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LEHIGH RIVER BASIN, HYDROPOWER STUDY, STAGE 1. RECONNAISSANCE R--ETC(U)

SEP 80

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1 OF 4

AD A099372

Lehigh River Basin
Hydropower Study
Stage 1
Reconnaissance Report

September 1980

Rept. No. DAEN/NAP-12202/RR-80/09

U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

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The purpose of the Lehigh River Basin hydropower study is to assess the potential of hydroelectric power development in the entire Lehigh River Basin, Pa. and to develop a plan for this development by consideration of all possible alternatives to optimize the basin's hydropower production. The scope of this plan is to include both public and private sectors.

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This particular reconnaissance report presents the results of a Stage 1 investigation of the water resources of the Lehigh River Basin, Pa. It provides a framework under which further studies will be undertaken by placing emphasis on data collection and problem identification. A description of the study area as to its natural resources including climate, hydrology, geology, soils, fish and wildlife ; its human and economic resources; cultural and scenic resources is given. Several hydropower management alternatives are also presented.

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LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY

STAGE 1 RECONNAISSANCE REPORT

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LEHIGH RIVER BASIN

HYDROELECTRIC POWER STUDY

CHAPTER I INTRODUCTION

Since 20 April 1977, when President Carter proposed his comprehensive energy plan, the nation as a whole has intensified its interest in renewable alternative energy sources such as wind, solar, and hydroelectric power. This study of hydroelectric power generation in the Lehigh River basin is a direct result of local concern about our national energy situation and the rising costs resulting from the increased scarcity of fossil fuels.

STUDY AUTHORITY

On 10 May 1977 the Committee on Public Works and Transportation of the U.S. House of Representatives adopted a resolution authorizing the Board of Engineers for Rivers and Harbors to review the report on the Delaware River basin, published in House Document 522, 87th Congress, 2nd Session, and other pertinent reports with a particular view to determining whether any modifications of the recomendations contained therein are advisable at the present time in the interest of hydroelectric power and allied purposes in the Lehigh River basin. A copy of the resolution is included in Appendix A.

STUDY SCOPE

The purpose of this planning study is to assess the potential of hydroelectric power development in the entire Lehigh River basin (See Plate 1), and to develop a plan by considering all potential alternatives to optimize the basin's hydropower production. The scope of the plan is to include both the public and private sectors. To this end the study will

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encourage public and private coordination and exchange. The study will investigate current and future energy problems and needs and assess the potential contributions of hydroelectric power to meet increased energy demands and to lessen our nation's dependence on non-renewable energy resources.

In defining the study area, consideration has been given to the area which would be impacted by the development of hydroelectric power facilities in the Lehigh River basin. From the standpoint of direct environmental and social impacts the Lehigh River's drainage basin has been delineated as the principal study area. From the standpoint of power utilization, the study area has been expanded to include the power market area of the Pennsylvania - New Jersey - Maryland interconnected bulk electric supply system (PJM).

COORDINATION

On 27 November 1979 formal announcement of the study was made to all known interested federal, state, county, and local elected officials and agencies, clearinghouses, special interest groups and interested individuals. An initial public meeting was held on 29 January 1980 in order to obtain input on local desires and needs. A copy of the formal announcement and responses is contained in Appendix A. A summary of comments made during the initial public meeting is contained in Chapter V, Views of Concerned Interests.

At the Federal level, coordination has been initiated with the Delaware River Basin Commission, the Federal Energy Regulatory Commission, the U.S. Department of Energy, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the Heritage Conservation and Recreation Service, and other interested agencies.

The U.S. Fish and Wildlife Service and the Federal Energy Regulatory Commission (FERC) have both provided direct input to this Reconnaissance Report. The Fish and Wildlife Service prepared a planning aid report outlining the existing fish and wildlife resources of the basin. This report is contained in Appendix B and briefly summarized in Chapter II. FERC outlined the existing makeup of the Pennsylvania - New Jersey - Maryland interconnected bulk electric supply system. The discussion on Power Resources in Chapter II, as well as portions of the Power Development section in Chapter III were taken from the FERC report.

At the state and local levels coordination has been initiated with the Pennsylvania Department of Environmental Resources, the Governor's Energy Council of Pennsylvania, the Pennsylvania Public Utility Commission, as well as a number of municipal bodies, local planning groups, utilities, and private interests.

A meeting was held on 20 May 1980 with the Department of Energy (DOE) and all Lehigh Basin hydropower feasibility study loan applicants under DOE's Small Scale Hydro Program. The purpose of the meeting was to review the ongoing hydropower work in the Lehigh Basin and to discuss ways to coordinate the various efforts and avoid duplication of effort. Those in attendance generally agreed to formally set up a progress and information exchange committee to maintain coordination.

OTHER STUDIES

House Document #245, 72nd Congress, 1st Session. Investigations were undertaken under the provisions of House Document #308, Sixty-ninth Congress, first session with regard to navigation, power, flood control and irrigation within the Lehigh River Basin. Two plans were investigated for power development. The first plan considered conventional development of a dam below the junction of Bear Creek (the current location of the Francis E. Walter Dam) and another below the junction of Tobyhanna Creek with the Lehigh River with a total installed capacity of 22,000 kilowatts producing 54,911 megawatt-hours of energy annually. The second plan consisted of a dam at Tobyhanna with a combination tunnel and pipeline through three regulating reservoirs on Mud Run, Stony Creek and the lower Bear Creek to a powerhouse on the Lehigh River near Jim Thorpe. The project would utilize 942 feet of power head with an installed capacity of 103,200 kilowatts with the capability to product 255,430 megawatt-hours of energy annually. These projects were found not to be economically justified at that time.

House Document #587, 79th Congress, 2nd Session. This study completed in 1946 authorized the construction of the Francis E. Walter (Bear Creek) Reservoir and two local flood protection projects at Allentown and Bethlehem. Although limited in authority to a flood control investigation, the Tobyhanna project was reevaluated in conjunction with the Federal Power Commission in order to assess the feasibility of expanding the system to include pumped water from the proposed Bear Creek Reservoir. The expanded project could develop 1020 feet of fall and a potential capacity of 150,000 kilowatts. The new plan was found to be economically feasible based on preliminary estimates but was not investigated in detail due to the limited authority of the study.

House Document #522, 87th Congress, 2nd Session. The Philadelphia District prepared the Comprehensive Survey of the Water Resources of the Delaware

River Basin which is the report under review. This plan for the coordinated long range development of the Water Resources of the Delaware River Basin was authorized by Congress in August 1962. Recommendations were made for construction of a number of multipurpose reservoirs throughout the Basin. Authorized under this plan were the Beltzville Lake, Aquashicola Lake, and Trexler Lake projects as well as a modification to the existing F.E. Walter Reservoir within the Lehigh River Basin. Of these four only the Beltzville Lake project has been constructed.

During the study, a power work group was formed by the Federal Power Commission at the request of the Philadelphia District Engineer. The work group considered development of hydroelectric power using pumped storage in a combination of the Tobyhanna Reservoir and Beltzville Lake. This plan called for construction of an upper reservoir on Stoney Creek which would draw water from two lower reservoirs: what is now Beltzville Lake on the Pohopoco Creek and a proposed reservoir on the Lehigh River at the Tobyhanna site. In addition several alternatives were evaluated utilizing pumped water from Beltzville Lake alone. These systems were found not to be economically feasible at that time.

The National Hydroelectric Power Study. This ongoing study was authorized under Public Law 94-587. Section 167(a) authorized the Secretary of the Army, acting through the Chief of Engineers to conduct a study of the most efficient metnods of utilizing the nations hydroelectric power resources. Under this study The Corps has undertaken several studies including an assessment of the opportunities for increased hydroelectric output, an analysis of the need for increases in hydroelectric power development, recommendations on a national hydroelectric development program, and consideration of changes to legislative, institutional and policy practices which affect the development and efficient utilization of hydroelectric power projects. The study will encompass from a general standpoint the efforts under the Lehigh Basin Hydropower Study and will aid substantially in its conduct.

The Rural Hydroelectric Power Development Initiative. The Department of Energy is coordinating the activities of several Federal agencies in an accelerated program to identify and develop potential small-scale hydropower resources at existing dam sites in rural areas. This effort is part of the President's Rural Energy Initiative. Several hundred sites were nominated for study by agencies such as the Rural Electrification Administration, the Farmer's Home Administration, the Department of Housing and Urban Development, and the Economic Development Administration. Reconnaissance studies of these sites are currently underway. The Corps of Engineers has prepared reconnaissance reports under this program along with the Federal Energy Regulatory Commission (FERC, formerly the Federal Power Commission) the Bureau of Reclamation and the Department of Energy. The Philadelphia District has completed reconnaissance investigations of hydropower additions at two sites in the Lehigh Basin: Beltzville Lake and Francis E. Walter Reservoir. Both were found to be economically feasible.

The Delaware River Basin Commission (DRBC) is currently conducting a comprehensive (Level B) study of the Delaware River Basin. The objective of this study is to develop a plan for the management of the water resources of the basin, including hydroelectric power. The commission's proposals encourage the development of small-scale hydroelectric power at existing and proposed impoundments. As part of their study DRBC requested the Federal Energy Regulatory Commission to identify potentially feasible hydroelectric developments in the Delaware River Basin. FERC identified eight potential conventional developments and 43 potential pumped-storage projects. Of these 51 projects, six are located within the Lehigh River Basin. The proposed Francis E. Walter modified project and the Penn Haven Reservoir were considered for possible conventional development. The pumped-storage projects identified in the Lehigh Basin were the Kunkletown project on Aquashicola Creek, and three schemes in the Pohopoco Creek basin utilizing the Penn Forest and Wild Creek Reservoirs and Hell Creek.

DRBC, in conjunction with the Pennsylvania Department of Environmental Resources, has recently applied to FERC for preliminary permits to conduct hydropower addition studies at both the Francis E. Walter Dam and Beltzville Lake.

The Heritage Conservation and Recreation Service (HCRS) of the Department of the Interior has an effort underway to present the Lehigh Canal system to the public as a complete cultural heritage and recreational area. In their efforts to promote the canal system, which extends 46 miles from Easton to Jim Thorpe, HCRS has identified the potential contribution of the reactivation of old hydroelectric mill facilities in their plan to preserve the area's historic industrial heritage.

The Pennsylvania Department of Environmental Resources (DER) has recently completed a study of the Lehigh River to determine the eligibility of portions of the river and tributaries to be included in the state scenic river system. DER has recommended the segment of the mainstem Lehigh River from Jim Thorpe to Francis E. Walter dam as well as many tributaries in this segment to be considered for state designation.

DER is also developing a flexible State Water Plan for wise management of water resources to meet present and future need of the people of Pennsylvania. A draft report on the results of the studies in sub-basin 2 which includes the Lehigh River Basin was completed in September 1977. Completion of the final report is scheduled in 1980.

Other Studies Several private groups and municipalities are studying potential hydroelectric additions at several existing dams in the Lehigh Basin. The Borough of Lehighton, the Borough of Weatherly, the City of Bethlehem, and the City of Allentown, the Chain Dam Hydropower Corporation, and the Pennsylvania Hydroelectric Development Corporation have initiated reconnaissance investigations. Preliminary permit applications to conduct independent feasibility studies have been submitted to FERC on Francis E. Walter Dam, Beltzville Lake, and Chain Dam. A preliminary permit has already been obtained by the Pennsylvania Hydroelectric Development Corporation to conduct a feasibility study of Easton Dam and Locks 23 & 24 on the Delaware Canal at the mouth of the Lehigh River. Several other preliminary permit applications are anticipated during the course of this study.

THE REPORT AND STUDY PROCESS

This Reconnaissance Report presents the results of a Stage 1 investigation of the water resources of the Lehigh River basin. The purpose of a Stage 1 investigation is to determine the need for more detailed studies and to establish preliminary study objectives and the framework in which further studies will be undertaken. Emphasis during Stage 1 was placed on data collection and problem identification. The identification and evaluation of alternative plans was undertaken at a preliminary level only. In order to get a total picture of the study area, Federal, regional, state, and local plans and programs were reviewed and evaluated. This allowed the establishment of a sound data base and the identification of problem areas which will be evaluated further during Stage 2.

During Stage 2 alternative ways to achieve the planning objectives developed in Stage 1 will be identified and analyzed. This analysis will utilize preliminary engineering, economic, social, and environmental considerations to assess each alternative. Those that prove viable will be analyzed in greater detail in Stage 3.

The final plan development phase, Stage 3, will consider and evaluate detailed, implementable plans. Stage 3 ends with the selection of a plan, and, if appropriate, a recommendation for its authorization.

CHAPTER II

DESCRIPTION OF THE STUDY AREA AND ITS RESOURCES

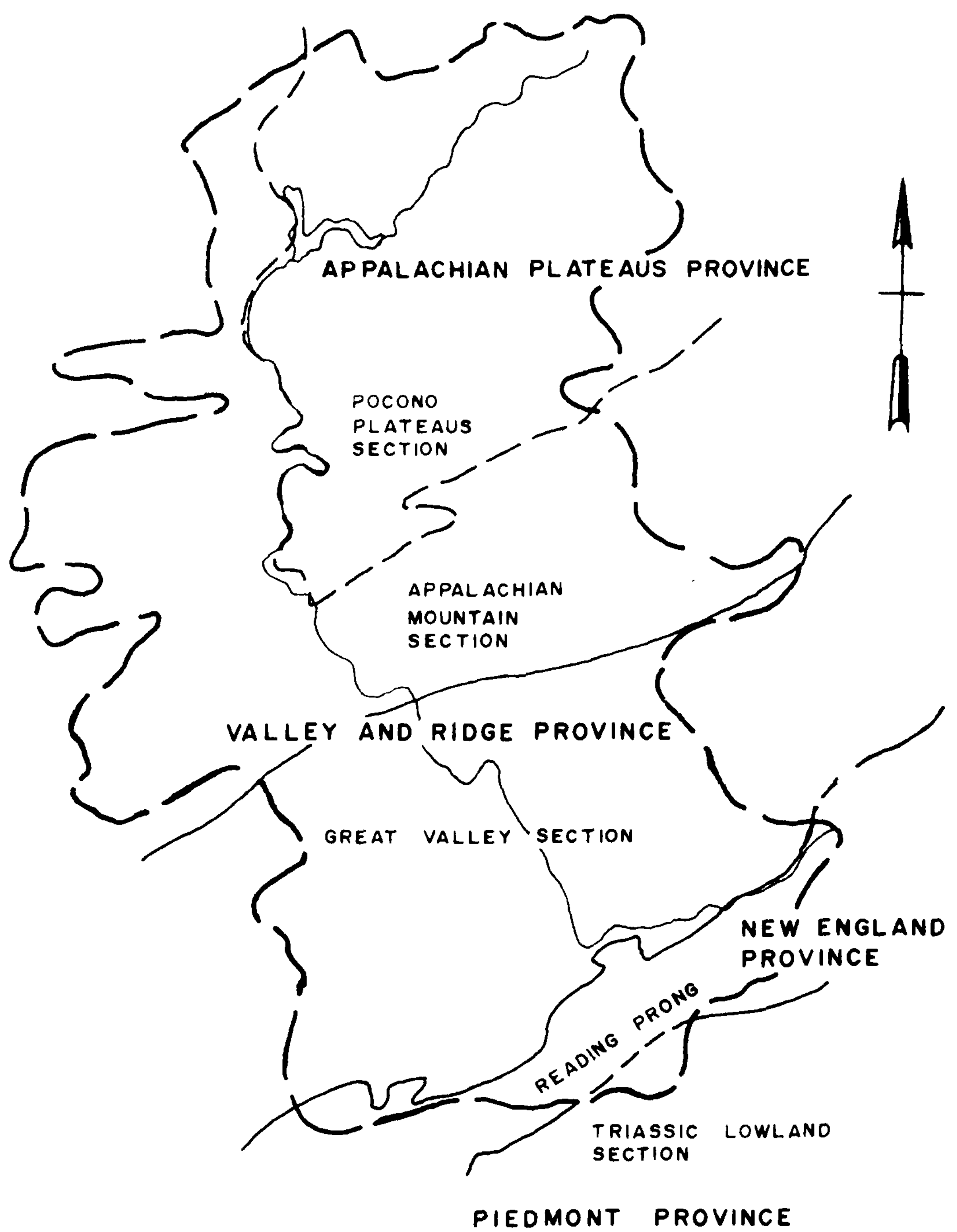
STUDY AREA

The Lehigh River drains an area of 1370 square miles in northeastern Pennsylvania, covering portions of Wayne, Lackawanna, Monroe, Luzerne, Carbon, Schuykill, Berks, Bucks, Northampton and Lehigh counties. The watershed accounts for one-quarter of the Delaware River drainage area above Easton. Plate 1 shows the location of the Lehigh River basin.

Within the ten county area there are 101 municipalities which are either totallv or partially located in the basin. Allentown and Bethlehem, the largest cities, support the main industrial development in the basin, Bethlehem being dominated by one large steel plant. The City of Easton is the third largest community in the study area. Outside of Carbon, Lehigh, and Northampton counties the study area is essentially rural in nature with the exception of Hazelton (Luzerne County). Textiles and cement are the most important products originating from this area of the basin.

