood Control Storage	= 162,200 A-F
Proposed Reallocation	= 65,950 A-F
Percent of Total Storage	= 33%

Original Total Cost: $62,000,000 (Oct 82)

Original Reallocated Cost: $20,460,000 (Oct 82)



GRANGER LAKE (200,100 A–F)

San Gabriel River, Texas

Fort Worth District

Reservoir: Lake O' The Pines

General Location: Cypress Bayou Basin, Texas

District: Fort Worth

Report: Cypress Bayou Basin Feasibility Report
February 1987

Purpose: To study and evaluate the water resource problems and needs of the Cypress Bayou Basin. Reallocation of storage at Lake O' The Pines investigated as an alternative water supply source.

Sponsor: Due to nature of study, none identified.

Recommendations: To take no federal action at this time and to defer further studies regarding storage reallocations at Lake O' The Pines until water supply needs develop within the study area.

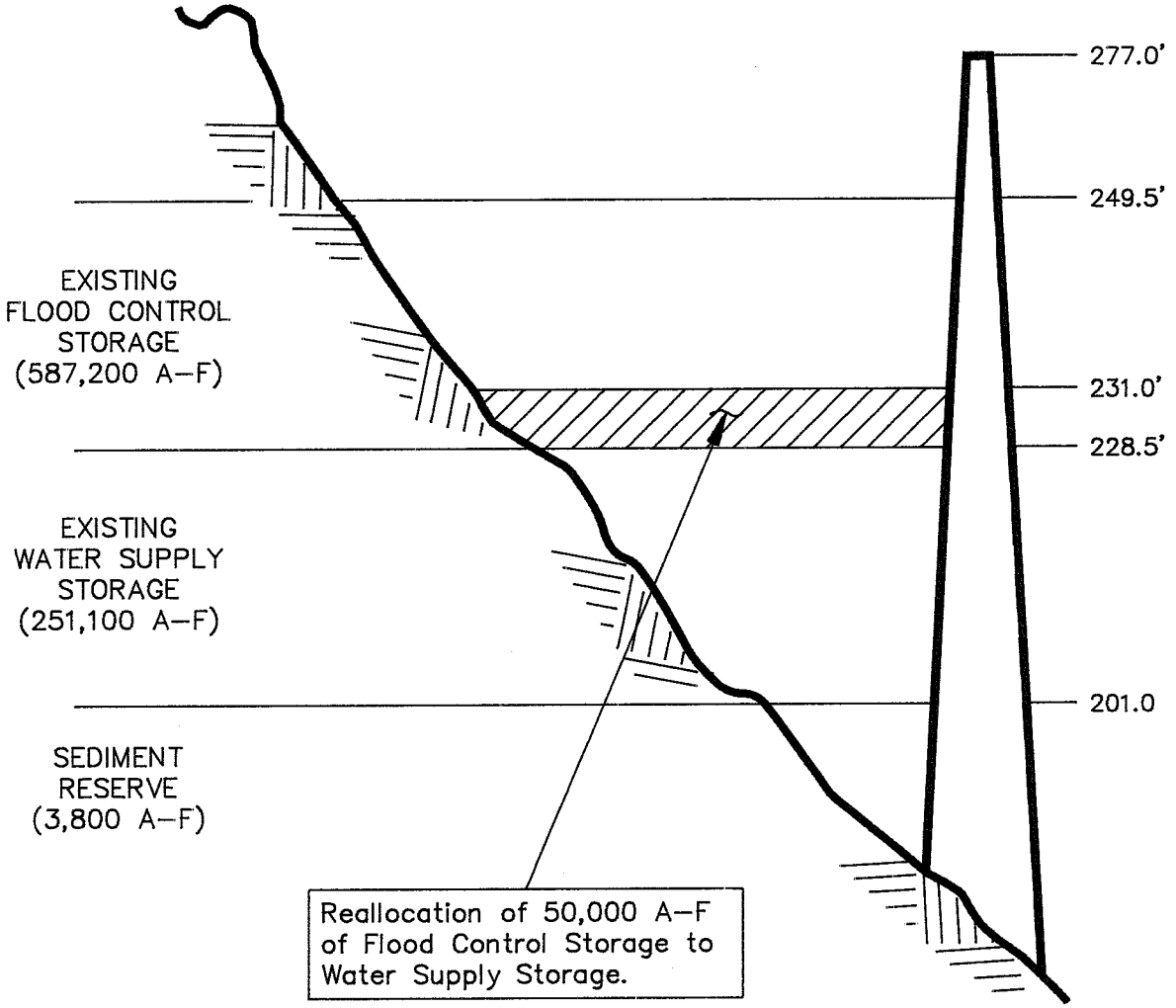
Aug 1987 Status: The report is under review by BERH.

Storage Reallocation:

Total Storage =	838,300 A-F
Flood Control Storage =	587,200 A-F
Investigated Reallocation =	50,000 A-F
Percent of Total Storage =	6.0%

Original Total Cost: $14,900,000 (Oct 59)

Original Reallocated Cost: $894,000 (Oct 59)



LAKE O' THE PINES (838,300 A–F)

Cypress Bayou Basin, Texas
Fort Worth District

Reservoir: Rathbun Lake

General Location: Chariton River, Iowa

District: Kansas City District

Report: Reallocation of Storage at Rathbun Lake
May 1985

Purpose: To provide rationale for the reallocation of storage from the recreation purpose to municipal and industrial water supply storage.

Sponsor: Rathbun Regional Water Association (RRWA)

Recommendations: That 15,000 A-F of recreation storage be reallocated to municipal and industrial water supply storage.