NATURAL RESOURCES

Physiography. The Lehigh basin lies mainly within two physiographic provinces. (See Figure 1). The northernmost, known as the Appalachian Plateau Province, contains that portion of the watershed above White Haven. This region is glaciated and contains numerous lakes and swamps at 1500 to 2000 feet above sea level. Below White Haven the basin lies within the



SOURCE:
USGS PROFESSIONAL PAPER 381

SCALE OF MILES

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LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY

PHYSIOGRAPHIC PROVINCES

PHILADELPHIA DISTRICT CORPS OF ENGINEERS

FIGURE 1

Valley and Ridge Province, which is recognized as consisting of two sections, the Appalachian Mountain Section and the Great Valley Section. The Appalachian Mountain Section, which adjoins the Plateau Province, is a broad band of long narrow ridges and intermontane valleys whose axes lie in a northeast-southwest direction, transverse to the general course of the river. The ridges and steep slopes are moderately wooded. Elevations of the terrain range from 400 to 1400 feet above sea level. The southernmost ridge, Blue Mountain, is cut by the river at Lehigh Gap. The Great Valley Section, a broad rolling terrain, extends northeast to the mouth of the Lehigh at Easton, on the Delaware River, and to the southwest across Pennsylvania. South of the Great Valley Section minor portions of the Lehigh Basin lie within the New England and Piedmont Provinces.

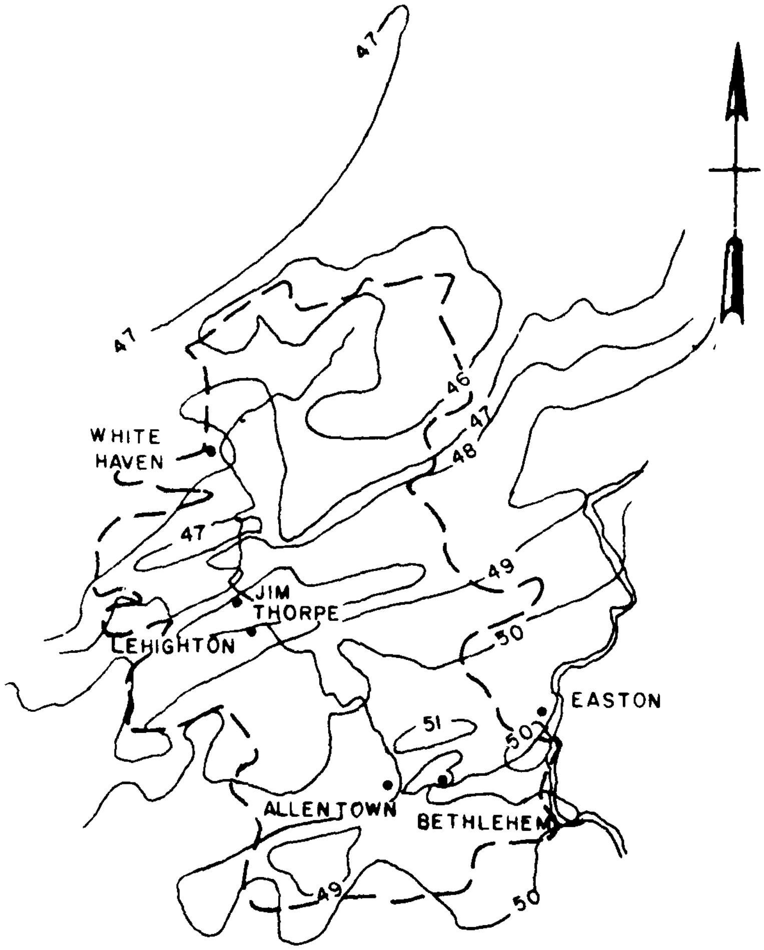
The mainstem Lehigh River traverses over 103 miles of variable terrain from its source in the Pocono Mountains in Wayne County to its confluence with the Delaware River at Easton. Over its length the mainstem falls 1890 feet from an elevation of 2050 feet at its source near Gouldsboro, PA. Gradients in the main stem of the River average 26.2 feet per mile above White Haven and Allentown, and 4.1 feet per mile for 17 miles from Allentown to the mouth. In contrast slopes in tributary streams average 50 feet per mile. Table 1 presents the data on 15 principal tributaries of the Lehigh River.

TABLE 1
PRINCIPAL TRIBUTARIES OF THE LEHIGH RIVER

Stream	Enters River, Miles Above Mouth	Drainage Area, Sq. Mi.	Length, Miles	Elev. at Source, ft.	Elev. at Mouth, ft.
Saucon Cr.	9.2	58.2	16.5	640	206
Monocacy Cr.	11.1	49.6	18.0	760	212
Little Lehigh Cr.	16.2	107.0	24.0	830	225
Jordan Cr.	--	81.0	32.0	740	228
Hokendauqua Cr.	22.0	42.6	15.0	760	282
Aquashicola Cr.	35.7	81.2	22.5	1,500	380
Lizard Cr.	38.8	53.8	15.0	750	415
Pohopoco Cr.	40.5	111.7	23.0	1,820	435
Mahoning Cr.	42.1	37.3	14.0	1,040	480
Mauch Chunk Cr.	46.5	8.9	8.0	1,120	512
Nesquehoning Cr.	48.4	33.8	13.0	1,540	568
Black Cr.	55.4	62.6	14.5	1,720	760
Mud Run	64.8	35.9	15.0	1,850	970
Bear Cr.	77.6	50.2	13.0	2,020	1,250
Tobyhanna Cr.	83.5	128.3	32.0	2,080	1,410

Climate and Hydrology. Although very near the Atlantic coast, the climate of the Lehigh Basin is largely continental, being dominated by air masses moving eastward from the interior of North America, while being modified by influences of the Great Lakes and the Appalachian Mountains. The continental air masses cause moderate to heavy rainfall over the entire Delaware Basin when mixed with the moist tropical masses that move up from the south. Generally west to southwest air flow brings the hot dry weather which is responsible for summer droughts. North to south airflow bringing Canada's artic air into the Basin occurs in the winter.

i. Temperature. Figure 2 shows average annual temperature variations within the Lehigh River area. Average yearly temperatures range from 46 to 51°F throughout the Lehigh area. The National Oceanic and Atmospheric



SOURCE
USGS PROFESSIONAL PAPER 381
NOTE:
VALUES IN °F

SCALE IN MILES
0 10 20

LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY
AVERAGE ANNUAL TEMPERATURE
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 2

Administration maintains detailed records. The data presented in Table 2 was extracted from NOAA's "Local Climatological Data, Annual Summary with Comparative Data, 1978, Allentown, Pennsylvania". The data at Allentown is considered representative of monthly variations throughout the Lehigh Area.

Extreme variations range from an uncharacteristic high of 105°F during the summer months, usually accompanied by high humidity, to a low of -20°F during the winter season.

TABLE 2
AVERAGE MONTHLY TEMPERATURE VARIATIONS, ALLENTOWN, PENNSYLVANIA

Month	Mean °F	Maximum °F	Minimum °F
January	27.5	35.3	19.6
February	29.5	38.0	21.0
March	38.5	48.0	29.0
April	49.7	60.9	38.5
May	59.8	71.1	48.5
June	69.3	80.3	58.2
July	73.8	84.8	62.8
August	71.9	82.5	61.2
September	64.6	75.2	53.9
October	53.8	64.9	42.6
November	42.4	51.4	33.4
December	31.2	39.0	23.4
Annual	51.0	61.0	41.0

2. Precipitation. Hourly and daily as well as total monthly precipitation amounts are published by the NOAA in its Climatological Data Bulletin. The administration operates 16 precipitation stations in the Lehigh Basin. Nine of these stations are equipped with continuous recording rainfall gages. The remaining 7 stations are equipped with nonrecording gages which are read one or more times daily.

Table 3 provides average monthly precipitation data at the Allentown station. Figure 3 shows the average variation throughout the Basin.

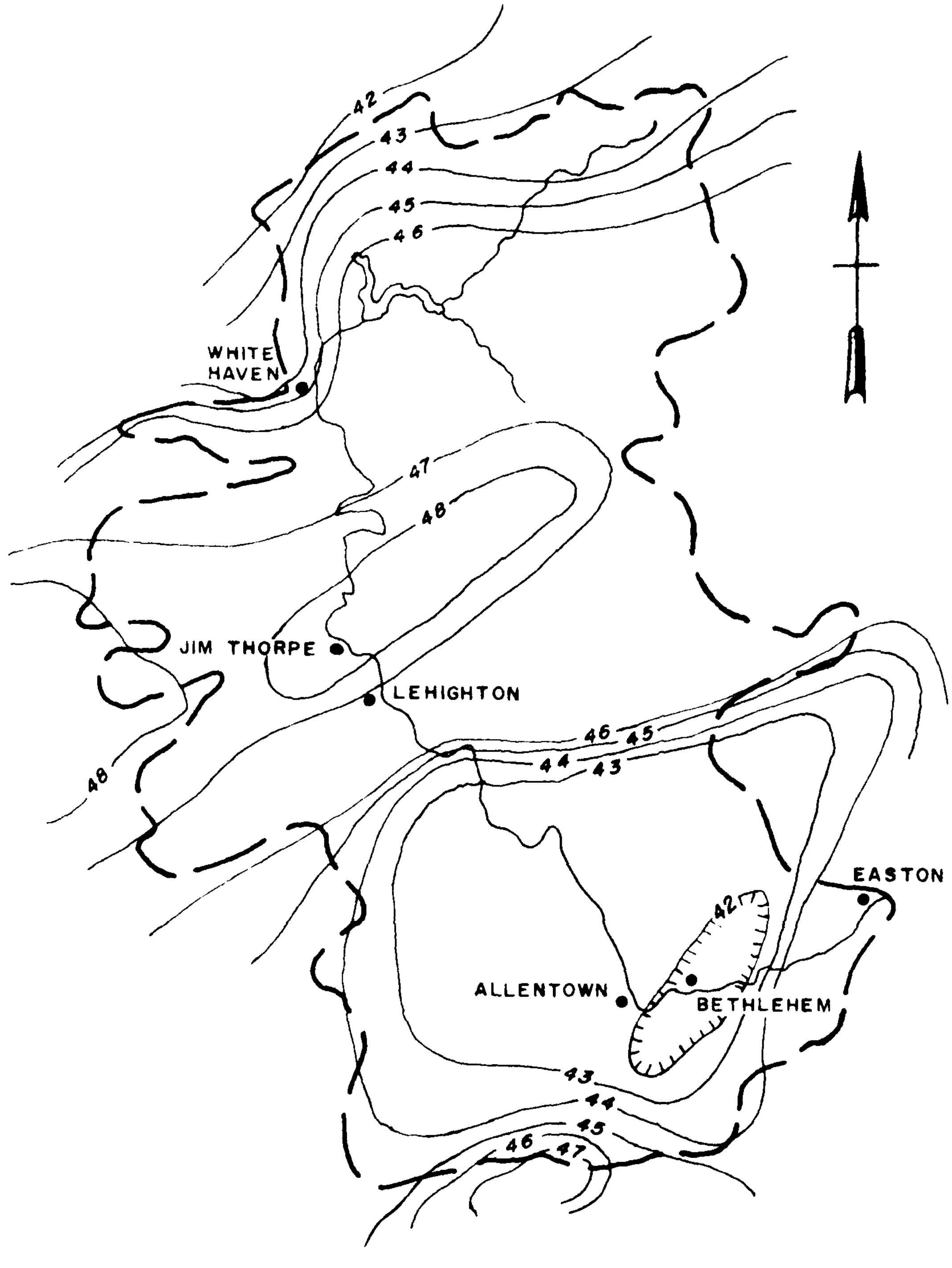
TABLE 3
AVERAGE MONTHLY PRECIPITATION DATA, ALLENTOWN, PENNSYLVANIA

Month	Average Precipitation (inches)	Month	Average Precipitation (inches)
January	3.26	July	6.29
February	2.89	August	4.46
March	3.73	September	3.98
April	3.79	October	2.76
May	3.84	November	3.69
June	3.68	December	3.77

Intense precipitation in the Lehigh Basin results from two general storm types: those of tropical origin and those of extra-tropical origin such as thunderstorms and northeasters. Historically the heaviest precipitation has been deposited when these storm types have combined. Hurrican Diane in August 1955 was of this type and deposited an average of 7 inches of precipitation over the Lehigh Basin.

In contrast to storm events, several noteworthy droughts have occured in the Delaware River Basin since 1876. The worst drought experienced in the Basin was from August 1961 to May 1967, causing considerable concern over the water resources of the Delaware Basin. Prior to the sixties the worst drought experienced occurred in 1930 and the next most severe in 1895.

3. Runoff. In respect to its drainage p ern, the Lehigh watershed consists of contrasting areas which differ in their run-off characteristics. In the area that lies downstream from Lehigh Gap, and comprises one-third,



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LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY

AVERAGE ANNUAL PRECIPITATION

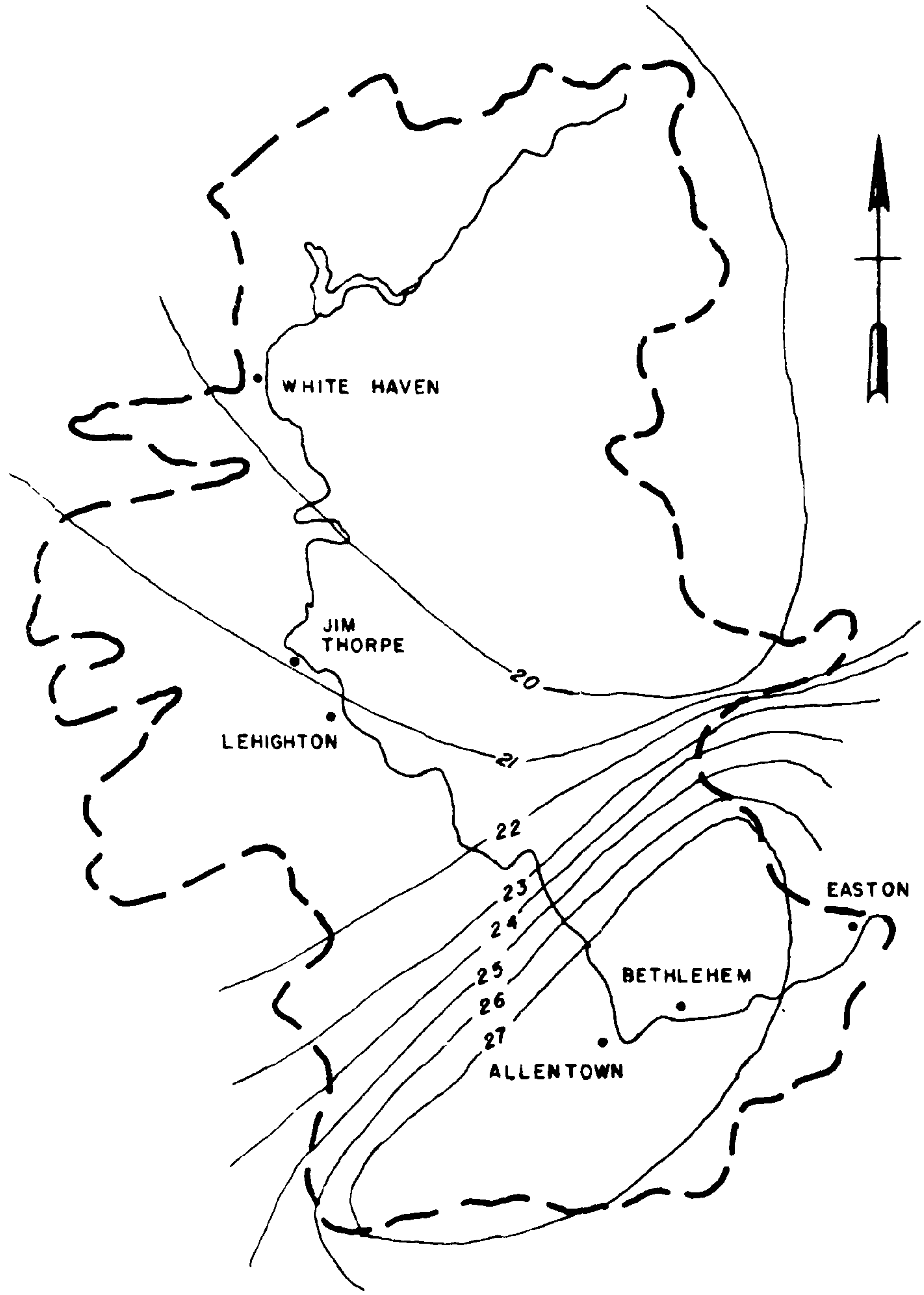
PHILADELPHIA DISTRICT CORPS OF ENGINEERS

FIGURE 3

or more, of the entire watershed, the stream channels and basin surfaces have moderate slopes and correspondingly moderate rates of run-off. Between Lehigh Gap and the vicinity of Jim Thorpe is an area composed of ridges and valleys extending entirely across the watershed and drained by four principal tributaries, viz., Aquashicola and Pohopoco Creeks, which enter from the northeast, with Lizard and Mahoning Creeks which enter from the southwest. The watersheds of the streams that enter from the southwest are much smaller and shorter in extent than those which enter from the northeast. The tributaries in this area are characterized by moderate slopes in their main channels and steep slopes in the basin surfaces and in the channels of their feeders and headwater streams. Upstream from the ridge and valley area lies the southeastern escarpment of the Appalachian Plateau, on which the terrain and the stream channels slope steeply and deliver the run-off rapidly. On the plateau peneplain which is drained by Tobyhanna Creek and the extreme upper part of the main stem of Lehigh River, slopes are moderate and there are many ponds and swamps, conducive to slow runoff.

Precipitation in the Basin is lost through evapotranspiration and infiltration. Average annual water losses in the Basin are shown in Figure 4. These losses are the difference between the basin precipitation and the run-off directly contributing to the steamflow.

The United States Geological Survey currently maintains 16 streamflow gaging stations within the Lehigh Basin. Gage locations are shown on Figure 5. Complete records can be obtained through U.S.G.S. while select



SOURCE
USGS PROFESSIONAL PAPER 381

NOTE
VALUES IN INCHES REPRESENT DIFFERENCE BETWEEN PRECIPITATION AND RUNOFF

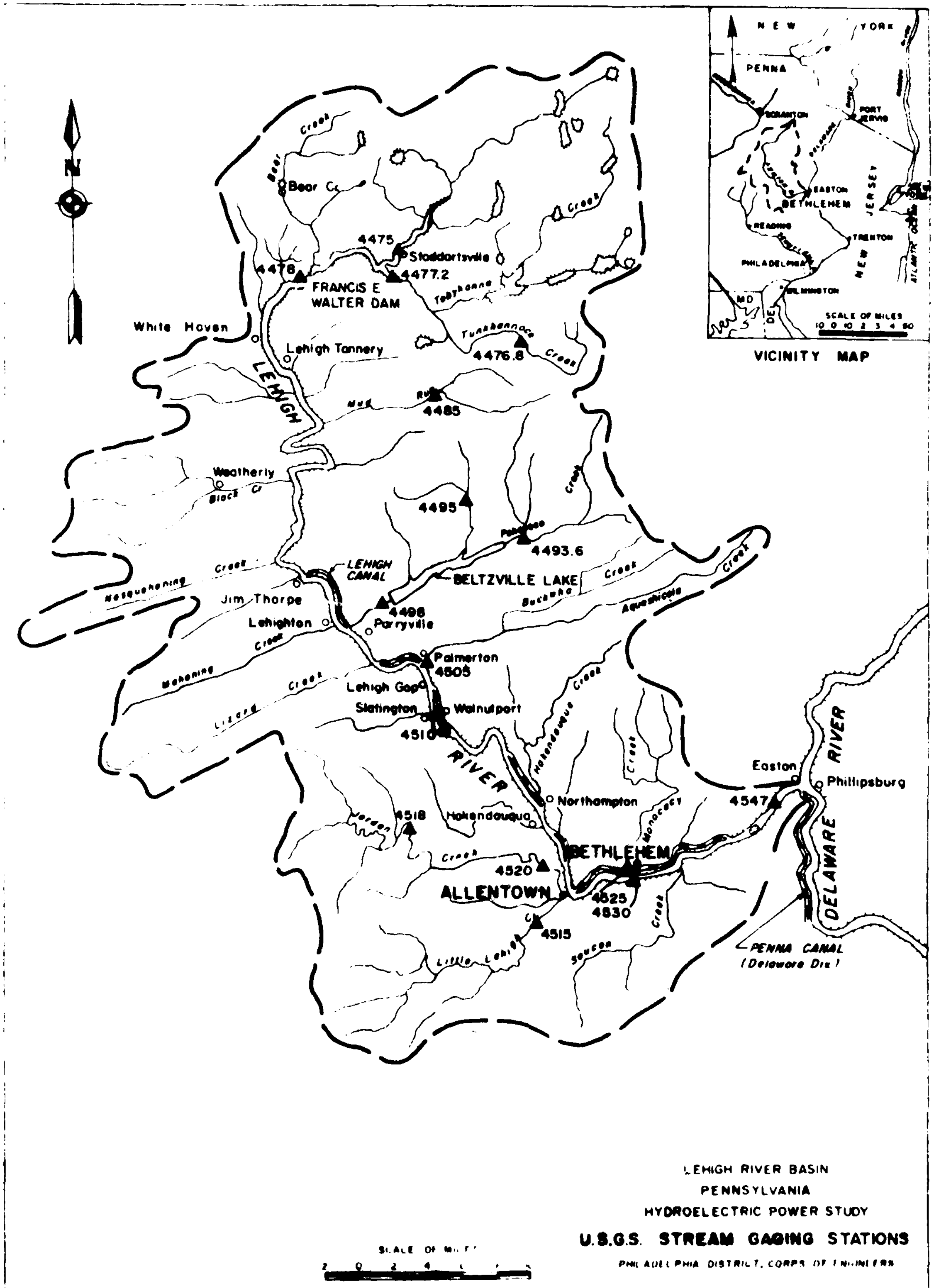
SCALE OF MILES
0 8 16

LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY

AVERAGE ANNUAL WATER LOSS

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 4



LEHIGH RIVER BASIN

PENNSYLVANIA

HYDROELECTRIC POWER STUDY

U.S.G.S. STREAM GAGING STATIONS

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 6

characteristics are presented in Table 4. As can be seen from Table 4 mean runoff in the Basin averages about 2 cfs/mi^2 which is characteristic of most drainage areas in the northeastern United States.[1]

4. Dams & Reservoirs. High flows on the Lehigh River are regulated by Francis E. Walter Dam, Beltzville Lake, Wild Creek and Penn Forest Reservoirs. These storage reservoirs significantly influence flood runoff characteristics. Mean annual flood runoff measured at Bethlehem is considerably lower than that at Walnutport which lies upstream of Beltzville, Wild Creek, and Penn Forest Reservoirs. These values average 21.4 cfs/mi^2 and 30.5 cfs/mi^2 respectively[2].

One hundred and thirty nine dams and one natural lake are known to be located within the Lehigh River basin. The U.S. Fish and Wildlife Service identified these sites in relation to basin fish and wildlife resources with site data presented in Appendix C, as extracted from Water Resources Bulletin Number 5 published by the Pennsylvania Department of Environmental Resources.

(1) Allis - Chalmers Corporation
(2) PA DER State Water Plan, Subbasin 2 Draft Report, September 1977.

TABLE 4
USGS STREAM GAGING STATIONS

Station Number	Location	Period of Record Yrs	Drainage Area (mi^2)	Average Discharge (cfs)	Mean Runoff (cfs/mi^2)	Quality of Records Remarks
01447500	Lehigh River at Stoddartsville, Pa.	35	91.7	188	2.05	Records good except those for winter periods which are fair.
01447680	Tunkhannock Creek near Long Pond, Pa.	14	18.0	47.3	2.63	Records good except for winter periods. Diversion above station since 1969 to Wild Creek Basin.
01447720	Tobyhanna Creek near Blakeslee, Pa.	17	118.0	261	2.21	Records good except for winter periods. Occasional regulation by Pocono Lake, minor upstream diversion to Wild Creek Basin.
01447800	Lehigh R. below F.E. Walter Res near White Haven, Pa.	21	290	617	2.13	Records good except for winter periods. Regulated by F.E. Walter Lake since 1961.
01448500	Dilltown Creek near Long Pond, Pa.	30	2.39	4.95	2.07	Records good except for winter periods, and doubtful Jan 9 to July 26 which are fair.
01449360	Pohopoco Creek at Kresgeville, Pa.	12	49.9	111	2.22	Records good except for winter periods which are fair.
01449500	Wild Creek at Hatchery, Pa.	38	16.8	36.2	2.15	Records good, completely regulated since 19[illegible] by Penn Forest Reservoir.
01449800	Pohopoco Creek below Beltzville Dam	11	96.4	223	2.31	Records good, regulated by Beltzville Lake, Wild Creek Res., Penn Forest Dam, upstream diversion to City of Bethlehem
01450500	Aquashicola Creek at Palmerton, Pa.	39	76.7	153	1.99	Records good, occasional diversion above station from Pohopoco Creek, occasional diversion by N.J. Zinc Company.
01451000	Lehigh River at Walnutport, Pa.	32	889	1,860	2.09	Records good except for winter periods which are fair.

TABLE 4 (cont'd)
USGS STREAM GAGING STATIONS

Station Number	Location	Period of Record Yrs	Drainage Area (mi^2)	Average Discharge (cfs)	Mean Runoff (cfs/mi^2)	Quality of Records/Remarks
01451500	Little Lehigh Creek near Allentown, Pa.	33	80.8	97.5	1.21	Records good
01451800	Jordan Creek near Schnecksville, Pa.	13	53.0	95.4	1.80	Records good
01452000	Jordan Creek near Allentown, Pa.	34	75.8	113	1.49	Records good
01452500	Monocacy Creek at Bethlehem, Pa.	30	44.5	51.8	1.16	Records fair
01453000	Lehigh River at Bethlehem, Pa.	70	1,279	2,339	1.83	Records good
01454700	Lehigh River at Glendon, Pa.	12	1,359	3,031	2.23	Records good

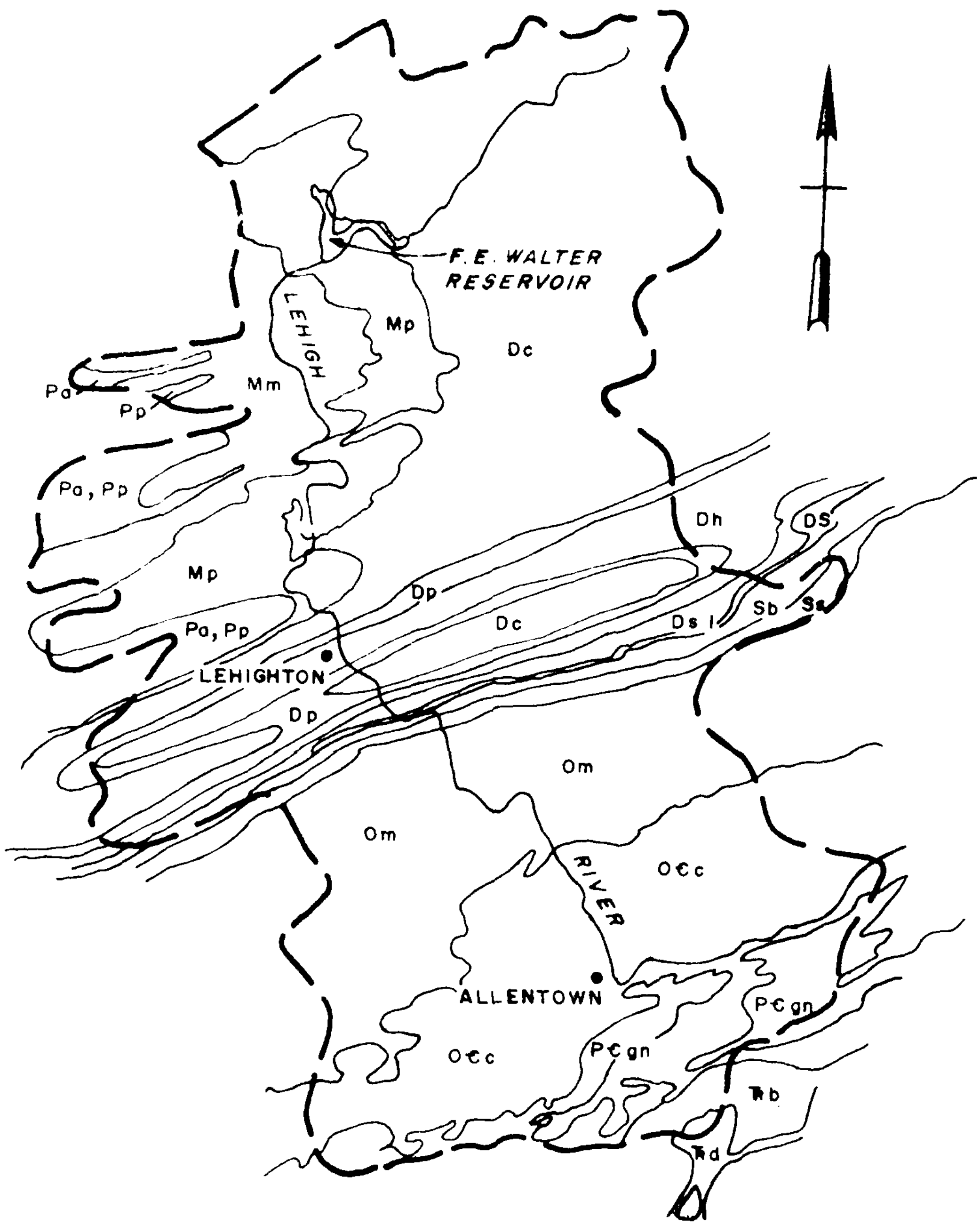
Geology. Geological formations in the mountainous regions of the Basin are predominantly shale and sandstone. Rich deposits of anthracite occur in Luzerne, Carbon and Schuykill counties. In the Appalachian Valley Section, the stream first enters a slate formation, which is extensively quarried. It then flows over a limestone formation which is especially adapted to the manufacture of cement.

In the upper part of the watershed the effects of glacial action are marked in the smoothing down of summits, the scouring of valley walls, and the deep accumulation of rock waste at irregular intervals. The coarse, erosion-resisting glacial deposits have frequently interrupted the pre-glacial drainage channels, forming ponds and some swamp and marsh land. The river has eroded its channel progressively deeper from its source to its exit from the mountains at Lehigh Gap. From White Haven to Jim Thorpe, a distance of 30 miles, it flows through a gorge and rapids are frequent. The steep gradients of the river bed and the narrow gorges indicate that the formations resist erosion to an extent that prevented the river from carving its channel to full maturity. The river has not developed waterfalls for the reason that the rock formations in its bed do not present sufficient variation in hardness. Nearly all outcrops are limestone, sandstone, and metamorphosed strata. Below Lehigh Gap, the subterranean structure is cavernous where soluble limestone deposits were disintegrated by ground water flow. Existence of the cavities is manifested during low flows by dry reaches in the river's tributaries.

The geologic representation of the area is presented on Figure 6, with the map index presented in the following Table 5.

TABLE 5
GEOLOGIC MAP INDEX

Map Symbol	Formulation/Group	Description
Cq-	Quartzose Rocks:	Not Shown narrow bands lying between OEc and PEgn
Dc-	Catskill Formation:	red and gray shale, sandstone, and some conglomerate
D_h-	Hamilton Group:	Hard dark shale, flaggy sandstone, limy shale and impure limestone
Dp-	Portage Group:	Sandstone, sandyshale and shale
DS-	Limestone, shale and sandstone:	
D_sl-	Sandstone, shale and limestone:	
Mm-	Mauch Chunk Formation:	Shale, sandstone, and some conglomerate
Mp-	Pocono Formation:	Sandstone and conglomerate, some shale in lower part
Om-	Martinsburg Shale:	Shale, slate, sandstone, and some limestone
OC_c-	Carbonate Rocks:	limestone and dolomite
Pa-	Allegheny Formation:	Shale and sandstone, some conglomerate and coal
Pp-	Pottsville Formation:	Sandstone and conglomerate, some shale and coal
pEgn-	Gneiss and related crystalline rocks	
b-	Brunswick Formation:	Shale and minor sandstone, conglomerate
d-	Diabase:	Igneous sills and dikes intruding Triassic and older rocks
Sb-	Bloomburg Red Beds:	Chiefly red shale and sandstone
Ss-	Shawangunk Conglomerate:	Conglomerate, sandstone and some shale



SOURCE
USGS PROFESSIONAL PAPER 381

NOTE
SEE INDEX

SCALE OF MILES
0 8 16

LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY
GEOLOGIC MAP
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 6

Soils. The soils of the Lehigh Basin can be divided into five broad groups based on association with a specific parent material. These groups are: soils formed in materials weathered from noncarbonate sedimentary rocks, carbonate sedimentary rocks, igneous and metamorphic rocks, glacial till, and unconsolidated water sorted materials. The soils can be further categorized by hydrologic soil groups based on infiltration rates. Infiltration rates are dependent on the soil's physical and chemical composition, dominant slope, and depth of soil profile. The Soil Conservation Service of the U.S. Department of Agriculture has mapped the soils in this area.

The northern portions of the basin that lie in the Appalachian Plateaus Province are comprised of soils formed in glacial till. They generally have slow infiltration rates and average 30 inches in depth over shale and sandstone bedrock. Just to the south, encompassing most of Carbon County, is the Valley and Ridge Province which contains parallel bands of soils that were either formed in materials weathered from noncarbonate sedimentary rocks or glacial till. These soils have better than average infiltration rates. They are generally 30 to 70 inches deep and are also underlain by shale and sandstone.

The Lehigh Valley in Lehigh and Northampton counties contains soils weathered from noncarbonate sedimentary rocks of the Martinsburg formation. The substrata is mainly shales and sandstones. In the southern half of the valley thick beds of limestone lie below the Martinsburg formation. Soils in the valley vary from 15 to 40 inches in depth and have slow or very slow infiltration rates.

The southern edge of the Lehigh Basin lies in the Reading Prong of the New England Province. The soils here are underlain mainly by igneous and metamorphic rock with limestone and dolomite sedimentary rock also present at some locations. The soils generally have above average infiltration rates and are 20 inches deep or more. Many sinkholes have developed in this area due to the solubility of the limestone beds. These sinkholes allow surface water to freely enter the subsurface water system.

Fish and Wildlife. The Lehigh basin is ecologically diverse containing a variety of habitats including forests, pasture and cropland, abandoned fields in various stages of reversions to forest, swamps and marshes, lakes and streams, and urban areas. Aquatic habitat includes almost 6900 acres of reservoirs, lakes and ponds, and several hundred miles of fishable streams. Water quality varies from excellent to severely degraded, degradation resulting from a history of coal mining operations with subsequent mine drainage, and industrial and municipal wastes. The effects of the operations are most heavily felt in the lower seven miles of the Lehigh River.

The study area's vertebrate fauna consists of 51 species of mammals, 220 birds, 23 reptiles, 24 amphibians, and 48 fish. Two endangered species as defined by the Federal Endangered Species Act of 1973 are known to inhabit the Lehigh area. The bald eagle and peregrine falcon are occasionally seen in the basin during autumn, migrating along ridges such as Blue Mountain. In addition the Pennsylvania Fish Commission has determined that the bog turtle is endangered in the State. Bog turtles usually occur in relatively small isolated colonies, with some being reported in Lehigh and Northampton counties.