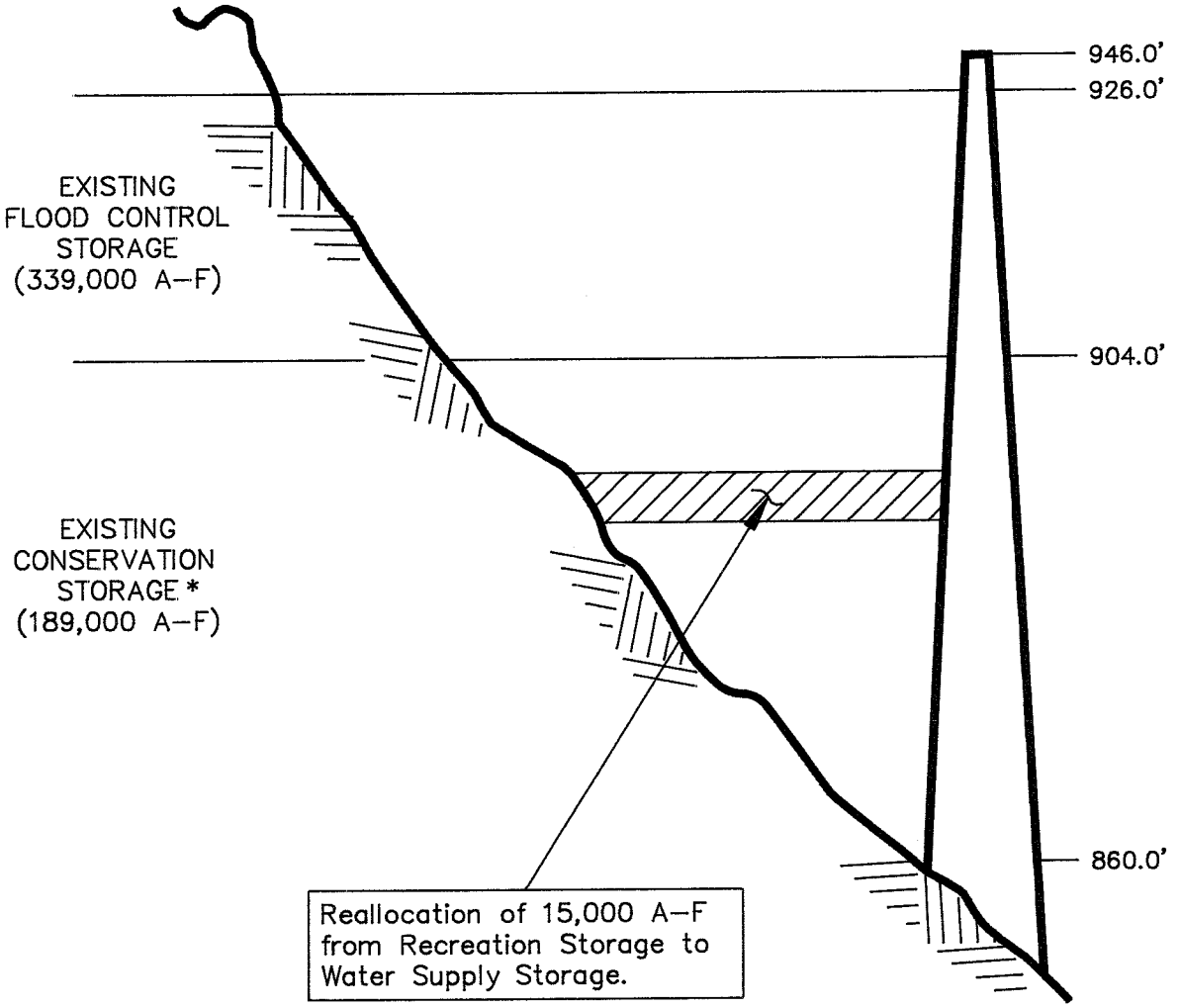
Aug 1987 Status: In approving the report, the Chief of Engineers noted that ". . . actual reallocations are made only through the vehicle of immediate use water supply storage contracts." A contract for the purchase of 3,340 A-F of water supply storage has been approved by the Secretary of the Army, although the terms of sale are different than recommended in the reallocation report. Therefore, 3,340 A-F of storage are reallocated to water supply.

Storage Reallocation:

Total Storage =	528,000 A-F
Recreation Storage =	43,660 A-F
Proposed Reallocation =	3,340 A-F
Percent of Total Storage =	0.63%

Original Total Cost: $23,353,376 (Jul 67)

Original Reallocated Cost: $147,826.87 (Jul 67)



No Scale

RATHBUN LAKE (528,000 A–F)

Chariton River, Iowa
Kansas City District

* includes 47,000 A–F Recreation Storage
68,000 A–F Water Quality Control Storage
74,000 A–F Navigation Storage

Reservoir: Rough River Lake

General Location: Rough River, Kentucky

District: Louisville District

Reports: Contract between the United States of America and City of Leitchfield, Kentucky for Water Storage Space in Rough River Reservoir, Kentucky, 18 April 1966

Contract between the United States of America and City of Hardinsburg, Kentucky for Water Storage Space in Rough River Lake, Kentucky, 5 December 1978

Purpose: To study the feasibility of modifying the project to include provisions for municipal water supply from Rough River Reservoir.

Sponsors: 1966: City of Leitchfield, KY
1978: City of Hardinsburg, KY

Recommendations: 1966: That the existing project be revised to incorporate 120 A-F of storage for municipal water supply from the permanent storage for the City of Leitchfield, KY.

1978: That the existing project (since modified to raise conservation pool level from 465' to 470' in Dec 1969) be revised to incorporate 150 A-F of storage for municipal water supply from the conservation storage for the City of Hardinsburg, KY.

Aug 1987 Status: Leitchfield contract approved 3 August 1966. Hardinsburg contract approved 12 March 1979. Both contracts are in force.

Storage Reallocation:[1] Total Storage = 334,380 A-F
Conservation Storage = 29,800 A-F

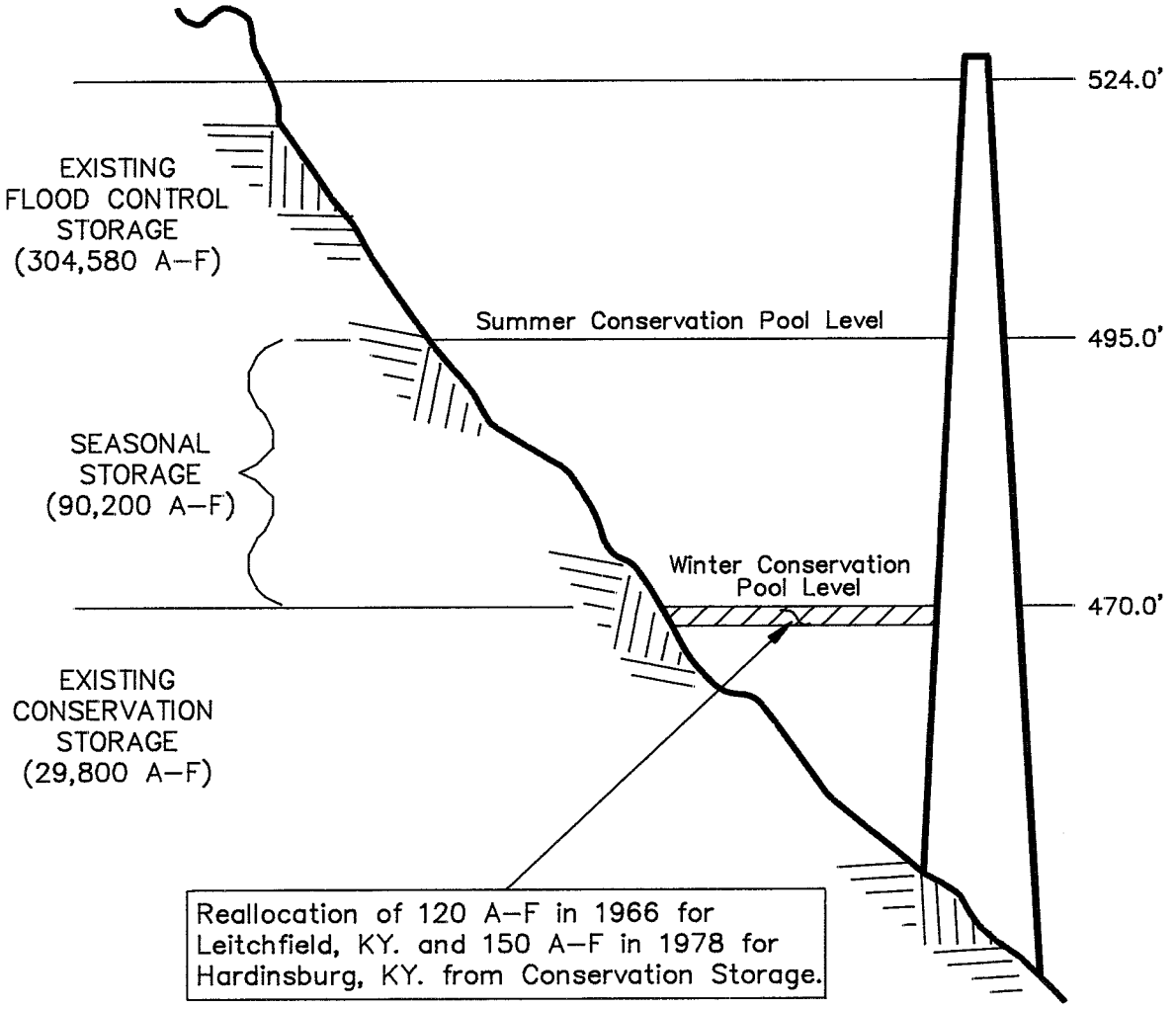
1966: Proposed Reallocation = 120 A-F
Percent of Total Storage = 0.036%