The Lehigh River basin offers a widespread opportunity for wildlife related outdoor recreation. There are more than 113,000 acres of public land open to hikers, bird-watchers, hunters and fisherman. There are almost 88,000 additional acres of private land open to public hunting as a result of the Pennsylvania Game Commission's Cooperative Farm Game and Safety Zone Programs. In addition the Fish Commission's stocking program insures a supply of game fishes throughout the study area. Details of the fish and wildlife resources of the basin, as prepared by the U.S. Fish and Wildlife Service is presented in Appendix B.

HUMAN AND ECONOMIC RESOURCES

This subsection presents information on the people and economy of the Lehigh Valley beginning with its history and development. General information is presented covering the states comprising the Pennsylvania - New Jersey - Maryland bulk electric supply interconnection.

History and Development.

1. Settling in: Who and Where. The Delaware and Lehigh Rivers provided ready access to the Lehigh Valley, which was settled in the early 1700's by German, Swiss and Scotch-Irish immigrants.

German settlers founded Upper Milford as the first township in 1737. Among the German immigrants, the Moravians founded two religious communities: Nazareth in 1740 and Bethlehem, on the banks of the Lehigh, in 1741. Bethlehem was planned and located to serve as the religious center for the Moravian community, a position it still holds today. It quickly became the valley's economic trade center and was the area's dominant city throughout the 1700's. In 1752 the City of Easton was founded as the county seat of the newly formed Northampton county. In 1762 Allentown was founded at the forks of Jordan and Lehigh Creeks for its trade and milling potential. These three cities became and remain the area's dominant metropolises.

2. Transportation. Early transportation was difficult. The first settlers relied on Indian trails and both rivers for travel. The first road was laid in 1735 and others quickly followed, but the rivers were the roads during much of the 1700's. Rafts and dugout canoes transported settlers and their farm goods to the market in Philadelphia. Durham boats--wide, flat freight carriers--improved freight transportation on the Delaware River after 1750.

About 60 years after coal was discovered in Pennsylvania, legislative permission was granted to the Lehigh Coal and Navigation Company in 1818 to improve navigation on the Lehigh River. Two years later the company began construction on 84 miles of interconnected canals that linked Stoddardsville to Easton.

The canals created a greatly expanded market for area agricultural goods. They also expanded freight transportation opportunities and stimulated the developing coal mining industry, which led to railroad development in the region. The Lehigh Valley Railroad opened in 1855. Its tracks paralleled the Lehigh Canal and the Lehigh River. As railroads grew, canal use declined. In addition to causing a dramatic growth in industry and development, railroads brought many new people to the Lehigh Valley and lessened the Pennsylvania-German influence that had dominated the area from the 1700's through the 1830's.

3. <u>Industry and the Economy</u>. The first Lehigh Valley residents created an agricultural economy, which was gradually supplemented by a manufacturing-based one as industry took hold. In the mid-1700's, small forges and furnaces, powered by charcoal from local trees, manufactured the region's abundant iron ore. This industry coupled with artisan-based commerce--weavers, gunsmiths, shoemakers--remained unchanged through the American Revolution because there had been almost no influx of labor, skills or capital into the valley.

From the 1790's to the 1830's, the area's economy--still based largely on agriculture--was increasingly prosperous. The number of towns and villages increased, and almost all contained taverns, grist mills and tanneries. Many also boasted distilleries, saw mills, lime kilns and iron furnaces.

Although trade volume continued to grow as more roads were built, the valley's economy did not make dramatic gains until the Industrial Revolution in the 1800's. Railroad growth brought in large numbers of immigrant laborers, who built canals and manned the anthracite coal, slate, and iron and zinc ore mining industries. Their wives and children provided a source of cheap labor for the textile industry, which by 1890 had become the region's leading employer with mills in almost every town.

Portland cement was a locally-invented product using local materials that became one of the Lehigh Valley's biggest employers. It, together with the growing iron industry, revolutionized industrial and commercial building.

Technical advances in the first half of the 19th century, coupled with the switch from waterwheel to stream power, resulted in a major increase in iron, cement, and slate production. In the 40 years from 1850 to 1890, iron production was the area's leading industry in terms of product value. During this period, railroad growth increased the value of valley product almost nine-fold and valley employment almost six-fold.

Competing goods and changing economic conditions meant that the iron and zinc production peak had passed by 1880. The last mines for both closed in the 1920's. The cement industry, on the other hand, continued to gain strength, manufacturing 70% of the country's Portland cement by 1900. The textile mills also survived and prospered, and are still a significant contributor to the valley's economy. They switched from the manufacture of silk cloth to the manufacture of other materials and ready-to-wear garments to keep pace with change.

Although agriculture's role in the region's economy has continued to decline since 1890, it is still a significant part of the increasingly industrialized Lehigh Valley.

Economic Profile.

1. Setting. The Lehigh River Basin covers a vast expanse of land which traverses four SMSA's. This area covers 6,080 square miles and is approximately the size of the States of Connecticut and Rhode Island combined. The counties consist of Berks County within the Reading, Pennsylvania SMSA; Lackawanna, Monroe, and Luzerne Counties, within the Northeast Pennsylvania SMSA; Carbon, Northampton, and Lehigh Counties within the Allentown-Bethlehem-Easton, Pennsylvania-New Jersey SMSA; Bucks County within the Philadelphia, Pennsylvania SMSA and Schuylkill and Wayne Counties.

The study area has a favorable location relative to metropolitan areas and to the eastern seaboard. In addition it is well-endowed with natural resources which include anthracite coal, limestone, slate, zinc, and iron ore as well as rich farm lands and diverse recreational areas which encompass a "Four Seasons" operation. Manufacturing, highly diversified, is the leading industry and is augmented by an excellent transportation network and an adequate supply of labor. The area's long term prospects have improved dramatically due to its large deposits of anthracite coal. However, foreign imports of textiles and steel may continue to have a dampening effect on the area's steel and textile industries.

2. Population. Population for the counties which comprise the study area was 2,146,200 in 1976 as shown in Table 6. This amounts to a 0.82 percent annual growth rate from 1970. This growth rate has been approximately the same since 1950 and reflects the demographic stability of this area.

TABLE 6
POPULATION BY COUNTY WITHIN THE LEHIGH RIVER BASIN AREA

(1,000'S)

	1930	1940	1950	1960	1970	1976
Berks	231.7	241.9	255.7	275.4	296.4	305.9
Bucks	96.7	107.7	144.6	308.6	415.1	468.6
Carbon	63.4	61.7	57.6	52.9	50.6	52.2
Lackawanna	310.4	301.2	257.4	234.5	234.1	235.3
Lehigh	172.9	177.5	198.2	227.5	255.3	265.3
Luzerne	445.1	441.5	392.2	347.0	342.3	343.9
Monroe	28.3	29.8	33.8	39.6	45.4	55.9
Northampton	169.3	169.0	185.2	201.4	214.4	224.6
Schuylkill	235.5	228.3	200.6	173.0	160.1	159.2
Wayne	28.4	29.9	28.5	28.2	29.6	35.3
TOTALS	1,781.7	1,788.5	1,753.8	1,881.1	2,043.3	2,146.2

SOURCE: 1978 PENNSYLVANIA STATISTICAL ABSTRACT.

As shown in Table 7 the population of the United States and of each of the states that would be influenced by any power developed in the Lehigh River Basin has consistently increased since 1930. With the exception of the Commonwealth of Pennsylvania, all of the states have grown at a faster rate than the rest of the nation as a whole.

TABLE 7
POPULATION TRENDS

(U. S. Bureau of Census Data)
Population in Thousands

	Maryland		Delaware		New Jersey		Pennsylvania		United States	
Year	Pop.	% Chg.	Pop.	% Chg.	Pop.	% Chg.	Pop.	% Chg.	Pop.	% Chg.
1930	1,631.5		238.4		4,041.3		9,631.4		122,775.0	
1940	1,821.2	11.6	266.5	11.8	4,160.2	2.9	9,900.2	2.8	131,669.3	7.2
1950	2,343.0	28.6	318.1	19.4	4,835.3	16.2	10,498.0	6.0	150,697.4	14.5
1960	3,100.7	32.3	446.3	40.3	6,066.8	25.5	11,319.4	7.8	178,464.2	18.4
1970	3,922.4	26.5	548.1	22.8	7,168.2	18.2	11,793.9	4.2	202,166.4	13.3

SOURCE: BALTIMORE DISTRICT CORPS OF ENGINEERS; RAYSTOWN HYDRO POWER, PLAN OF STUDY JUNE 1975.

As can be seen in Table 8, the study area population density in 1976 varied greatly from county to county with 47.6 persons per square mile in Wayne County to 763.2 persons per square mile in Bucks County.

TABLE 8
POPULATION DENSITY BY COUNTY, WITHIN THE LEHIGH RIVER BASIN

(Persons Per Square Mile)

	Land Area (sq-Miles)	1960	1970	1976
Berks	862	318.8	343.8	354.9
Bucks	614	500.1	676.0	763.2
Carbon	404	130.6	125.2	129.2
Lackawanna	454	516.6	515.7	518.3
Lehigh	348	655.7	733.6	762.4
Luzerne	886	389.4	386.3	388.1
Monroe	611	64.8	74.3	91.5
Northampton	376	538.5	570.1	597.3
Schuylkill	784	221.0	204.2	203.1
Wayne	741	38.0	39.9	47.6
TOTALS	6080	309.4	336.1	353.0

SOURCE: 1978 PENSYLVANIA STATISTICAL ABSTRACT.

3. Employment and Income: Since 1975, total employment in the Lehigh River Basin Study Area has increased each year and this trend is expected to continue. Total nonagricultural wage and salary jobs have also increased since 1975, due to the growth of the nonmanufacturing sector, as the manufacturing group has remained stagnent. Increases in employment in the future are expected to come from state and local government, services and mining and the retail trade firms as projected by the Pennsylvania Bureau of Employment Security in its Annual Planning Report for Fiscal Year 1979. A breakdown of employment by industry, and county for 1976 is shown in Table 9 As can be seen manufacturing is the dominant industry employing approximately 44 percent of the total labor force.

TABLE 9
EMPLOYMENT BY MAJOR INDUSTRY DIVISION
IN PENNSYLVANIA, BY COUNTY: 1st QUARTER, 197[illegible]

Industry	Berks	Bucks	Carbon	Lackawanna	Lehigh	Luzerne	Monroe	Northampton	Schuylkill	Wayne	Total
Agriculture, forestry and fisheries	248	610	0	26	302	201	83	103	100	26	1,699
Mining	1,162	388	0	109	284	1,179	0	153	2,012	17	5,304
Construction	3,771	5,384	333	1,938	4,459	6,215	981	3,501	1,231	382	28,195
Manufacturing	49,111	45,358	7,293	26,531	42,608	42,157	4,428	42,799	22,397	2,217	284,899
Transportation, communication and public utilities	5,095	3,949	505	3,847	7,079	5,817	1,381	2,748	1,580	295	32,296
Wholesale & retail trade	24,059	36,152	2,123	18,538	23,987	24,375	4,389	13,027	7,170	1,372	155,192
Finance, insurance, and real estate	4,979	4,011	327	3,021	4,351	4,821	763	2,304	1,269	440	26,286
Service	17,407	17,793	1,603	12,692	17,536	13,487	5,360	9,175	3,912	1,225	100,190
Government	3,388	1,919	355	2,987	2,396	4,837	866	793	1,717	935	20,193
TOTALS	109,220	115,564	12,539	69,689	103,002	103,089	18,251	74,603	41,388	6,909	654,254

SOURCE: 1978 PENNSYLVANIA STATISTICAL ABSTRACT: TABLE 81

There are large pockets of unemployed labor within the study area. A comparison of the labor force data for SMSA's, the state and the United States in Table 10, reflects this condition. Foreign imports, which result in a reduction in domestic employment in the same industries, and the continuing shift of population and industry to the Southwest U.S. "Sunbelt" area are factors which tend to worsen the local employment situation. However, the increasing coal production in the region may offset this somewhat.

TABLE 10
TOTAL CIVILIAN LABOR FORCE, EMPLOYMENT,
UNEMPLOYMENT AND UNEMPLOYMENT RATE
UNITED STATES, PENNSYLVANIA, AND SMSA's
WITHIN THE LEHIGH RIVER BASIN AREA

1977 Annual Average
(in thousands)

Area	Labor Force	Employment	Unemployment	Unemployment Rate
United States	97,401.0	90,546.0	6,855.0	7.0
Pennsylvania	5,168.0	4,770.0	398.0	7.7
Northeast Pennsylvania SMSA	271.5	245.1	26.4	9.7
Allentown-Bethlehem-Easton SMSA	300.2	279.2	21.0	7.0
Philadelphia SMSA	2,006.3	1,887.2	179.2	8.7
Reading SMSA	145.5	136.5	9.0	6.2

SOURCE: NORTHEAST PENNSYLVANIA BUREAU OF EMPLOYMENT SECURITY
ANNUAL PLANNING REPORT FISCAL YEAR 1979, TABLE 11, 1G 20

Total and per capita income for 1975, by county are presented in Table 11. Per capita income ranges from $4,696 in Wayne County to $6,558 in Lehigh County. Six of the nine counties in the Study Area had per capita incomes below that in the State and seven out of nine were below the U.S. average.

TABLE 11
TOTAL AND PER CAPITA INCOME BY COUNTY
SELECT YEARS 1959-1975

	1959		1970		1975	
County	Total ($ Millions)	Per Capita	Total ($ Millions)	Per Capita	Total ($ Millions)	Per Capita
Berks	653.3	2,390	1,268.0	[illegible]	[illegible]	[illegible]
Bucks	756.4	2,470	[illegible]	4,109	[illegible]	[illegible]
Carbon	103.8	1,978	183.0	3,619	258.[illegible]	[illegible]
Lackawanna	422.7	1,816	788.0	3,366	[illegible]	[illegible]
Lehigh	563.2	2,494	1,060.7	4,150	[illegible]	[illegible]
Luzerne	604.1	1,754	1,158.3	3,383	[illegible]	[illegible]
Monroe	90.9	2,315	190.0	4,181	[illegible]	[illegible]
Northampton	465.3	2,328	890.9	4,149	[illegible]	[illegible]
Schuylkill	289.9	1,688	536.9	3,355	82[illegible].8	[illegible]
Wayne	44.8	1,598	94.4	3,190	[illegible]	4,696
Pennsylvania	24,928.6*	2,219*	46,900.0	3,971	69,500.0	5,874
United States	328,990+	1,850+	808,200.0	3,966	1,243,300	5,834

SOURCE: 1978 PENSYLVANIA STATISTICAL ABSTRACT TABLE 91
STATISTICAL ABSTRACT OF U.S. 1976

*1960 PENNSYLVANIA STATISTICAL ABSTRACT
+1975 STATISTICAL ABSTRACT OF U.S.

4. Earnings. Earnings by industry are presented in Table 12. The manufacturing sector is the predominant industry with approximately 40 percent of total earnings, similar to this sector's share of total employment. Apparel and related products, primary metal products and electrical and electronic machinery, equipment and supplies are the most significant industries within the manufacturing sector. Also contributing to the economy of the study area are earnings realized from wholesale trade, retail trade and the service industry, which accounted for 29.5 percent of total earnings.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	17.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	2.8	[illegible]	[illegible]	[illegible]	8.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	16.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	1,351.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] PENNSYLVANIA STATISTICAL ABSTRACT, TABLE 92

[illegible] NOT SHOWN TO AVOID DISCLOSURE OF CONFIDENTIAL INFORMATION

Although not clearly reflected in the earnings data, Lackawanna, Luzerne and Schuylkill Counties overlie parts of the Middle Eastern and Great Northern Anthracite Basins which are known as the "Anthracite Capital of the World".

Production from the coal fields in these counties amounted to 4.5 million tons in 1975, roughly 85 percent of the total produced in the state. Estimated recoverable reserves of anthracite were calculated to be about 5.8 billion tons in 1975 according to Pennsylvania Department of Commerce's County Industrial Reports for 1976.

In addition, although not significant in terms of earnings, agriculture is an important industry, with rich farm and pasture land located throughout most of the study area. Products grown or produced include dairy products, poultry products, potatoes, alfalfa, corn, honey, eggs, cut flowers, wheat, and oats. Also the area is one of the major national mushroom producers and is noted for having source of the finest fruit and crop farms in the state and country.

CULTURAL AND SCENIC RESOURCES

The Lehigh River area is rich in both history and beauty. The Pennsylvania State Historic Preservation office maintains an inventory of historic sites throughout the state. Table 13 lists those sites within the Lehigh River Basin, many of which have been included in the National Register of Historic Places.

The U.S. Heritage Conservation and Recreation Service, in conjunction with several local preservation groups, has recently been exploring the historical significance of the Lehigh canal, with the aim of stabilizing its historical value through contemporary utilization mixed with historical revitalization. This effort should bring into focus more clearly the value of the area's historical resources and the need to conduct contemporary planning efforts with an understanding of historical significance.

TABLE 13
PENNSYLVANIA INVENTORY OF HISTORIC PLACES
LEHIGH RIVER BASIN

Name and Location of Property
Shelter House, Emmaus Trout Hall, Allentown
Dorneyville Crossroad Settlement, Allentown vicinity
Bethlehem Historic District, Bethlehem
George Taylor House, Catasaqua
Kemmerer House, Emmaus
Mechling Homestead, Hosensack
Dillingersville Union School, Zionsville
Haines Mill Historical Museum, Cetronia
Lehigh Canal, Bethlehem-Allentown
Hefrich's Springs Grist Mill, Whitehall Twp.
Western Salisbury Union Church, Allentown
Historic Village of Salisburg, Salisburg
Adelaide Mill, Race & Courts Sts., Allentown
Alburtis Lock Ridge Historical Society Linden Grove Pavilion, Coppersburg
Lehigh Canal (Allentown/Bethlehem/Freemansburg)
Zollinger-Harned Co. Building, Allentown
Neuweiler Brewery, 401 N. Front St., Allentown
Tavern at the Hill of Zion, Old Kings Hwy. Zionsville
Coppersburg Historic District, Coppersburg
Bethlehem Historic District 1, Subdistrict A
Delaware Division of the Pennsylvania Canal, Bethlehem

TABLE 13 (cont'd)
PENNSYLVANIA INVENTORY OF HISTORIC PLACES
LEHIGH RIVER BASIN

Name and Location of Property

Gemeinhaus-Lewis David De Schweinitz Residence, W. Church Street, Bethlehem

Gristmiller's House, Old York Road, Bethlehem

Moravian Sun Inn, Main Street, (10-2-73) Bethlehem

Old Waterworks Bethlehem

Tannery, The, Easton

Lehigh Canal: Eastern Section Glendon and Abbott Street Industrial Sites, Easton

Nicholas, Jacob House, Ferry Street, Easton

Seipsville Hotel, Old Nazareth Road

Asa Packer Mansion, Packer Road, Jim Thorpe

St. Mark's Episcopal Church, Jim Thorpe

Carbon County Jail, Jim Thorpe

Harry Packer Mansion

Central RR of N.J. Station, Jim Thorpe

Lehigh Valley RR Station, Weatherly

Lehigh Canal-Carbon County

Lehigh Canal Museum, Canal Road, Franklin Twp.

Reiber House, Reiber Street, Franklin Twp.

Old Mauch Chunk Historical District, Jim Thorpe

Mauch Chunk and Summit Hill Switchback Railroad, Jim Thorpe

Keller Home , Broad Street, Hazelton

John Michael Home, Middle Smithfield Twp.

Ross Common Manor, Ross Twp.

Lutheran Home Administration Bldg., Topton

In addition to its cultural resources, the Lehigh River is rich in scenic beauty. The Pennsylvania Department of Environmental Resources has recently completed a study of the Lehigh River to determine if it should be included in the state's Scenic River System. The study recommended that the main stem, from below Francis E. Walter Dam to Jim Thorpe, be designated scenic. It also recommended that several tributaries in the Upper Lehigh basin be designated as either wild or scenic. Table 14 shows the limits of the DER proposal.

TABLE 14
PROPOSED WILD AND SCENIC RIVER SEGMENTS
LEHIGH RIVER BASIN

Stream Name	Recommended Segment Limits	Recommended Classification
Lehigh River	Francis E. Walter Dam to Bench Mark 548 at Bear Mt., Jim Thorpe	Scenic
Black (Hayes) Creek	Fourth Run	Scenic
Sandy Run	Old Railroad Grade Crossing	Wild
Hickory Run	Hickory Run Lake	Scenic
Leslie Run	Poor Man's Pond	Scenic
Mud Run	Panther Creek	Scenic
Drakes Creek	Junction with unnamed tributary below Christmans	Scenic
Stoney Creek	Yellow Run	Wild
Black Creek	Quakake Creek	Scenic
Bear Creek	Unnamed tributary below Bear Creek Dam 1400' elevation	Wild
Little Bear Creek	Headwaters	Wild
Glen Onoko	Headwaters	Wild
Jeans Run	Headwaters to Nesquehoning Creek	Wild
Nesquehoning Creek	Jeans Run Confluence	Scenic

POWER RESOURCES

As noted previously, the scope of the study area has been expanded beyond the Lehigh Basin for power marketing considerations to include the area covered by the Pennsylvania-New Jersey-Maryland (PJM) interconnected bulk electric supply system which conforms with the area of the Middle Atlantic Area Reliability Council (MAAC). See Plate 2. Covering about 50,000 square miles, with a population in excess of 20 million people, the MAAC region stretches east from the Ohio-Pennsylvania border and Lake Erie to the New Jersey coast and south from the New York-Pennsylvania boundary to south of Washington, D.C.

The MAAC is one of nine regional councils formed under the National Electric Reliability Council (NERC), an organization formed voluntarily by the electric utility industry in 1968 to augment the reliability and adequacy of bulk supply systems in North America. The utility systems comprising MAAC operate on an integrated and coordinated basis and participate in coordinated planning of their generation and transmission. The utilities listed below are signatories under the MAAC Coordination Agreement:

Atlantic City Electric Company
Baltimore Gas and Electric Company
Delmarva Power and Light Company
*Jersey Central Power and Light Company
*Metropolitan Edison Company
*Pennsylvania Electric Company
Pennsylvania Power and Light Company
Philadelphia Electric Company
Potomac Electric Power Company
Public Service Electric and Gas Company
UGI Corporation

* Subsidiaries of General Public Utilities Corporation (GPU).

Associates Include:

Allegheny Electric Cooperative representing the Pennsylvania and New Jersey Cooperatives

The Easton Utilities Commission representing the Maryland Municipals

The City of Vineland Electric Utility representing the New Jersey Municipals

The City of Dover representing the Delaware Municipals

Southern Maryland Electric Cooperative representing the Maryland Cooperatives.

Basic to the coordinated operation of PJM is an extensive, large capacity transmission network of 500, 345 and 230 kilovolt lines which effectively link load concentrations and power supply centers, and interconnect PJM with neighboring power pools as well as individual utilities. Plate 3 shows the market's major transmission lines and generating stations as of January, 1980.

It is expected that this large power pool would receive any energy generated by possible future hydroelectric developments in the Lehigh River Basin. Energy requirements of the market in 1979 amounted to nearly 172 billion kilowatt-hours with an associated annual peak demand, occurring in the summer of about 32 million kilowatts at a system load factor of 62 percent. The bulk of the load is concentrated in major load centers located in the eastern portion of the the market area, such as Washington, D.C., Baltimore, Philadelphia, Trenton, and Northeast New Jersey. Total MAAC installed capability from all generating sources at the close of 1979 was 45 million kilowatts leaving a reserve margin above demand of about 40 percent.

Several Congressional Acts, one of which dates back to as early as 1906, require that preference in the sale of electric energy from Federally owned hydro projects be given to publicly owned utilities, such as municipals and cooperatives. Table 15 lists, by state, the 48 municipals and 18 cooperatives located in the market area, including their 1978 electric power needs. Plate 4 shows the geographical location of these publicly owned systems, identifying each by number or letter corresponding to Table 15. The numbers identify the municipals and letters show the location of the cooperatives' headquarters.

TABLE 1[illegible]
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
PUBLICLY OWNED ELECTRIC UTILITIES IN
LEHIGH RIVER BASIN POWER MARKET AREA-1978

New Jersey

Map No.	Type*	Utility	Installed Capacity** (kW)	Net Generation (1,000 kWh)	Energy Requirements (1,000 kWh)	Peak Demand (kW)	Load Factor (%)
1	M	Butler	0	0	92,586	20,450	51.7
2	M	Lavallette	0	0	11,537	4,062	32.4
3	M	Madison	0	0	70,108	15,840	50.5
4	M	Milltown	0	0	38,652	10,000	44.1
47	M	Park Ridge	0	0	33,963	8,500	45.6
48	M	Pemberton	0	0	6,530	1,290	57.8
5	M	Seaside Heights	0	0	25,116	10,170	28.2
6	M	South River	2,200	0	41,699	11,770	40.4
A	C	Sussex REC (1)	0	0	73,420	17,280	48.5
7	M	Vineland	110,050	259,472	335,629	73,500	52.1
TOTAL			112,250	259,472	729,240	172,862	48.2

Delaware

Map No.	Type*	Utility	Installed Capacity** (kW)	Net Generation (1,000 kWh)	Energy Requirements (1,000 kWh)	Peak Demand (kW)	Load Factor (%)
8	M	Clayton	0	0	4,601	1,086	48.4
B	C	Delaware EC	0	0	313,383	67,735	52.8
9	M	Dover	171,200	500,452	403,478	93,000	49.5
10	M	Lewes	3,438	513	38,673	7,300	60.5
11	M	Middletown	0	0	17,080	3,258	59.8
12	M	Milford	0	0	69,034	15,700	50.2
13	M	Newark	0	0	171,291	37,685	51.9
14	M	New Castle	0	0	17,207	4,079	48.2
15	M	Seaford	7,302	0	50,414	9,305	61.8
16	M	Smyrna	0	0	33,825	6,165	62.6
TOTAL			181,940	500,965	1,118,986	245,313	52.1

* M - Municipal C - Cooperative
** Nameplate Rating

TABLE 15 (CONT'D)
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
PUBLICLY OWNED ELECTRIC UTILITIES IN
LEHIGH RIVER BASIN POWER MARKET AREA-1978

Map No.	Type*	Utility	Installed Capacity** (kW)	Net Generation (1,000 kWh)	Energy Requirements (1,000 kWh)	Peak Demand (kW)	Load Factor (%)	
		Virginia						
C	C	Accomack-Northampton	3,153	1,527	100,219	21,603	53.0	
TOTAL			3,153	1,527	100,219	21,603	53.0	
		Maryland						
17	M	Berlin	3,592	6,520	26,578	5,523	54.9	
18	M	Centreville	0	0	38,002	7,900	54.9	
D	C	Choptank EC	0	0	307,388	69,000	50.9	
19	M	Easton	47,210	64,053	110,336	23,000	54.8	
E	C	Southern Maryland EC	0	0	1,013,423	226,000	51.2	
20	M	St. Michaels	0	0	35,136	9,100	44.1	
TOTAL			50,802	70,573	1,530,863	340,523	51.3	
		Pennsylvania						
F	C	Allegheny EC (2)						
G	C	Adams EC	0	0	195,161	53,211	41.9	
H	C	Bedford REC	0	0	74,893	18,678	45.8	
I	C	Central EC	0	0	156,797	33,256	52.7	(3)
J	C	Claverack REC	0	0	131,570	30,621	49.0	
K	C	New Enterprise REC	0	0	30,758	7,870	44.6	
	C	Northwestern REC	0	0	176,573	40,143	49.5	(3)

* M - Municipal   C - Cooperative
** Nameplate Rating

TABLE 15 (CONT'D)
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
PUBLICLY OWNED ELECTRIC UTILITIES IN
LEHIGH RIVER BASIN POWER MARKET AREA-1978

Pennsylvania (Cont'd)

Map No.	Type*	Utility	Installed Capacity** (kW)	Net Generation (1,000 kWh)	Energy Requirements (1,000 kWh)	Peak Demand (kW)	Load Factor (%)	
L	C	Somerset REC	0	0	134,809	28,307	45.0	(3)
M	C	Southwest Central REC	0	0	199,413	45,299	50.3	
N	C	Sullivan County REC	0	0	37,448	8,670	42.9	(3)
O	C	Tri-County REC	0	0	108,489	24,732	39.3	(3)
P	C	United EC	0	0	113,516	23,851	45.8	(3)
Q	C	Valley REC	0	0	143,546	35,464	46.2	
R	C	Warren EC	0	0	38,581	8,205	39.0	(3)
21	M	Berlin	0	0	11,141	2,112	60.2	
22	M	Blakely	0	0	29,406	6,800	49.4	
23	M	Catawissa	0	0	9,635	1,811	60.7	
24	M	Duncannon	0	0	7,073	1,409	57.3	
25	M	East Conemaugh	0	0	5,199	1,016	58.4	
26	M	Ephrata	4,240	0	80,760	16,430	56.1	
27	M	Girard	0	0	19,689	4,128	54.4	
28	M	Goldsboro	0	0	1,699	364	53.3	
29	M	Hatfield	0	0	12,435	2,690	52.8	
30	M	Hooversville	0	0	2,773	672	47.1	
31	M	Kutztown	0	0	31,239	7,140	49.9	
32	M	Landsdale	0	0	109,460	24,500	51.0	
33	M	Lehighton	0	0	32,131	5,800	63.2	
34	M	Lewisberry	0	0	1,170	300	44.5	
35	M	Middletown	0	0	58,272	11,800	56.4	
36	M	Mifflinburg	0	0	29,984	7,608	45.0	
37	M	Olyphant	0	0	22,996	3,815	68.8	
38	M	Perkasie	0	0	30,050	6,104	56.2	
39	M	Quakertown	0	0	81,663	17,000	54.8	
40	M	Royalton	0	0	2,244	516	49.6	

* M - Municipal C - Cooperative
** Nameplate Rating

TABLE 15 (CONT'D)
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
PUBLICLY OWNED ELECTRIC UTILITIES IN
LEHIGH RIVER BASIN POWER MARKET AREA-1978

Pennsylvania (Cont'd)

Map No.	Type*	Utility	Installed Capacity** (kW)	Net Generation (1,000 kWh)	Energy Requirements (1,000 kWh)	Peak Demand (kW)	Load Factor (%)
41	M	Schuylkill Haven	0	0	41,157	7,600	61.8
42	M	Smethport	0	0	9,326	1,800	59.1
43	M	St. Clair	0	0	10,401	1,944	61.1
44	M	Summerhill	0	0	2,455	552	50.8
45	M	Watsontown	0	0	11,000	2,200	57.1
46	M	Weatherly	2,000	0	24,156	5,216	52.9
TOTAL			6,240	0	2,219,068	499,634	50.7
MAAC GRAND TOTAL			354,385	832,537	5,698,376	1,279,935	50.8

(1) Sussex REC is a member of the Allegheny Electric Cooperative and is located in New Jersey.
(2) The Allegheny Electric Cooperative consists of 13 member cooperatives in Pennsylvania and 1 in New Jersey, and is responsible for all of their bulk power supply. The energy requirement for the entire system in 1978 was 1,614,974 MWh with an associated peak demand of 375,587 kW and a load factor of 49.1 percent. Peak demands shown for individual member cooperatives are those which occured at the time of Allegheny Electric Cooperatives system peak and, therefore, are not necessarily maximum annual demands.
(3) Based on actual annual peak demand which differs from demand at time of Allegheny Electric Cooperatives system peak.
See footnote (2).

* M - Municipal C - Cooperative
** Nameplate Rating

CHAPTER III

PROBLEM IDENTIFICATION

INTRODUCTION

The energy problems facing our nation were summarized by President Carter in his 5 April 1979 "Address to the Nation." The President stated that the fundamental cause of our Nation's energy crisis is our dependency on petroleum. He went on to cite reduced domestic oil production and growing imports from foreign countries as signs of the problem. He indicated that as a result we are dangerously exposed to sudden price rises and interruptions in supply. He stated that there is no single solution but that we must both produce more and conserve more. We must use American technology to give us energy security in the future. He added that these steps are necessary because of the serious petroleum problem and the broader energy challenge facing the country.

The President's message of 5 April 1979 was one in a series of energy speeches stressing the need to develop our nations energy resources, both renewable and nonrenewable, as rapidly as possible. Several studies including the Corps' National Hydroelectric Power Study have indicated that the nation's hydroelectric power potential could save the county hundreds of thousands of barrels of oil per day thereby playing an important role in solving our current energy problems.

The purpose of this chapter is to identify the energy and water-related problems and needs in the Lehigh area in order that the investigation of hydroelectric power in the Lehigh Basin can be responsive to both local and national issues.

NATIONAL OBJECTIVES

The national objectives that the Corps must plan for are listed in the Principles and Standards for Planning Water and Related Land Resources originally established 10 September 1973 by the Water Resources Council and modified 14 December 1979. As required by the Principles and Standards, this study will be directed toward achievement of National Economic Development (NED) and Environmental Quality (EQ) as co-equal national objectives. NED is to be achieved by increasing the value of the Nation's output of goods and services and improving national economic efficiency. EQ is to be achieved by the management, conservation, preservation, creation, restoration or improvement of the quality of certain natural and cultural resources and ecological systems.

In addition to the two objectives discussed above, the additional considerations of Regional Economic Development (RED) and Other Social Effects (OSE) will be addressed, and a separate account will be developed for each plan evaluated. The RED account will include both the beneficial and adverse effects of a plan on a region's income, employment, population, economic base, environment, social development and other factors relevant to the development of the region. The OSE account will include the beneficial and adverse effects of a plan on the distribution of real income and employment; the security of life, health, and safety; educational, cultural, and recreational opportunities; emergency preparedness; and other social factors.

Within the framework of these general objectives the President, in his 27 March 1979 "Address to Congress" set forth several national energy related objectives, including;

o reducing dependence on foreign oil and minimizing the effects of supply disruptions, with conservation a key element;

o implementing programs and policies that encourage domestic energy production and efficient use, without serious inflationary impact.

o developing inexhaustible energy sources for sustained economic growth through the next century;

o making the transition from primary reliance on depletable oil and gas to predominant use of more abundant energy sources;

o using all energy sources in ways that do not endanger the environment and the health or safety of our citizens.

These objectives form the basis for this investigation and provide the setting for the following discussion of regional characteristic, problems and needs.

PROFILE OF THE STUDY AREA

This section profiles the existing conditions in the study area as well as the future conditions if no Federal action is taken as a result of this study. This first part of the section was taken from a planning aid report which was prepared by the Federal Energy Regulatory Commission. It outlines the existing power development and projected future requirements. The second part of the section deals with water resources development in the Lehigh River Basin.

Power Development in the Study Area. Located in northeastern Pennsylvania and covering an area of 1,370 square miles, the Lehigh River Basin lies in the service areas of the Metropolitan Edison Company (one of the three integrated operating subsidiaries of the General Public Utilities

Corporation) and the Pennsylvania Power and Light Company. Both utilities are MAAC members and participants in the PJM power pool.