1978: Proposed Reallocation = 150 A-F
Percent of Total Storage = 0.045%

Original Total Cost: $9,114,600 (Oct 57)

Rough River Lake (continued)

1 Originally, the conservation (sediment) pool level was set at 465'. In 1966, Leitchfield, KY was allowed the storage from elevation 464.9' to 465' for water supply. Flood control storage was reallocated to winter recreation storage in Dec 69 by permanently raising the conservation pool level to 470'. Hardinsburg, KY was then, in 1978, allocated storage for water supply from the conservation storage.



ROUGH RIVER LAKE (334,380 A–F)

Rough River, Kentucky
Louisville District

Reservoir: Sam Rayburn Reservoir

General Location: Angelina River, Neches River Basin, Texas

District: Fort Worth District

Report: Sam Rayburn Storage Reallocation Study
June 1986

Purpose: To determine the advisability and feasibility of modifying storage allocations to provide water supply to the city of Huntington, TX.

Sponsor: Lower Neches Valley Authority (LNVA)

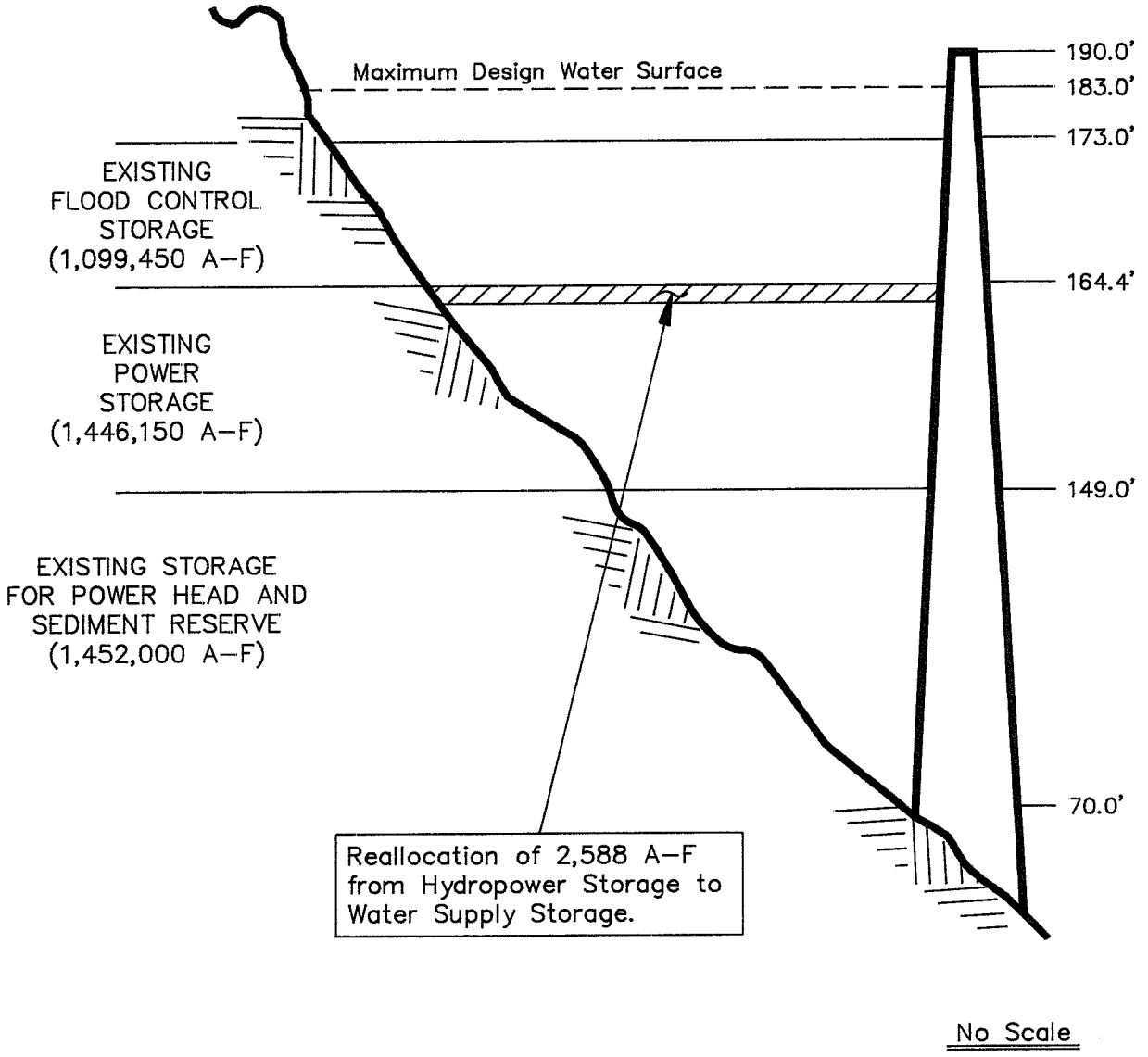
Recommendations: That the Chief of Engineers authorize the district engineer to enter into negotiations with LNVA to contract for 2588 A-F of storage which was previously reallocated in 1969.

Aug 1987 Status: Project is on hold as the Corps is attempting to negotiate a contract with the local sponsor.