Table 16 shows the past and estimated future power requirements of the MAAC. Energy requirements consist of total deliveries to ultimate consumers plus transmission and distribution losses and energy unaccounted for. Ultimate consumers may be broadly categorized as rural and residential, commercial, industrial, and "all other". "All other" includes street and highway lighting, electrified transportation, irrigation and drainage pumping, internal company use, etc... Estimated future energy requirements do not include pumping energy associated with existing pumped storage hydroelectric projects or any that may be constructed in the market area.

The factors that brought about lower system growth rates since 1973, such as the oil embargo, increases in the cost of fuel oil, and adverse economic conditions, continue to affect the MAAC system. Taking into account these factors along with emphasis by member utilities on load management and conservation, the average annual peak load growth for the MAAC systems between 1980 and 1999 is projected to be 2.4 percent. As shown in Table 16, the estimated peak demand of the market will amount to 42.4 million kilowatts in 1989, and reach 52.3 million kilowatts by 1999. In view of the magnitude and expected growth of power requirements in the selected market area, it appears that any power generated from possible future hydroelectric development(s) in the Basin could be effectively utilized in this large power pool.

As previously mentioned, the total MAAC installed capability at the close of 1979 was 45 million kilowatts (summer rating), of which 61.7 percent was

TABLE 16
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
PAST AND ESTIMATED FUTURE POWER REQUIREMENTS
LEHIGH RIVER BASIN POWER MARKET AREA
1960-1979 (Actual) /1

	Energy (GWh)	Peak Demand (MW)	Load Factor (%)
1960	62,570	11,912	59.8
1965	88,822	16,346	62.0
1970	130,504	23,838	62.5
1975	151,495	28,969	59.7
1976	159,500	29,264	62.0
1977	163,377	32,180	58.0
1978	169,036	31,686	60.9
1979	171,810	31,654	62.0

1980-1999 (Estimated) /2

	Energy (GWh)	Peak Demand (MW)	Reserve Margin (MW)	Net Dependable Capability /3 (MW)
1980	177,848	33,550	11,205	44,755
1981	184,476	34,550	11,460	46,010
1982	191,391	35,610	11,691	47,301
1983	197,578	36,590	11,823	48,413
1984	204,058	37,600	11,485	49,085
1989	236,938	42,370	14,176	56,546
1994	265,900	47,130	12,079	59,209
1999	297,700	52,290	13,730	66,020

GWh - Gigawatt-Hours - Million Kilowatt-Hours
MW - Megawatts - Thousand Kilowatts

/1 As reported by PJM Interconnection.

/2 Based on "MAAC Regional Reliability Council Coordinated Bulk Power Program" report dated April 1, 1980.

/3 Since peak is expected to occur in summer, capability figures are based on summer ratings.

fossil steam, 15.7 percent nuclear, 1.0 percent combined cycle, 16.6 percent internal combustion and gas turbine, 2.1 percent conventional hydro and 2.9 percent pumped storage. Of the 27.8 million kilowatts of fossil steam capability, 44 percent was oil-fired and 56 percent coal-fired. Scheduled for construction through the summer of 1989 is a total of 13.8 million kilowatts, of which 13.4 percent is oil-fired steam, 22.5 percent coal-fired steam, 62.3 percent nuclear and 1.8 percent in various types of peaking capacity. The net capability of projected additions between the summers of 1989 and 1999 is estimated to be 9.4 million kilowatts, 41.7 percent of which is fossil steam, 17.0 percent hydro, 3.8 percent nuclear and 37.5 percent unknown or other types.

In addition to capacity necessary to meet actual loads as they occur, utilities must provide reserve capacity for scheduled maintenance and contingency purposes such as forced outages of generating units, possible derating of units and deviations in load forecasts. Reserve generating capacity is defined here as the difference between dependable generating capability and peak demand. For the period 1980-1989 the average reserve margin is estimated to be 33 percent, and is expected to decrease to approximately 27 percent for the period 1990-1999.

Although, theoretically, all of the market's publicly owned electric utilities as identified in Chapter 2 could utilize any hydroelectric power that may be developed in the Lehigh River Basin via PJM's extensive transmission network, those likely to benefit the most from this power would be the ones within economic transmission distance. For study purposes, this was taken to be a 100 mile radius from Beltzville Lake, located approximately in the center of the Basin.

There are 38 publicly owned systems (32 municipals and 6 cooperatives) located within the 100 mile radius of Beltzville Lake. Eight additional cooperatives are included for preference considerations because they, together with the six cooperatives previously mentioned, are members of the Allegheny Electric Cooperative. All of these 46 publicly owned utilities and their past power requirements are listed in Table 17. In 1978, their power requirements amounted to 3.1 billion kilowatt-hours with a peak demand of about 700 thousand kilowatts, or approximately two percent of total market requirements. Table 18 shows the estimated future requirements of these utilities. As shown in Table 18, it is estimated that the preference customer load will grow to about 7.7 billion kilowatt-hours and a peak demand of 1.7 million kilowatts by the year 2000.

The 14 cooperatives listed in Table 3 are all members of the Allegheny Electric Cooperative, organized in 1946. Allegheny, headquartered in Harrisburg, Pennsylvania, is responsible for the bulk power requirements of its member distribution cooperatives. During 1978, these cooperatives provided electricity to about 150,000 customers of various classes of service, and served a rural population estimated to be in the order of a half million in all or parts of 47 counties. All of the member cooperatives are located in Pennsylvania, except for Sussex Electric Cooperative located in New Jersey. Although only six member cooperatives are located within the 100 mile radius of Beltzville Lake, all 14 members are, nevertheless, considered preference customers for power from possible future hydroelectric developments in the Lehigh River Basin since they obtain their requirements at the same rate through Allegheny. Any possible benefits from additional power sources will be shared equally by the members regardless of the actual sources serving a particular co-op load.

TABLE 17

LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
PAST POWER REQUIREMENTS OF PUBLICLY OWNED ELECTRIC UTILITIES
IN LEHIGH RIVER BASIN POWER MARKET AREA
WITHIN 100 MILE RADIUS OF BELTZVILLE LAKE

Utility	1960 Energy (MWh)	1960 Peak (kW)	1965 Energy (MWh)	1965 Peak (kW)	1970 Energy (MWh)	1970 Peak (kW)	1975 Energy (MWh)	1975 Peak (kW)	1978 Energy (MWh)	1978 Peak (kW)
Allegheny Electric Cooperative /1										
Adams EC	36,931	8,356	51,943	12,408	97,424	22,201	151,103	38,493	195,161	53,211
Bedford REC /2	21,942	3,995	31,936	6,107	49,590	10,492	64,734	14,976	74,893	18,678
Central EC /2	50,366	9,439	64,028	13,120	88,791	21,439	136,810	31,002	156,797	33,256
Claverack REC	33,568	8,027	47,038	10,801	78,941	18,667	119,875	26,658	131,570	30,621
New Enterprise REC /2	8,013	1,664	11,739	2,222	18,038	4,324	26,660	6,213	30,758	7,870
Northwestern REC /2	57,541	12,460	73,879	15,237	107,940	24,241	153,084	33,043	176,573	40,143
Somerset REC /2	24,761	5,620	36,611	8,404	63,133	14,554	101,780	23,375	134,809	28,307
Southwest Central REC /2	47,274	10,803	70,353	15,244	106,341	22,577	158,169	32,027	199,413	45,299
Sullivan County REC	9,624	2,430	14,561	3,806	23,963	6,054	32,715	8,892	37,448	8,670
Sussex REC	8,049	1,511	13,643	2,835	27,655	6,300	59,708	14,340	73,420	17,280
Tri-County REC	35,076	9,332	46,293	12,340	67,797	19,836	97,091	27,732	108,489	24,732
United EC /2	31,887	8,665	44,333	12,112	63,405	16,522	95,178	24,380	113,516	23,951
Valley REC	36,673	8,013	48,649	11,672	80,087	19,644	122,539	28,135	143,546	35,464
Warren EC /2	12,963	4,309	17,902	5,894	25,143	7,725	35,652	11,329	38,581	8,205
Total - Cooperatives	415,269	94,624	572,908	132,202	898,248	214,567	1,355,098	320,585	1,614,974	375,587

/1 Allegheny Electric Cooperative consists of 13 member cooperatives in Pennsylvania and 1 (Sussex) in New Jersey, and is responsible for all of their power supply. For this reason, all the members are included in the list even though some of them do not have customers within the 100 mile radius. Peak demands shown for member cooperatives are those which occurred at the time of Allegheny EC system peak.

/2 These members of Allegheny EC do not have customers within the 100-mile raduis.

/3 Estimated.

TABLE 17 (cont'd)
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
PAST POWER REQUIREMENTS OF PUBLICLY OWNED ELECTRIC UTILITIES
IN LEHIGH RIVER BASIN POWER MARKET AREA
WITHIN 100 MILE RADIUS OF BELTZVILLE LAKE

Utility	1960 Energy (MWh)	1960 Peak (kW)	1965 Energy (MWh)	1965 Peak (kW)	1970 Energy (MWh)	1970 Peak (kW)	1975 Energy (MWh)	1975 Peak (kW)	1979 Energy (MWh)	1979 Peak (kW)
Blakely (Pa.)	7,557	1,872	10,434	2,390	15,997	3,313	24,256	4,584	29,406	6,800
Butler (N.J.)	24,134	6,696	39,120	9,600	60,168	14,300	84,678	19,100	92,586	20,450
Catawissa (Pa.)	5,199	1,000	6,428	1,288	7,708	1,555	8,782	1,626	9,635	1,811
Duncannon (Pa.)	2,887	700	3,552	705	5,189	1,040	6,503	1,280	7,073	1,409
Ephrata (Pa.)	22,672	5,000	32,242	7,144	56,664	11,404	70,555	14,472	80,760	16,430
Goldsboro (Pa.)	735	150	865	178	1,273	259	1,587	333	1,699	364
Hatfield (Pa.)	4,218	1,010	6,101	1,480	10,130	3,375	13,033	3,975	12,435	2,690
Kutztown (Pa.)	10,988	2,400	14,579	3,187	21,232	4,214	30,356	6,460	31,239	7,140
Lansdale (Pa.)	60,845	16,116	78,484	20,988	97,528	23,194	106,500	24,000	109,460	24,500
Lavallette (N.J.)	3,085	1,488	4,168	1,824	6,386	2,768	8,752	3,771	11,537	4,062
Lehighton (Pa.)	14,277	2,812	17,486	3,510	25,906	4,795	30,558	5,700	32,131	5,800
Lewisberry (Pa.)	390	95	477	119	856	235	1,007	221	1,170	300
Madison (N.J.)	23,596	5,427	33,684	7,640	52,862	11,720	73,652	16,560	70,108	15,840
Middletown (De.)	4,539	865	6,365	1,230 /3	9,377	1,712	15,907	3,158	17,080	[illegible]
Middletown (Pa.)	16,122	3,700	18,429	3,904	24,435	5,605	46,088	10,000	58,272	11,800
Mifflinburg (Pa.)	7,428	1,739	9,482	2,192	16,322	3,591	23,147	5,978	29,984	7,608
Milltown (N.J.)	14,035	2,745	20,136	3,960	31,955	7,175	35,227	8,635	38,652	10,000
Newark (De.)	30,895	6,750	58,435	12,849	118,494	26,874	152,465	35,478	171,291	37,685
New Castle (De.)	6,186	1,373	8,796	1,891	12,960	3,060	17,088	4,783	17,207	4,079
Olyphant (Pa.)	6,824	1,680	8,266	1,872	12,892	2,580	17,239	3,220	22,996	3,815
Park Ridge (N.J.)	10,636	2,700	17,120	3,920	24,607	6,552	30,733	8,568	33,963	8,500
Pemberton (N.J.)	2,094	430 /3	2,588	494	3,423	804	6,274	1,356	6,530	1,290
Perkasie (Pa.)	9,867	2,203	14,839	2,997	22,011	4,406	25,556	5,404	30,050	6,104
Quakertown (Pa.)	25,805	5,400	31,091	6,657	49,387	9,524	66,487	14,080	81,663	17,000
Royalton (Pa.)	891	270	1,166	272	1,654	372	2,088	476	2,244	516
St. Clair (Pa.)	5,246	1,119	6,308	1,285	8,291	1,728	9,993	1,858	10,401	1,944
Schuylkill Haven (Pa.)	15,195	3,335	19,432	3,872	29,471	5,983	35,723	7,106	41,157	7,600
Seaside Heights (N.J.)	5,856	3,275	7,725	4,000	12,378	5,880	21,370	9,360	25,116	10,170
South River (N.J.)	16,244	4,050	23,176	5,678	33,125	9,196	39,187	11,812	41,699	[illegible]
Vineland (N.J.)	126,863	24,752	174,385	35,694	268,268	55,964	295,256	71,600	335,629	73,500
Watsontown (Pa.)	4,927	1,087	6,716	1,447	8,425	1,771	9,800	1,900	11,000	2,200
Weatherly (Pa.)	7,147	1,700	8,841	2,025	11,362	2,608	25,112	5,265	24,156	5,216
Total - Municipals	497,383	113,939	690,916	156,292	1,060,736	237,557	1,334,959	312,119	1,488,329	331,651
Grand Total	912,652	208,563	1,263,824	288,494	1,958,984	452,124	2,690,057	632,704	3,103,303	[illegible]

TABLE 18
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
ESTIMATED FUTURE POWER REQUIREMENTS
PUBLICLY OWNED ELECTRIC UTILITIES
IN
LEHIGH RIVER BASIN POWER MARKET AREA
WITHIN
100 MILE RADIUS OF BELTZVILLE LAKE

	1980	1985	1990	1995	2000
Cooperatives					
Energy (GWh)	1770	2320	2980	3700	4590
Peak Demand (MW)	404	530	680	845	1045
Load Factor (%)	50.0	50.0	50.0	50.0	50.0
Municipals					
Energy (GWh)	1590	1940	2310	2670	3080
Peak Demand (MW)	356	434	517	598	689
Load Factor (%)	51.0	51.0	51.0	51.0	51.0
Total					
Energy (GWh)	3360	4260	5290	6370	7670
Peak Demand (MW)	760	964	1197	1443	1734
Load Factor (%)	50.5	50.4	50.4	50.4	50.5

The 1978 energy requirements of Allegheny Electric Cooperative of about 1.6 billion kilowatt-hours amounted to around one half of the total preference customer load. Of this total, 78 percent was sold to rural residential and farm consumers and 11 percent to commercial and industrial consumers. The remaining 11 percent was accounted for mainly by distribution losses and energy unaccounted for, plus relatively insignificant amounts of energy sold to all other classes of service. There has been relatively little industrial consumption in the past (about 8 percent in 1978) and it is expected that this trend will continue.

Allegheny does not own, at the present time, any existing generating or transmission facilities. All of its power requirements are met by purchases from the Power Authority of the State of New York (PASNY), Metropolitan Edison Company (GPU), Pennsylvania Electric Company (GPU), Jersey Central Power & Light Company (GPU), and West Penn Power Company. During 1978, 45 percent of the requirements were supplied by PASNY, 46 percent by the three subsidiaries of GPU and nine percent by West Penn Power Comany. PASNY is a member of the Northeast Power Coordinating Council (NPCC) and the New York Power Pool (NYPP) while West Penn Power is a subsidiary of the Allegheny Power System and a member in the East Central Area Reliability Coordination Agreement (ECAR). PASNY's Niagara Power is delivered to Allegheny Electric Cooperative members through transmission services provided by Niagara Mohawk Power Corporation and New York State Electric & Gas Corporation, the New York transmission agents, and by GPU subsidiaries, the Pennsylvania transmission agents. Allegheny now owns a 10 percent undivided share of the Susquehanna Nuclear Electric Station, which is currently being constructed by the Pennsylvania Power and Light Company near Berwick, Pennsylvania.

Allegheny is also an applicant in licensing proceedings before the Federal Energy Regulatory Commission in connection with several potential hydro projects outside the Lehigh and Delaware Basins.

The 32 municipal systems listed in Table 17 play a relatively equal role to the cooperatives in the total preference customers' power requirements. During 1978, these municipals provided electric power to about 97,000 customers of various categories, serving a population of approximately 250,000 people. Although the municipals serve substantially fewer customers, their combined load nearly equals that of the cooperatives due to the much higher commercial and industrial load carried by the municipals. Of the total 1978 municipal energy requirement of 1.5 billion kilowatt-hours, 39 percent was sold to residential customers, 19 percent to commercial customers and 32 percent to industrial customers.

At the present time, Vineland, New Jersey, is the only one of the 32 municipals generating any of its requirements, producing about 77 percent of its own energy needs in 1978, or 17 percent of the combined municipal load. The remainder of the municipal load is met with purchases from private utilities in PJM. Of the total purchases, 29 percent was from Pennsylvania Power & Light Company, 20 percent from GPU, 7 percent from Philadelphia Electric Company and 5 percent from Atlantic City Electric Company. Each municipal system purchases power separately, and it is anticipated that they will continue to rely mostly on wholesale purchases for the foreseeable future.

Water Resources Development in the Study Area. The water resources of the Lehigh River Basin have been a major factor in its development over the years. The Lehigh River was used for drinking water and transportation by the Delaware Indians and the early European settlers. In the 1800's this transportation system was greatly improved by the construction of the Lehigh Canal and the Delaware Canal, allowing movement of goods to and from Philadelphia and points south. The canal was operational until competition from railroads and a depressed economy forced its closing in 1931.

The Lehigh River and its tributaries have been studied a number of times by the Army Corps of Engineers, as was indicated in the introductory chapter of this report. As a result of these studies, two multi-purpose dam and reservoir projects and two local flood protection projects have been constructed in the Lehigh Basin.