Storage Reallocation:
Total Storage = 3,997,600 A-F
Flood Control Storage = 1,099,412 A-F
Proposed Reallocation = 2,588 A-F
Percent of Total Storage = 0.23 %

Original Total Flood Control Cost: $13,978,700 (Sep 61)

Original Reallocated Cost: $31,595.50 (Sep 61)



SAM RAYBURN LAKE (3,997,600 A-F)

Angelina River, Neches River Basin, Texas

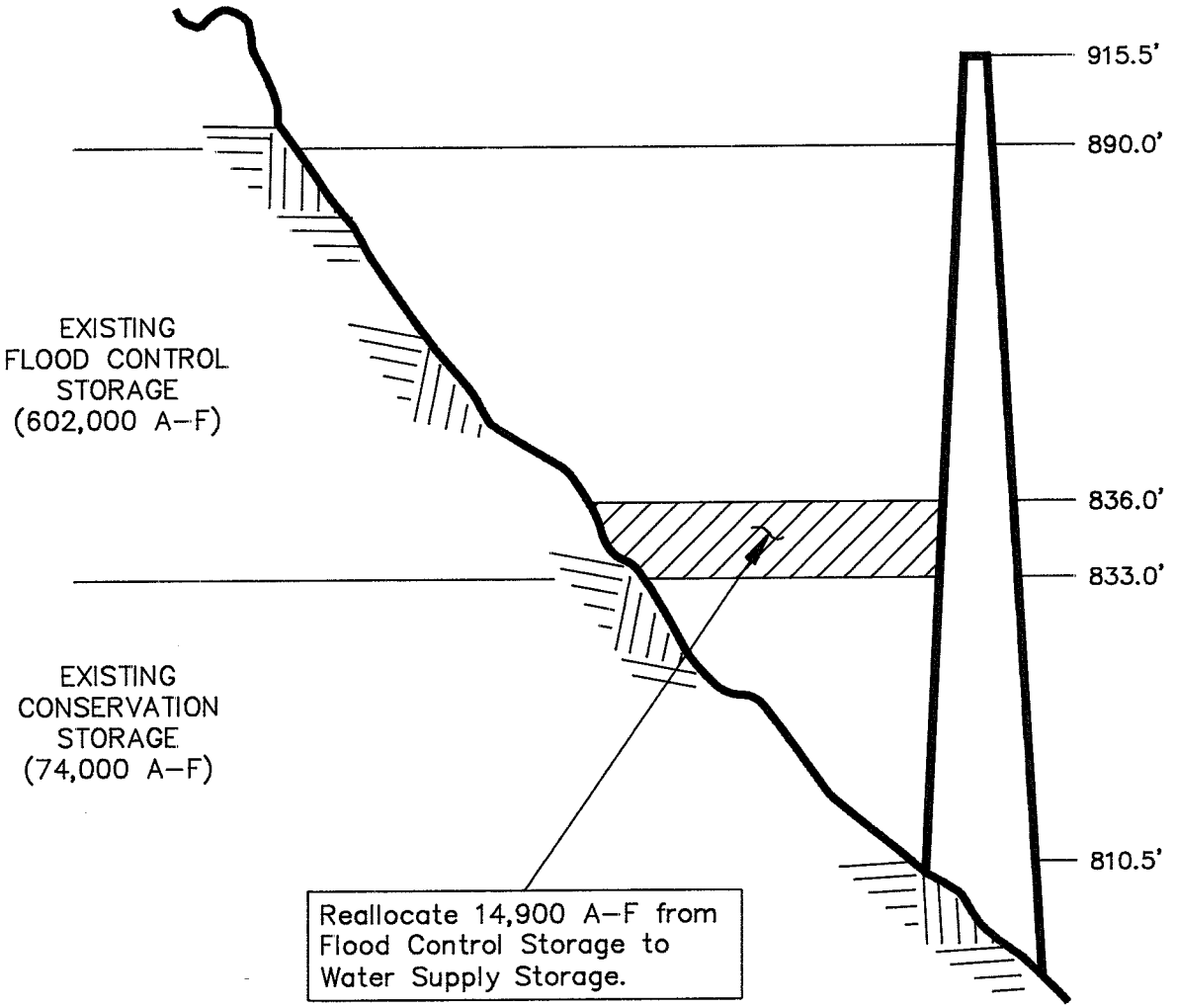
Fort Worth District

Reservoir:	Saylorville Lake
General Location:	Des Moines River Basin, Iowa
District:	Rock Island District
Report:	Reallocation of Reservoir Storage in Lake Red Rock and Saylorville Lake, December 1981 Reallocation of Reservoir Storage in Saylorville Lake for Municipal and Industrial Water Supply, April 1982
Purpose:	To analyze the reallocation of conservation storage in Saylorville Lake for municipal and industrial water supply.
Sponsor:	Iowa Natural Resources Council (INRC)
Recommendations:	That 14,900 A-F of flood control storage be reallocated to water supply storage.
Aug 1987 Status:	Present reallocation is in operation as of 1 October 1983.

Storage Reallocation:

Total Storage = 676,000 A-F
Flood Control Storage = 602,000 A-F
Proposed Reallocation = 14,900 A-F
Percent of Total Storage = 2.2%

Updated Total Cost: $169,709,000 (1981)



SAYLORVILLE LAKE (676,000 A-F)

Des Moines River, Iowa

Rock Island District

Reservoir: Waco Lake

General Location: Brazos River Basin, Texas

District: Fort Worth District

Report: Waco Lake Storage Reallocation Study
October 1982

Purpose: To study the feasibility of increasing conservation storage space (reallocation of flood control storage to water supply storage) to increase the dependable water supply yield of the lake to meet immediate and future water needs of the City of Waco.

Sponsor: Brazos River Authority (BRA) in cooperation with the City of Waco.