Francis E. Walter Reservoir is part of the Congressionally authorized plan for flood control in the Lehigh River Basin. The dam is located on the Lehigh River a short distance below the mouth of Bear Creek, in Luzerne County, between White Haven and Stoddartsville. It is approximately 70 miles above the City of Allentown and 77 miles above the junction of the Lehigh River with the Delaware River at Easton.

Francis E. Walter Reservoir controls a drainage area of approximately 288 square miles by providing 110,000 acre-feet of storage of which 108,000 acre-feet is reserved for flood control purposes. The remaining 2,000 acre-feet is maintained as a permanent pool for water conservation and for public use.

The reservoir is formed by an earthfill dam measuring 3,000 feet along the crest and 234 feet in height, with a low concrete overflow section and gate-controlled outlet works discharging through a tunnel. The cost of construction for the project, completed in 1961, was $11,087,400.

Downstream floods are controlled by operating Francis E. Walter Reservoir in conjunction with local projects in the downstream areas. It is estimated the combined action of the reservoir and the improvement projects at Allentown and Bethlehem would prevent $23,600,000 in damages if a flood such as that associated with Hurricane Diane in 1955 were to recur. Damages prevented by the reservoir since its completion are estimated to be $4,490,100, of which approximately $1,836,000 was prevented in June 1972 during Tropical Storm Agnes.

The City of Allentown is located in Lehigh County along the Lehigh River, 17 miles upstream from its junction with the Delaware River at Easton. The Lehigh Valley has been subjected to many severe floods because a large portion of the upstream river Basin consists of steeply sloping terrain, which promotes very rapid runoff of rainfall. The flood of May 1942 caused damages in Allentown estimated at $990,000, and the flood of August 1955 was approximately of the same magnitude. The authorized projects for flood protection on the Lehigh River include local flood protection facilities at Allentown, Francis E. Walter Reservoir, and local protection facilities at Bethlehem.

The project at Allentown consisted of straightening and deepening over 1-1/2 miles of main channel and constructing a levee at the upstream end of the project, a training dike to direct the river flow around a sharp bend at the mouth of Little Lehigh Creek, and a concrete wall and two sections of levee between these two structures. These improvements, combined with the Francis E. Walter Reservoir, will reduce damages in Allentown by 70 percent in the event of a flood equivalent to that of May 1942. It is estimated that

$917,000 in flood damages were prevented by the project in June 1972 during flooding caused by Tropical Storm Agnes. Construction of the project at Allentown began in September 1958 and was completed in June 1960. The Federal cost of the project was $1,615,582. The City of Allentown assumed responsibility for maintenance of the protective facilities in August 1960.

Bethlehem is located in Northampton and Lehigh Counties on the Lehigh River, 16 miles above the river's mouth at Easton. In May 1942, a major flood caused damages in this city estimated at $6,390,000. More than half of this damage was incurred by the Bethlehem Steel Corporation, a large steel producer located in the city. To protect against similar floods, the authorized project provides a system of concrete floodwalls and paved-slope earth levee along the Lehigh River, and pumping stations located at various points on the river to discharge storm runoff from the protected area. This local flood control system, functioning as part of the basin system, provides complete protection from flood discharges similar to that of May 1942.

It is estimated that the levees prevented $4,480,000 in f[illegible]od damages from the Lehigh River in June 1972 during Tropical Stor[illegible] the pumping stations are estimated to have prevented an additional 17 to 18 million dollars in damage to the Bethlehem Steel plant by pumping runoff from the protected area and preventing major damage and business loss.

Construction of protective facilities on the right bank began in June 1960 and was completed in 1964. The Federal and non-Federal costs of the project were $1,520,995 and $699,594, respectively. The City of Bethlehem assumed responsibility for maintenance of the project on 6 May 1964.

As a result of the 1955 floods, Congress authorized a comprehensive study of the water resources and needs of the entire Delaware River Basin, including the Lehigh Basin. Based on that study by the Army Corps of Engineers, Congress in 1962 authorized construction of six multi-purpose projects and the modification of two existing projects. Three of the new projects and one modified project are located in the Lehigh Basin.

Beltzville Lake was the fist of these to be constructed. The dam is located on the Pohopoco Creek about five miles from its confluence with the Lehigh River near Lehighton, Pennsylvania. Beltzville Lake controls a drainage area of about 96 square miles by providing 94,310 acre-feet of storage of which 53,087 acre-feet is reserved for flood control purposes. The remaining 41,223 acre-feet is maintained as a permanent pool for water conservation and for public use. The reservoir and most surrounding land have been turned over to the Commonwealth of Pennsylvania for operation as a state park.

The reservoir is formed by an earthfill dam measuring 4,300 feet along the crest and 170 feet in height with a spillway excavated in the right abutment and a gate-controlled outlet works discharging through a tunnel. The project was completed in 1972 and is now operated in conjunction with Francis E. Walter Reservoir and the local projects in Allentown and Bethlehem to control downstream floods.

A second component of the 1962 plan is the modification of Francis E. Walter Dam to provide an additional flood control capability and also to provide for water supply and recreation benefits. F.E. Walter at present acts only for flood control and provides for a small amount of recreation. The authorized modifications will make it serviceable for long-term storage and water supply. The modified dam structure will rise 263 feet above the riverbed and have a length of 3,500 feet. With these modifications, the inactive storage will be 2,000 acre-feet. The normal pool storage for water supply and recreation will be 70,000 acre-feet and will extend upstream for 7 miles. The flood control storage of 108,000 acre-feet provided in the original project described previously will remain unchanged. The project will provide recreation for a capacity of 250,000 visitors annually. The Delaware River Basin Commission has recommended in its draft Level B report for the Delaware River Basin that this modification be constructed.

The other two authorized new projects located in the Lehigh Basin are Trexler Lake and Aquashicola Lake. Neither has been built. Trexler Lake would be located on Jordan Creek about seven and one half miles northwest of Allentown and about twelve miles above the confluence of Jordan Creek with the Lehigh River. The dam would be an earth and rockfill structure having an overall length of 850 feet and height of 130 feet. The reservoir would contain approximately 15,000 acre-feet of flood control storage and 40,000 acre-feet of long term storage for water supply and recreation. Due to local opposition expressed in 1979 during the advanced engineering and design phase of the project, and subsequent congressional actions opposing the appropriation of construction funds, this project is currently considered to be "inactive".

Aquashicola Lake would be located on Aquashicola Creek about four and one half miles upstream from its confluence with the Lehigh River and about three miles east of Palmerton, Pennsylvania. The dam would be a compacted earthfill structure having an overall length of about 2000 feet and a height of 110 feet. The reservoir would contain approximately 20,000 acre-feet of flood control storage and 25,000 acre-feet of long term storage for water supply and recreation. The project has been deferred due to its marginal economic justification. A restudy will be necessary to determine whether an economically justified and locally supported plan of authorized scope can be developed.

Since the 1700's numerous dams have been constructed by various private interests and municipalities on the Lehigh River and its tributaries. Those on the lower reaches of the Lehigh itself were constructed mainly to divert water into the Lehigh Canal for navigation. On the upper reaches of the Lehigh and on the tributaries, most dams were originally constructed for recreational or industrial water uses. In more recent years several municipal water supply reservoirs have been constructed.

The Commonwealth of Pennsylvania Department of Environmental Resources (DER) maintains an inventory of dams and reservoirs in Pennsylvania, including the Lehigh Basin. This inventory currently contains 139 sites in the Lehigh Basin. Table 19 lists these dams along with data such as height of dam, drainage area, and storage volume. In addition, several dams constructed on the Lehigh River in the 1800's in conjunction with the Lehigh Canal have been breached or destroyed over the years and are not listed in the DER inventory. They are the Mauch Chunk, Parryville, Lehigh Gap, Laury's Station, Hokendauqua, and Chain Dams. The Chain Dam was reconstructed in 1973 by DER. Some of the others may be reconstructed by DER in the future.

The Heritage Conservation and Recreation Service, as part of their study of the Lehigh Canal, has recommended that the restoration potential of Hokendauqua Dam be explored. This restoration would allow rewatering of the canal at Catasauqua. They also have recommended continued restoration of the canal from Parryville to Jim Thorpe, including the possible construction of a dam on the Lehigh River in the vicinity of the original Mauch Chunk Dam.

TABLE 13

DAMS AND RESERVOIRS IN THE LEHIGH RIVER BASIN

FROM COMMONWEALTH OF PENNSYLVANIA INVENTORY

DAM NUMBER**	LATITUDE DEG.	LATITUDE MIN.	LONGITUDE DEG.	LONGITUDE MIN.	DRAINAGE AREA SQUARE MILES	SURFACE AREA ACRES	STORAGE VOLUME MILLION GALLONS	DAM HEIGHT FEET	NAME AND LOCATION: DAM OR RESERVOIR-STREAM-COUNTY-TOWNSHIP-OWNER
[illegible]	[illegible]	50.9	75	[illegible]	9.7	300	[illegible]	33	LAKE HAUTO, NESQUEHONING CREEK, CARBON, NESQUEHONING BORO., PANTHER VALLEY WATER COMPANY
[illegible]	[illegible]	51.6	75	54.0	[illegible]	52		6.	BEAR CREEK DAM, BEAR CREEK, CARBON, MAUCH CHUNK, LANSFORD-COALDALE WATER AUTHORITY
[illegible]	40	[illegible].9	75	[illegible]	[illegible]	[illegible]		[illegible]	NO. 1 DAM, LONG RUN, CARBON, FRANKLIN, LEHIGHTON WATER COMPANY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36.[illegible]	[illegible]	[illegible]	[illegible]	MAHONING CREEK DAM, MAHONING CREEK, CARBON, MAHONING, BORO. OF LEHIGHTON
13-[illegible]	[illegible]	50.[illegible]	75	[illegible]3.8	[illegible]	[illegible]	[illegible]	[illegible]	NO. 3 DAM, BEAVERDAM RUN, CARBON, MAHONING, LEHIGH VALLEY RAILROAD COMPANY
13-[illegible]	[illegible]	[illegible]9.1	75	[illegible]	[illegible]	[illegible]	[illegible]	15	UNNAMED DAM, POHOPOCO CREEK, CARBON, PARRYVILLE BORO., PALMER WATER COMPANY
13-[illegible]	[illegible]	54.9	75	[illegible]	[illegible]	3	[illegible]	[illegible]	QUAKAKE DAM, QUAKAKE CREEK, CARBON, PACKER, HAZELTON CITY WATER COMPANY
13-[illegible]	40	[illegible]	[illegible]	[illegible]	5.[illegible]	*	[illegible]	[illegible]	BEISEL RUN DAM, BEISEL RUN, CARBON, PACKER, WYOMING VALLEY WATER SUPPLY COMPANY
13-[illegible]	[illegible]	52.[illegible]	75	[illegible]	[illegible]	[illegible]	*	12	NO. 3 DAM, SILKMILL RUN, CARBON, JIM THORPE BOROUGH, MAUCH CHUNK WATER COMPANY
13-[illegible]	40	5[illegible].9	75	42.7	[illegible]	*	[illegible]		NO. 2 DAM, SILKMILL RUN, CARBON, JIM THORPE BOROUGH, MAUCH CHUNK WATER COMPANY
[illegible]	[illegible]	53.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*	1[illegible]	NO. 1 DAM, SILKMILL RUN, CARBON, JIM THORPE BOROUGH, MAUCH CHUNK WATER COMPANY
13-[illegible]	40	52.[illegible]	75	40.8	[illegible]	[illegible]	[illegible]	[illegible]	NO. 2 DAM, LONG RUN, CARBON, FRANKLIN, LEHIGHTON WATER SUPPLY COMPANY
13-[illegible]	40	53.8	[illegible]	38.[illegible]	4.[illegible]	[illegible]	*	9	NO. 3 DAM, PINE RUN, CARBON, PENN FOREST, LEHIGHTON WATER SUPPLY COMPANY
13-[illegible]	[illegible]	56.9	75	5[illegible]	[illegible]	20	[illegible]	[illegible]	UNNAMED DAM, TRIB. HOYLE CREEK, CARBON, BANKS, WEATHERLY WATER COMPANY
13-[illegible]	[illegible]	[illegible]8.2	[illegible]	[illegible]8.[illegible]	[illegible]	[illegible]	[illegible]	9	UPPER BUCK MOUNTAIN DAM, SCHAEFFERS RUN, CARBON, LAUSANNE, HAZELTON WATER COMPANY
13-[illegible]	[illegible]	50.[illegible]	75	39.9	106.[illegible]	*	*	3	UNNAMED DAM, POHOPOCO CREEK, CARBON, FRANKLIN, JOHN REBER
13-[illegible]	[illegible]	52.[illegible]	75	[illegible].2	[illegible]	*	*	[illegible]	UNNAMED DAM, ROBINSON RUN, CARBON, MAUCH CHUNK, CENTRAL RAILROAD OF NEW JERSEY
[illegible]	[illegible]	[illegible]1.5	[illegible]	[illegible]	[illegible]	*	[illegible]	14	C.C.C. DAM, SAND SPRING RUN, CARBON, KIDDER, PA. DEPT. OF FORESTS AND WATERS
13-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*	*	15	STAMETZ DAM, SAND SPRING RUN, CARBON, KIDDER, PA. DEPT. OF FORESTS AND WATERS
13-[illegible]	[illegible]	52.[illegible]	[illegible]	[illegible]3.9	2.9	*	*	[illegible]	UNNAMED DAM, BRANCH LEHIGH RIVER, CARBON, JIM THORPE BOROUGH, S. TALE SCHIFF AND COMPANY
13-[illegible]	[illegible]	[illegible]	75	46.[illegible]	[illegible]	5	6	[illegible]	INDIAN RUN DAM, INDIAN RUN, CARBON, LEHIGH, JOHN A. OTTEY
13-[illegible]	[illegible]	[illegible].5	75	49.3	0.[illegible]	1	8	10	EURANA PARK POOL, TRIB. BLACK CREEK, CARBON, WEATHERLY BORO., EURANA PARK COMMISSION
13-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.[illegible]	[illegible]	[illegible]	6	CHRISTMAN DAM, WILD CREEK, CARBON, PENN FOREST, PALMERTON FISHING AND HUNTING ASSOC.
13-[illegible]	[illegible]	53.[illegible]	[illegible]	3[illegible].2	9.[illegible]	[illegible]	[illegible]	12	UNNAMED DAM, PINE RUN, CARBON TOWAMENSING, PINE RUN ASSOCIATION
13-[illegible]	40	51.[illegible]	75	39.[illegible]	6.[illegible]	[illegible]	[illegible]	11	UNNAMED DAM, SAWMILL CREEK, CARBON FRANKLIN WALTER FRICK
13-[illegible]	[illegible]	[illegible]	75	41.0	[illegible].3	[illegible]	10	10	HICKORY RUN DAM, HICKORY RUN, CARBON, KIDDER. PA. DEPT. OF FORESTS AND WATERS
[illegible]	[illegible]	[illegible]	75	[illegible]	4.3	[illegible]	*	[illegible]	UNNAMED DAM, SAND SPRING RUN, CARBON, KIDDER, PA. DEPT. OF FORESTS AND WATERS
13-[illegible]	[illegible]	[illegible]		33.[illegible]	1[illegible]	239	2560	135	WILD CREEK RESERVOIR, WILD CREEK, CARBON, TOWAMENSING, CITY BETHLEHEM
[illegible]	[illegible]	[illegible]	[illegible]	34.[illegible]	16.5	461	6000	145	PENN FOREST RESERVOIR, WILD CREEK, CARBON, PENN FOREST, CITY BETHLEHEM
13-[illegible]	[illegible]	[illegible]	[illegible]	56.3	3.8	*	*	11	UNNAMED DAM, QUAKAKE CREEK, CARBON, PACKER, BOROUGH OF TAMAQUA
13-89	[illegible]	[illegible]	75	[illegible].0	4.[illegible]	1	1	10	SAYLORSVILLE DAM, HICKORY RUN, CARBON, KIDDER, PA. DEPT. OF FORESTS AND WATERS
13-[illegible]	[illegible]	[illegible]	75	[illegible]	1.9	11	18	18	HICKORY RUN PARK DAM, SAND SPRING RUN, CARBON, KIDDER, PA. DEPT. OF FORESTS AND WATERS

Notes: *Storage Volume Less than 0.5 M.G. or Surface Area Less than 1/2 Acre.