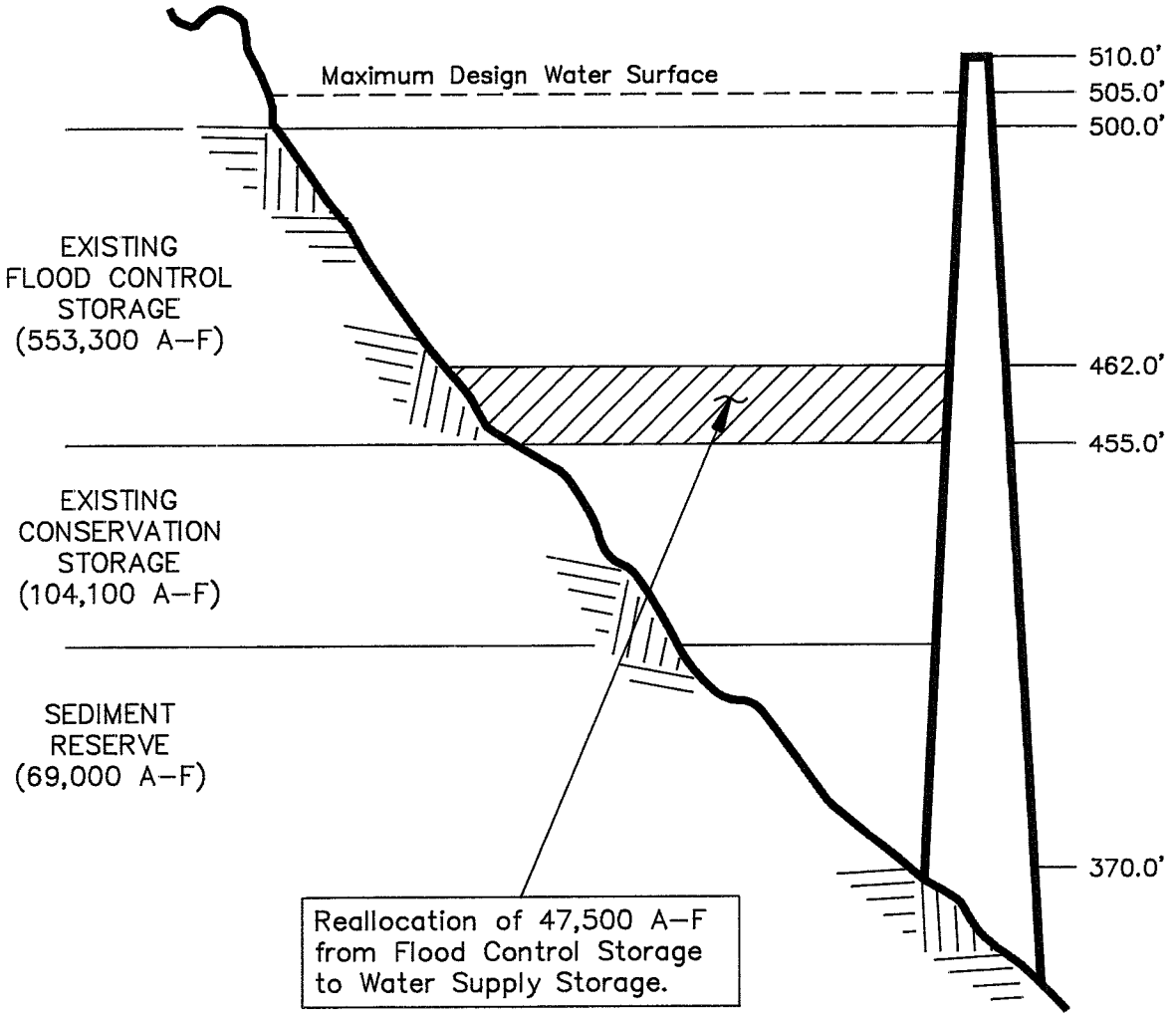
Recommendations: That the Chief of Engineers authorize the reallocation of 47,500 A-F of flood control storage to conservation storage and that the district engineer be authorized to enter negotiations with BRA to contract for the storage.

Aug 1987 Status: The Corps has consummated a contract with BRA. Actual reallocation will not take place for about five years since BRA is building an upstream lake and wants to study the effects on Waco before reallocating.

Storage Reallocation:
Total Storage = 657,400 A-F
Flood Control Storage = 553,300 A-F
Proposed Reallocation = 47,500 A-F
Percent of Total Storage = 7.2%

Original Total Cost: $53,603,000 (1976)

Original Reallocated Cost: $3,859,416 (1976)

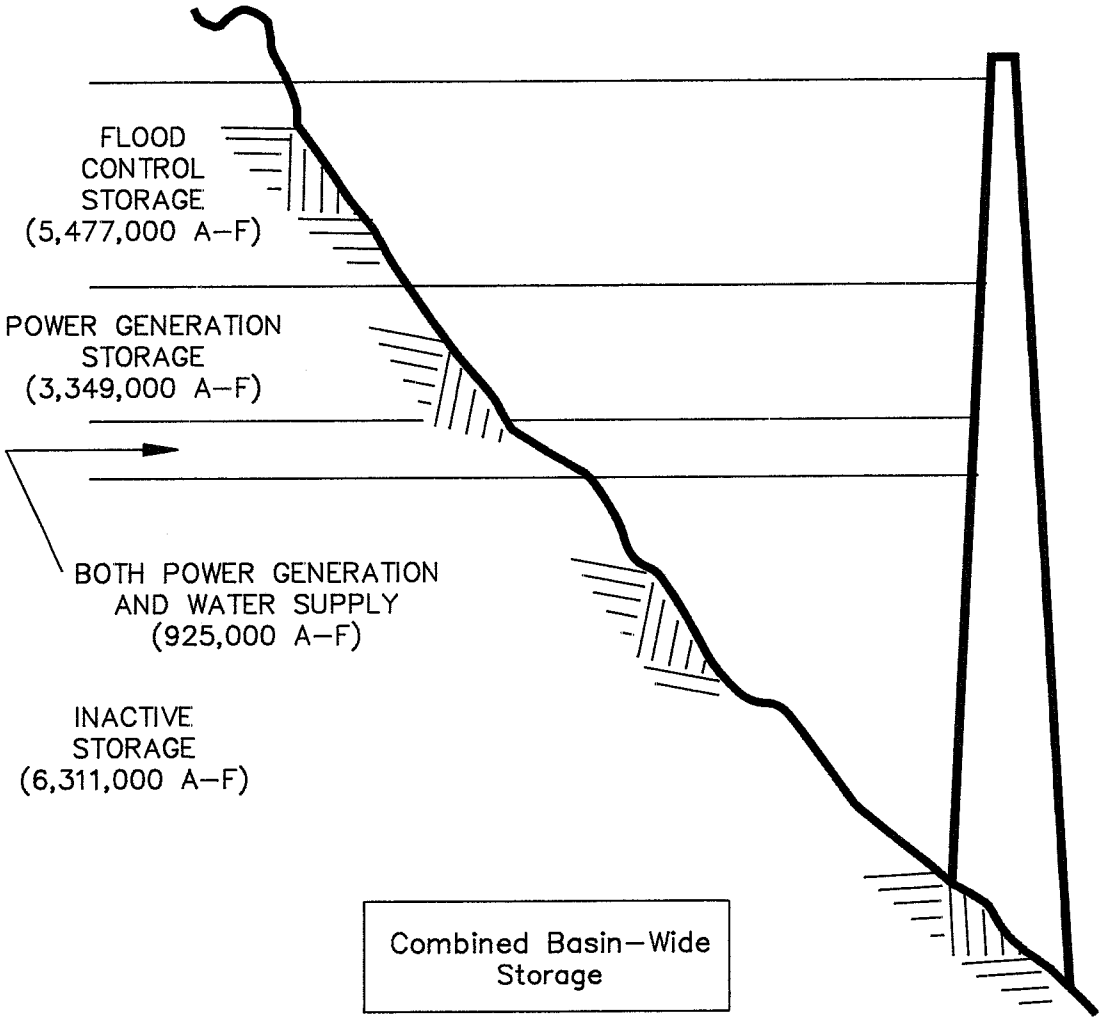


WACO LAKE (657,400 A-F)

Brazos River, Texas

Fort Worth District

Reservoir:	White River Basin Reservoirs (Table Rock, Bull Shoals, Norfolk, Beaver, Greers Ferry, & Clearwater)
General Location:	White River Basin, Arkansas & Missouri
District:	Little Rock District
Report:	White River Basin Reservoirs Arkansas and Missouri Feasibility Report, October 1983
Purpose:	To determine the advisability of modifying the operation of the lakes.
Sponsor:	U.S. Senate Committee on Environmental and Public Works.
Recommendations:	That only minor operational changes be considered in the current regulating plan for the lakes and that a detailed operational study be made to determine these changes relating to regulating stage and release patterns.
Aug 1987 Status:	Although several small water supply contracts (0.5 to 3 mgd) have been signed with various municipal users, no reallocation has taken place for any significant amounts of storage on an individual or basin-wide basis.
Storage Reallocation:	This study considered a variety of storage reallocations and operating changes for six reservoirs in the Basin. Storage reallocation was considered for flood control to hydropower, hydropower to recreation, and hydropower and flood control to fish and wildlife. Changes in the operating rules were considered for downstream releases and lake levels.



No Scale

WHITE RIVER BASIN (16,062,000 A–F)

Arkansas and Missouri
Little Rock District

Reservoir: Wister Lake

General Location: Poteau River, Oklahoma

District: Tulsa District

Reports: Contract between the United States of America and AES Shady Point, Inc. for Water Storage Space in Wister Lake, 5 February 1987

Letter Report Wister Lake

Purpose: To explore the possibilities of reallocating storage from Wister Lake to meet the immediate municipal and industrial water supply needs of Applied Energy Services, Shady Point, Inc., plus provide storage for future potential water supply users.

Sponsor: AES Shady Point, Inc.

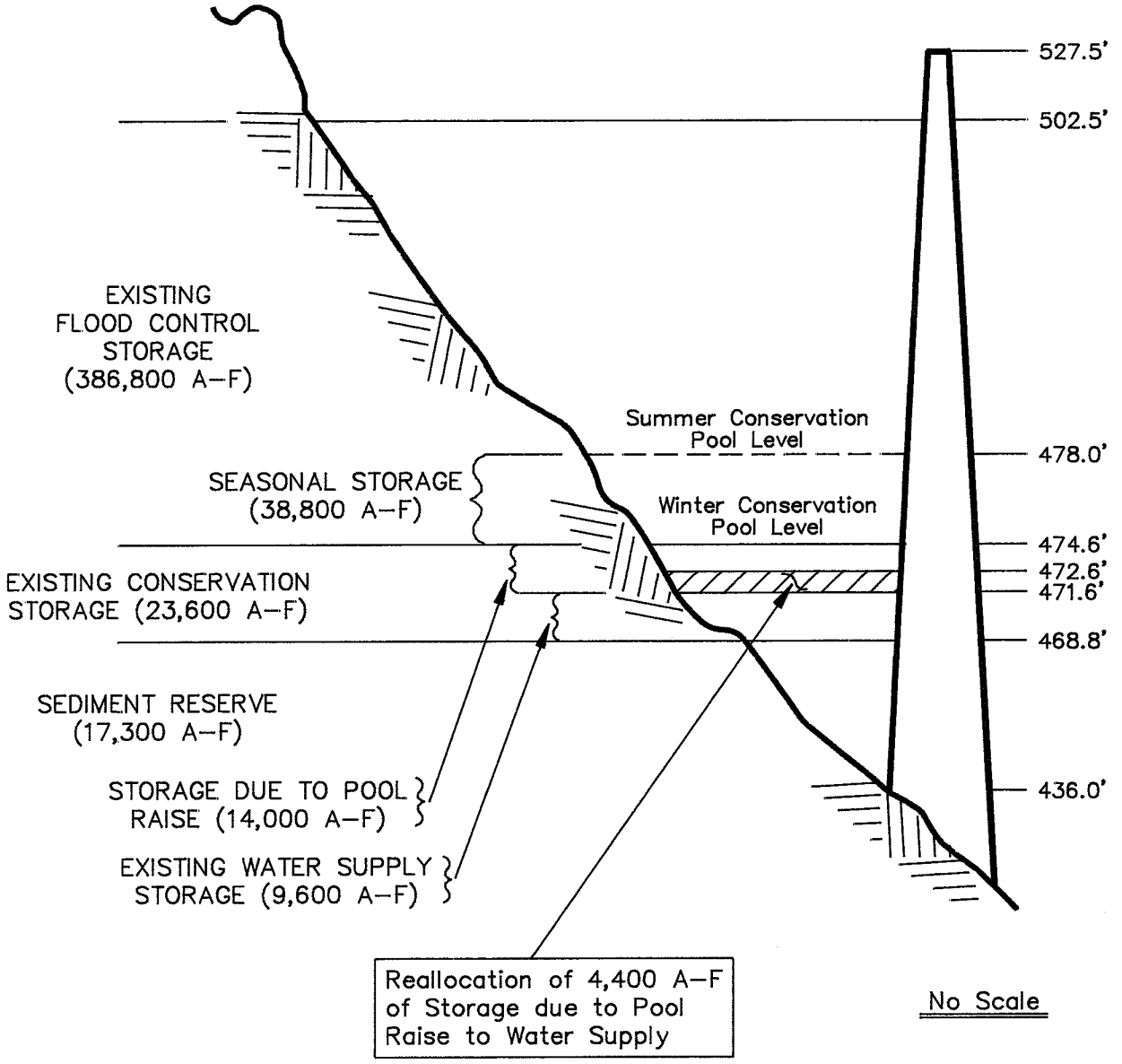
Recommendations: That 4,400 A-F of storage in Wister Lake be reallocated from conservation to water supply storage and that of this amount 4,053 A-F will be for AES and 347 A-F will be for future uses.

Aug 1987 Status: Reallocation of storage is in effect.

Storage Reallocation: Total Storage = 410,640 A-F
Conservation Storage (due to pool raise) = 14,000 A-F
Proposed Reallocation = 4,400 A-F
Percent of Total Storage = 1.1%

Original Total Cost: $10,879,000 (Jan 48)

Original Reallocated Cost: $114,400 (Jan 48)



WISTER LAKE (410,640 A–F)

Poteau River, Oklahoma

Tulsa District

APPENDIX B

MEMORANDUM OF UNDERSTANDING

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE STATE OF KANSAS
AND
THE U. S. DEPARTMENT OF THE ARMY
CONCERNING THE PURCHASE OF
MUNICIPAL AND INDUSTRIAL WATER SUPPLY STORAGE

1. Purpose. The purpose of this Memorandum of Understanding (MOU) is to establish a cooperative partnership between the State of Kansas and the Department of the Army to achieve the greatest possible level of benefits from reservoirs operated by the Corps of Engineers in the Kansas, Neosho, Marais des Cygnes, and Verdigris River Basins in Kansas.

2. Background. Since 1948, seventeen reservoirs have been constructed in Kansas by the United States Army Corps of Engineers. The purposes of these reservoirs include flood control, water supply, water quality, navigation, and other purposes. Water users below Federal reservoirs have enjoyed significant water supply benefits during periods of low flow due to water quality releases.

The rules for operating these reservoirs for flood control are well established. The following problems concerning low flow conditions in Kansas have been identified:

a. Water quality releases are not protected by the State.

b. The State has not obtained reservation rights to store inflows into Federal water quality storage.

c. The State has established minimum flow standards (for water quality, fisheries purposes, etc.) on several streams below Federal reservoirs. The State has not yet coordinated the program to maintain these flows with Federal reservoir operating plans.

d. The State water marketing program, utilizing water supply storage in Federal reservoirs, was designed to provide a dependable water supply. However, some entities have purchased this storage only as "insurance" for use during sporadic low flow conditions. Water supply releases made to these entities during low flow conditions are difficult to protect and much of the water is lost in transit. Maintenance of a regulated flow to meet both water supply and minimum flow standards would be far more efficient to administer.

e. Water quality standards and storage to meet these standards were developed prior to enactment of Public Law 92-500. This Act shifted the burden from the assimilative capacity of the rivers to the point of discharge. Operations of the projects have not been modified to reflect current water quality standards. Because of this, certain amounts of storage may not be used currently for the highest and best uses.

3. Overview of Initiative. The Federal/State partnership established in this MOU is designed to take advantage of a unique opportunity to solve the problems listed in paragraph 2, above, while simultaneously increasing the economic benefits to be derived from the system of Corps reservoirs in Kansas, increasing the level of dependable water supplies to meet the needs of municipalities and industries in Kansas, and increasing the level of recovery of past Federal investments in water resources development.

In order to achieve these objectives, the Department of the Army, in conjunction with the State, intends to conduct storage reallocation studies on nine reservoirs to determine if storage can be reallocated from water quality or other conservation purposes to water supply. It is anticipated that such reallocations can be achieved without serious affects on the purposes for which the projects were authorized and constructed for two reasons: (1) significant progress has been made in recent years to improve the quality of point-source discharges into these river systems, and (2) significant technological advances have been made in recent years in the area of computer-based river system simulations. It is expected that the reduction of dilution requirements and system-wide operation of multiple reservoir river systems will increase the effectiveness of available storage. This may allow significant quantities of storage to be reallocated to water supply.

For its part, the State of Kansas intends to purchase such reallocated storage, which will be used to provide an increased level of dependability to downstream water users within the State. Such purchases will be financed partially from revenues generated from the State's proposed Water Assurance Program, which will be introduced into the State legislature in 1986. Under the Assurance Program, water users in each of the four river basins would be authorized to form an Assurance District. The Assurance District will provide municipal and industrial water supplies to users under low flow conditions in return for payment associated with the cost of the storage space and the operation and maintenance expenses of such space incurred by the State.

In addition, the State intends to pursue legislation, if deemed necessary, providing for the protection of water quality releases, with the objective of preventing water from being withdrawn for other purposes from releases made for water quality.

Because of the unique nature of this opportunity, the Department of the Army will provide to the State a right of first refusal option on all storage to be reallocated. The purchase price of such storage will be considered as if it were authorized originally as municipal and industrial water supply storage. This procedure, which is responsive to the provisions of the 1958 Water Supply Act, represents a variation of standard procedures governing calculation of cost recovery requirements. This variation would be mutually beneficial to both State and Federal interests since this MOU represents the most effective way to maximize economic benefits, levels of water supply dependability, and Federal cost recovery. The State of Kansas is the only entity that has the capability of providing comprehensive solutions to the water resources problems in the Kansas, Neosho, Marais des Cygnes, and Verdigris River Basins in Kansas, in conjunction with the Department of the Army.

The expected sequence of events related to actual reallocation of storage and modified operation of the reservoirs is as follows:

a. Reallocation studies will establish the new storage requirements for water quality and other purposes.

b. Storage that is no longer required for water quality or other conservation purposes will become available for water supply.

c. The Corps and the State of Kansas will jointly establish a date for implementing new operating procedures for water quality at each reservoir. Project operations will follow the new procedures as of that date.

d. The storage identified for water supply will be made available to the State of Kansas during the period of and under terms of this MOU.

4. Procedures.

a. The Kansas Water Office intends to:

(1) Propose to the State legislature in 1986 a Water Assurance Program designed to accomplish the objectives summarized in paragraph 3, above.

(2) Place into an escrow account, by July 1, 1986, an amount of four million dollars ($4,000,000), which will be used toward purchases of storage made as a result of this MOU.

(3) Pay the cost of each increment of water supply storage as purchased and as described in paragraphs 4b(2) and (3) below.

(4) Obtain State legislation, if necessary, authorizing water quality reservation rights to the State and protection of water quality inflows and releases prior to the purchase of any storage under this MOU.

(5) Cooperate and work with the Army Corps of Engineers toward timely completion of the required reallocation studies.

(6) Participate equally in the costs of each reallocation study through in-kind or cash contributions up to a maximum of $40,000 per reservoir. Costs to be shared in this manner are limited to significant additional costs incurred by the Army Corps of Engineers in conducting reallocation studies pursuant to this MOU.

b. The Department of the Army intends to:

(1) Conduct reallocation studies on the reservoirs listed below to determine whether storage may be reallocated to water supply, the amount thereof that may be reallocated to water supply, and to adhere to the indicated schedule by the respective Corps Districts to the extent possible:

(a) Kansas City District, Corps of Engineers

Tuttle Creek	(by September 1986)
Pomona	(by September 1986)
Melvern	(by September 1986)

(b) Tulsa District, Corps of Engineers

John Redmond	(by July 1987)
Marion	(by December 1987)
Council Grove	(by December 1987)
Elk City	(by July 1988)
Toronto	(by July 1988)
Fall River	(by July 1988)

(2) Allow the State of Kansas to have a right of first refusal for the purchase of all storage that may be

reallocated to water supply storage pursuant to this MOU. This purchase option shall be in effect for a period of 10 years from the effective date of this MOU. During this period, the State may purchase one or a multiple of storage increments of not less than 10 percent which may be available for reallocation in each reservoir. To reduce administrative burdens, no more than three contracts shall be allowed for each project under this MOU. Should another party offer a purchase contract to the Department of the Army for all or a portion of such storage during this period, the State shall have 60 days to exercise its option under this paragraph or lose the option for that particular quantity of storage.

(3) Calculate the purchase price for storage that may be reallocated to water supply storage pursuant to this MOU as if it were authorized originally as municipal and industrial water supply storage. Under this procedure, a 10-year interest free period, as provided in the 1958 Water Supply Act, would be allowed. Thereafter, interest would be compounded annually at the project water supply interest rate. The State shall pay the cost of each increment of storage at the time of purchase. The State would be responsible for 100 percent of the actual operation and maintenance, major replacement, and major rehabilitation costs allocated to storage placed under contract.

(4) As part of the reallocation studies, perform studies required for NEPA compliance.

(5) Diligently pursue Congressional approvals of storage reallocations, if deemed necessary.

5. Conditions.

a. This MOU shall be effective for a period of 10 years from July 1, 1986, which is the effective date of this MOU.

b. This MOU is predicated upon the pursuit of solutions on a comprehensive basis. Should the initiative not move forward on a basin-wide basis due to failure of the State to create the Water Assurance Program, or to enact the legislation, if deemed necessary, as described in paragraph 4(a)(4), above, or should no Water Assurance Districts be formed within the effective period of this MOU, then the understandings contained herein shall become null and void.

c. Final approval of reallocation studies for each reservoir and sale of water supply storage for each reservoir, pursuant to this MOU, will be contingent upon the Kansas Water Office obtaining reservation rights for water quality storage remaining after reallocations.

d. This MOU may be modified or terminated by mutual consent of the signatories of the MOU or their designees or successors. All such changes shall be documented by written MOU.

Robert K. Dawson
Assistant Secretary of the Army
(Civil Works)
12/11/85
(date)

Joseph F. Harkins
Director
Kansas Water Office
11 Dec 1985
(date)

Witnessed by:

Robert Dole
United States Senate
12-11-85
(date)

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310-0103

23 DEC 1985

MEMORANDUM FOR THE DIRECTOR OF CIVIL WORKS

SUBJECT: Memorandum of Understanding with the State of Kansas for the Sale of Water Supply Storage

My memorandum of December 13, 1985, provided you with a signed copy of the subject Memorandum of Understanding (MOU). A key element of that MOU is a statement of intent by the Department of the Army to calculate the price of any water supply storage that may be made available as a result of the agreement with Kansas on the same basis that would have occurred if such storage originally had been authorized as municipal and industrial water supply storage.

In order to assure that the decision to calculate the price in this manner is not used improperly in other situations, a document setting forth the basis of the decision has been prepared and is provided with this memorandum. I suggest that the concepts embodied in the attached document be provided to the appropriate Corps elements.

Robert K. Dawson
Assistant Secretary of the Army
(Civil Works)

Attachment

77

Explanation of Basis for Water Supply Storage
Pricing Concept Embodied in the
Memorandum of Understanding between the
Department of the Army of the State of Kansas

Introduction

The Federal/State partnership established by the Memorandum of Understanding (MOU) of December 11, 1985, between the Department of Army and the State of Kansas, was designed to take advantage of a unique opportunity to solve water supply problems in the State of Kansas, to enhance the recovery of past Federal investments in water resources development in Kansas, and to shift a greater portion of the operation and maintenance expenses to the State. A key element of this partnership is the intention of the Department of the Army to calculate the price of any water supply storage that may be made available as a result of the new partnership on the same basis that would have occurred if such storage originally had been authorized as municipal and industrial water supply storage. The purpose of this document is to set forth the basis of the decision to calculate the price in this manner so that the approach is not used improperly in other situations.

The first point that is important in order to understand the decision is that the water supply storage to be sold on the basis mentioned above would not have been available for water supply purposes in the absence of the new partnership. The reason for this situation is that each of the nine reservoirs cited in the MOU contains conservation storage (other than municipal and industrial water supply storage) that may not be needed for originally authorized purposes if certain water quality inflows and releases are protected and if systemwide conjunctive operation of the reservoirs for conservation purposes can be attained. However, the Federal government cannot accomplish these pre-conditions for the availability of additional water supply storage unilaterally. The only way in which these pre-conditions can be attained is in cooperation with an entity with appropriate jurisdiction and sufficient authority to establish the pre-conditions. For the Kansas, Neosho, Marais des Cygnes, and Verdigris River Basins in Kansas, the only such entity that exists is the Kansas State government.

The second point that is important in understanding the decision is that, prior to entering into the MOU, a determination was made that no cost recovery from the storage in question was expected for the remaining physical life of the reservoirs. Furthermore, there was no expectation of relief from Federal operation and maintenance expenses allocated to such storage.

An explanation of the pre-conditions necessary for the availability of additional water supply storage is provided below.

Protection of Water Quality Inflows and Releases

All nine reservoirs included in the MOU have Congressionally mandated low flow releases for purposes other than municipal and industrial water supply. However, certain municipalities, industries, and other users have, in the past, withdrawn water made available from such releases and used such water for municipal and industrial purposes without payment to the Federal government for storage costs. In the absence of the MOU, this situation is expected to continue. In addition, upstream diversions of flows are expected to continue to reduce inflows into existing water quality storage in all nine reservoirs, thus reducing over time the expected yields and dependability of yields from water quality storage. Under the MOU, the State agreed to establish water quality reservation rights to protect water quality inflows and releases, including legislation if necessary.

Systemwide Conjunctive Operation of Reservoirs

Corps operating rules for flood control typically are developed on a systemwide basis. This is possible because the Corps has decision-making authority for all releases from flood control storage. However, such is not the case for water supply. Since water supply releases are made at the request of the owner of each particular increment of water supply storage, water supply releases generally are made at each reservoir in isolation. However, if substantially all of the water supply storage in a given river basin were owned by the same customer, and if that customer were willing to

cooperate fully with the Corps, then systemwide operation for water supply would be possible. In such a situation, many demands could be met by releases from more than one reservoir, and therefore the reservoirs in the system could share the risk of shortage, thus reducing the risk of shortage (increasing the level of dependability) to most users. This same effect could also be brought about by the construction of additional storage reservoirs. However, because of the new partnership established by the MOU, an increased level of dependability can be realized without additional construction, thus effectively creating new storage at no cost to the Federal government. The only entity with sufficient jurisdiction and authority to enable the synergism embodied in such systemwide conjunctive operation for water supply is the State of Kansas.

Other Considerations

In addition to its commitments to protecting water quality inflows and releases and pursuing systemwide operation in conjunction with the Corps, the State of Kansas has provided other considerations as contributions to the partnership embodied in the MOU. These are:

- cost sharing on a 50/50 basis of the reallocation studies to be conducted on each of the nine reservoirs,
- agreement to pay cash up front for all water supply storage purchases,
- immediate establishment of an escrow account of $4 million, earmarked for the purchase of water supply storage under the MOU, and
- immediate assumption of 100% of the operation and maintenance costs allocated to each increment of storage at the time of purchase.

Finally, it is important to note that the pricing concept embodied in the MOU with Kansas will be implemented only if the pre-conditions for the availability of additional storage described previously in this document are attained. The MOU provides specifically that the agreement will become null and void if such pre-conditions are not attained.

APPENDIX C

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