**"Pennsylvania Department of Environmental Resources Permit Number"

TABLE 19 (cont'd)
DAMS AND RESERVOIRS IN THE LEHIGH RIVER BASIN
FROM COMMONWEALTH OF PENNSYLVANIA INVENTORY

PERMIT* NUMBER	COORDINATES LATITUDE DEG.	MIN.	LONGITUDE DEG.	MIN.	DRAINAGE AREA SQUARE MILES	SURFACE AREA ACRES	STORAGE VOLUME MILLION GALLONS	DAM HEIGHT FEET	NAME AND LOCATION DAM OR RESERVOIR-STREAM-COUNTY-TOWNSHIP-OWNER
13- 93	41	[illegible]	75	35.[illegible]	[illegible]	18[illegible]	300	20	BIG BOULDER LAKE, GRASS LAKE CREEK, CARBON, KIDDER, SPLIT ROCK [illegible], INC.
13- 95	40	[illegible]	75	31.5	13.[illegible]	1	*	3	UNNAMED DAM, BUCKWHA CREEK, CARBON, LOWER TOWAMENSING, NORTH AMERICAN REFRA[illegible]
13- 96	40	50.2	75	53.5	10.[illegible]	*	*	3	UNNAMED DAM, NESQUEHONING CREEK, CARBON, MAUCH CHUNK, PANTHER VALLEY WATER [illegible]
13- 97	41	01.2	75	36.[illegible]	2.[illegible]	25	10	26	UNNAMED DAM, LAUREL RUN, CARBON, KIDDER, HOLIDAY POCONOS, INC.
13- 98	40	55.[illegible]	75	40.[illegible]	2.[illegible]	130	84[illegible]	30	BEAR CREEK LAKE, BEAR CREEK, CARBON, PENN FOREST, BEAR CREEK LAKE CORPORATION
13- 99	41	03.5	75	35.6	1.1	11[illegible]	43[illegible]	2	LAKE HARMONY, TRIB. TUNKHANNOCK CREEK, CARBON, KIDDER, LAKE HARMONY ESTATE
13-100	40	59.1	75	40.0	1.4	23	80	20	UNNAMED DAM, DRAKES CREEK, CARBON, PENN FOREST, YMCA OF PHILADELPHIA
[illegible]	40	49.[illegible]	75	36.1	2.6	*	*	6	NO. 4 DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
[illegible]	40	49.[illegible]	75	36.1	2.6	*	*	7	NO. 5 DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
[illegible]	40	49.4	75	36.1	2.6	*	*	10	UNNAMED DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
[illegible]	40	49.[illegible]	75	36.1	2.6	*	*	6	NO. 1 DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
[illegible]	40	49.4	75	36.1	2.6	*	*	9	NO. 2 DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
[illegible]	40	49.[illegible]	75	36.1	2.6	*	*	9	NO. 3 DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
13-10[illegible]	40	49.[illegible]	75	36.1	2.6	*	*	8	NO. 6 DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
13-10[illegible]	40	49.4	75	36.1	2.6	*	*	8	NO. 7 DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
13-10[illegible]	40	52.1	75	52.0	1.7	6	27	50	UNNAMED DAM, BROAD RUN, CARBON, BOROUGH OF NESQUEHONING, BOROUGH OF NESQUEHONING
[illegible]	41	[illegible]	75	[illegible]	288.[illegible]	90	35800	234	FRANCIS E. WALTER RESERVOIR, LEHIGH RIVER, CARBON KIDDER, U.S ARMY ENGRS., PHILA. DIST.
13-106	40	50.8	75	47.5	5.9	320	519	50	UNNAMED DAM, MAUCH CHUNK CREEK, CARBON, MAUCH CHUNK COUNTY COMMISSIONERS
13-107	40	49.[illegible]	75	36.0	2.3	2	*	7	CONSTANTINI DAM, MILL CREEK, CARBON, TOWAMENSING, ANTHONY R. CONSTANTINI
13-108	40	50.9	75	38.3	7[illegible].0	94[illegible]	22250	170	BELTZVILLE DAM, POHOPOCO CREEK, CARBON, FRANKLIN, U.S. ARMY ENGINEERS, PHILA. DIST.
35- 3[illegible]	41	14.9	75	27.6	15.[illegible]	64	80	8	GOULDSBORO DAM, LEHIGH RIVER, LACKAWANNA, CLIFTON, PA. GAS AND WATER COMPANY
35- 6[illegible]	41	12.8	75	37.6	[illegible].8	135	525	4	BEAR LAKE, POND CREEK, LACKAWANNA, LEHIGH, BEAR LAKE ASSOCIATION
35-1[illegible]	41	12.0	75	34.[illegible]	[illegible]	*	*	4	BAILER DAM, BUCKLEY RUN, LACKAWANNA, LEHIGH, W.J. BAILER
35-126	41	15.[illegible]	75	29.[illegible]	[illegible]	42	50	11	TAMARACK DAM, TAMARACK CREEK, LACKAWANNA, CLIFTON, ADOLPH SHAFFICH
39- 1	40	[illegible]	75	31.1	2.9	10	100	30	UNNAMED DAM, SPRING CREEK, LEHIGH, WHITEHALL, NORTHAMPTON BOROUGH MUNICIPAL AUTH.
39- 9	40	36.5	75	27.2	1129.0	*	*	13	NO. 7 DAM, LEHIGH RIVER, LEHIGH, HANOVER, LEHIGH COAL AND NAVIGATION COMPANY
39- 12	40	44.7	75	42.1	2.4	*	2	9	UNNAMED DAM, TROUT CREEK, LEHIGH, HEIDELBERG, SLATE BELT WATER COMPANY
39- 27	40	31.2	75	23.6	0.7	*	*	5	UNNAMED DAM, BRANCH SAUCON CREEK, LEHIGH, UPPER SAUCON, J.H. VAN SCIVER
39- 34	40	30.9	75	30.3	0.3	1	*	7	MILL DAM, BRANCH LITTLE LEHIGH, LEHIGH, UPPER MILFORD, G.W. ERNST
39- 35	40	35.8	75	28.4	187.0	*	*	8	UNNAMED DAM, LITTLE LEHIGH, LEHIGH, CITY ALLENTOWN, CITY OF ALLENTOWN
39- 37	40	35.0	75	32.0	7.3	2	2	7	MILL DAM, CEDAR CREEK, LEHIGH, SOUTH WHITEHALL, JACOB HAINES
39- 39	40	34.7	75	32.2	5.6	5	*	10	CEDAR CREEK DAM, NO. 1, CEDAR CREEK, LEHIGH, SOUTH WHITEHALL, R.L. PARR

Note: *Storage Volume Less than 0.5 M.G. or Surface Area Less than 1/2 Acre.
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TABLE 19 (cont'd)
DAMS AND RESERVOIRS IN THE [illegible]
FROM COMMONWEALTH OF PENNSYLVANIA [illegible]

PERMIT* NUMBER	COORDINATES LATITUDE DEG	MIN.	LONGITUDE DEG	MIN.	DRAINAGE AREA SQUARE MILES	SURFACE AREA ACRES	STORAGE VOLUME MILLION GALLONS	DAM HEIGHT FEET	NAME AND LOCATION: DAM OR RESERVOIR-STREAM-COUNTY-TOWNSHIP-OWNER
39- 43	40	38.1	75	36.1	2.2	3	4	6	KERNS DAM, JORDAN CREEK, LEHIGH, NORTH WHITEHALL, WALTER L. SCHOEMAKER
39- 46	40	37.7	75	34.3	68.8	3	*	6	WEHRS DAM, JORDAN CREEK, LEHIGH, SOUTH WHITEHALL, ALTON W. WEHR
39- 55	40	45.2	75	36.7	19.6	*	*	5	KERNS DAM, TROUT CREEK, LEHIGH, WASHINGTON, CHARLES B. NEFF
39- 56	40	38.0	75	31.6	74.5	*	*	3	UNNAMED DAM, JORDAN CREEK, LEHIGH, SOUTH WHITEHALL, TROJAN POWDER COMPANY
39- 65	40	44.4	75	38.4	4.9	*	*	8	UNNAMED DAM, LITTLE TROUT CREEK, LEHIGH, WASHINGTON, JEREMIAH OSWALD TROOP NO. 1, B.S.A.
39- 72	40	45.7	75	39.3	0.4	*	*	3	UNNAMED DAM, UNNAMED SPRING, LEHIGH, WASHINGTON, JOHN N. BACHMAN
39- 78	40	40.7	75	31.6	12.9	*	*	4	UNNAMED DAM, COPLAY CREEK, LEHIGH, WHITEHALL, GIANT PORTLAND CEMENT COMPANY
39- 79	40	46.2	75	36.8	0.5	*	*	2	UNNAMED DAM, TRIBUTARY LEHIGH RIVER, LEHIGH, WASHINGTON, EVANS YALE REALTY CORP.
39- 83	40	29.4	75	35.0	0.4	1	1	18	UNNAMED DAM, EAST BRANCH SWOPE CREEK, LEHIGH, LOWER MACUNGIE, BOROUGH OF ALBURTIS
39- 84	40	29.1	75	24.1	0.6	1	1	13	UNNAMED DAM, SAUCON CREEK, LEHIGH, UPPER SAUCON, LOCUST VALLEY COUNTRY CLUB
39- 85	40	35.7	75	30.3	12.0	8	8	3	LAKE MUHLENBERG, CEDAR CREEK, LEHIGH, CITY ALLENTOWN, CITY OF ALLENTOWN
39- 89	40	37.9	75	37.4	0.5	*	*	8	UNNAMED DAM, HORSESHOE SPRING CREEK, LEHIGH, LOWHILL, BOYS CLUB OF ALLENTOWN, INC.
39- 90	40	38.8	75	44.4	1.0	3	3	2	UNNAMED DAM, TRIBUTARY SWITZER CREEK, LEHIGH, LYNN, ALTON R. SNYDER
39- 91	40	36.8	75	42.3	1.1	*	*	8	UNNAMED DAM, TRIBUTARY LYON CREEK, LEHIGH, WEISENBERG, ROBERT MICKUS
40- 13	40	57.2	75	54.0	2.1	64	192	30	DAM F, DRECK CREEK, LUZERNE, HAZLETON, HAZLETON CITY AUTH. WATER DEPARTMENT
40- 14	40	57.0	75	54.2	2.5	13	45	22	DAM G, DRECK CREEK, LUZERNE, HAZLETON, HAZLETON CITY AUTH. WATER DEPARTMENT
40- 28	41	05.4	75	46.8	5.6	56	80	44	LAKE PENN, WRIGHT CREEK, LUZERNE, DENNISON, HARRY F. GOERINGER
40- 45	41	03.4	75	48.3	0.3	1	2	8	SANTER SPRINGS DAM, SOUTH BRANCH LINESVILLE CREEK, LUZERNE, FOSTER, WHITE HAVEN WATER CO.
40- 47	41	10.7	75	45.4	35.2	70	250	17	BEAR CREEK DAM, BEAR CREEK, LUZERNE, BEAR CREEK, MRS. LILY LEWIS KILNER
40- 50	41	12.9	75	40.6	1.6	40	100	15	MOUNTAIN LAKE DAM, MEADOW RUN, LUZERNE, BEAR CREEK, MT. AND MEADOW RUN LAKE ASSOC.
40- 51	41	13.2	75	40.1	1.2	45	200	18	MEADOW LAKE DAM, MEADOW RUN, LUZERNE, BEAR CREEK, MT. AND MEADOW RUN LAKE ASSOC.
40-143	41	11.6	75	40.2	0.3	31	63	12	INDIAN LAKE DAM, SHADES CREEK, LUZERNE, BUCK, STOUT-RAUP,. INC.
40-176	41	03.1	75	48.6	1.9	5	12	8	WATER SUPPLY DAM, TRIBUTARY LINESVILLE CREEK, LUZERNE, FOSTER, WHITE HAVEN MUNICIPAL AUTH
40-182	41	11.2	75	47.6	1.4	46	*	.	EIKES POND, TRIBUTARY TEN MILE RUN, LUZERNE, BEAR CREEK, HENRY. A BEHRENS
40-184	41	07.5	75	44.7	0.4	*	*	15	PINE VIEW DAM, PINE CREEK, LUZERNE, BEAR CREEK, GENNETT ENTERPRISE
40-216	41	06.3	75	45.6	3.5	14	18	17	WHITE HAVEN DAM, PINE CREEK, LUZERNE, BEAR CREEK, WHITE POCONOS, INC.
40-219	41	14.9	75	43.2	0.8	61	130	22	KIEL LAKE, TRIB. BEAR CREEK, LUZERNE, BEAR CREEK, ALEEDA DEVELOPMENT CORP.
45- 1	41	06.5	75	28.5	19.4	500	486	17	LAKE NAOMI, UPPER TUNKHANNOCK CREEK, MONROE, TOBYHANNA, FRANK C. MILLER ESTATE
45- 6	40	56.8	75	26.2	14.0	*	*	6	UNNAMED DAM, POHOPOCO CREEK, MONROE, CHESTNUTHILL, PA. POWER AND LIGHT COMPANY
45- 7	40	52.6	75	19.9	1.8	1	8	26	BLUE MT. DAM, AQUASHICOLA CREEK, MONROE, HAMILTON, BLUE MT. CONSOLIDATED WATER SUPPLY CO.
45- 8	41	09.8	75	31.8	9.5	229	400	18	BRADY DAM, TROUT CREEK, MONROE, COOLBAUGH, PA. GAME COMMISSION
45- 19	41	07.2	75	23.3	0.7	80	70	10	SUMMIT LAKE DAM, RED RUN, MONROE, COOLBAUGH, DELAWARE-LACKAWANNA & WESTERN RR COMPANY

Note: *Storage Volume Less than 0.5 M.G. or Surface Area Less than 1/2 Acre.
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TABLE 19 (cont'd)
DAMS AND RESERVOIRS IN THE LEHIGH RIVER BASIN
FROM COMMONWEALTH OF PENNSYLVANIA INVENTORY

PERMIT+ NUMBER	COORDINATES LATITUDE DEG	LATITUDE MIN.	LONGITUDE DEG	LONGITUDE MIN.	DRAINAGE AREA SQUARE MILES	SURFACE AREA ACRES	STORAGE VOLUME MILLION GALLONS	DAM HEIGHT FEET	NAME AND LOCATION: DAM OR RESERVOIR-STREAM-COUNTY-TOWNSHIP-OWNER
45- 36	41	12.0	75	24.5	13.9	170	210	7	TOBYHANNA NO. 2, TOBYHANNA CREEK, MONROE, COOLBAUGH, PA. DEPT. OF FORESTS AND WATERS
45- 38	41	08.8	75	23.4	3.4	44	93	20	LYNCHWOOD LAKE DAM, HAWKEY RUN, MONROE, COOLBAUGH, LYNCHWOOD LAKE ICE COMPANY
45- 39	41	07.1	75	23.7	0.9	*	*	8	SUMMIT LAKE, RED RUN, MONROE, COOLBAUGH, SUMMIT LAKE
45- 40	41	07.0	75	25.5	14.2	348	435	8	STILLWATER LAKE, TUNKHANNOCK CREEK, MONROE, TOBYHANNA, BOY SCOUTS OF AMERICA
45-100	40	50.7	75	23.0	11.0	5	9	11	CHICOLA LAKE DAM, AQUASHICOLA CREEK, MONROE, ROSS, J.R. KOSTENBADER
45-102	40	54.8	75	25.3	2.0	*	*	6	WEIR LAKE DAM, WEIR RUN, MONROE, CHESTNUTHILL, WEIR LAKE DEVELOPMENT COMPANY
45-126	41	05.9	75	27.0	1.6	90	115	15	LUTHERLAND DAM, BEAVER CREEK, MONROE, TOBYHANNA, LUTHERAN CONFERENCE & CAMP ASSOC.
45-128	40	57.2	75	29.5	2.0	1	*	12	TREXLER DAM, MIDDLE CREEK, MONROE, POLK, LEHIGH COUNCIL BOY SCOUTS OF AMERICA
45-144	40	51.9	75	18.2	2.9	*	*	10	ROSS COMMON DAM, ROSS COMMON CREEK, MONROE, ROSS BLUE MT. CONSOLIDATED WATER COMPANY
45-150	40	52.3	75	23.1	0.9	*	*	4	UNNAMED DAM, TRIBUTARY BUCKWHA CREEK, MONROE, ROSS, GEORGE A. KARCH
45-174	40	50.5	75	24.9	14.9	10	16	7	UNNAMED DAM, AQUASHICOLA CREEK, MONROE, ELDRED, MILTON A. BUSHKIRK
45-177	41	06.4	75	28.9	20.1	3	3	9	POCONO PINES DAM, TUNKHANNOCK CREEK, MONROE, TOBYHANNA, PA. POWER & LIGHT CO.
45-190	41	03.0	75	33.6	24.5	*	*	8	ASSOCIATION DAM, TUNKHANNOCK CREEK, MONROE, TUNKHANNOCK, TUNKHANNOCK FISHING ASSOC.
45-207	41	09.8	75	34.6	15.9	60	315	18	ARROWHEAD DAM, TROUT CREEK, MONROE, TOBYHANNA, ALL AMERICAN REALTY COMPANY
45-217	40	58.5	75	28.0	0.8	4	8	22	UNNAMED DAM, BRANCH POHOPOCO CREEK, MONROE, CHESTNUTHILL, WILLIAM H. CAMERON, JR.
45-222	41	05.8	75	32.4	75.2	750	1760	40	POCONO LAKE, TOBYHANNA CREEK, MONROE, TOBYHANNA, POCONO LAKE PRESERVE
45-227	41	59.7	75	29.9	2.7	42	66	13	INDIAN MOUNTAIN LAKE, MUD RUN, MONROE, TUNKHANNOCK, LEON ROSS AND JACK COHEN
45-229	40	53.1	75	24.2	2.6	7	14	21	UNNAMED DAM, PRINCESS RUN, MONROE, ROSS, FREDRICK & RUDOLF MUELLER
45-231	40	57.7	75	29.6	1.9	5	9	25	UNNAMED MIDDLE CREEK, MONROE, POLK, LEHIGH COUNCIL BOY SCOUTS OF AMERICA
45-240	41	06.8	75	33.7	1.0	9	*	3	LAKE ONOCUP, DAVEY RUN, MONROE, TOBYHANNA, POTTER, INC.
45-241	41	11.6	75	22.2	1.8	57	86	20	UNNAMED DAM, DRESSER RUN, MONROE, COOLBAUGH, NAUS AND NEWLYN, INC.
48- 1	40	46.6	75	32.6	892.0	*	*	18	NO. 4 DAM, LEHIGH RIVER, NORTHAMPTON, LEHIGH, THREE MILE BOATING ASSOCIATION
48- 12	40	41.3	75	12.4	1373.0	*	*	30	EASTON DAM, LEHIGH RIVER, NORTHAMPTON, CITY OF EASTON, PA. DEPT. OF FORESTS AND WATERS
48- 30	40	36.0	75	20.7	45.0	*	*	4	UNNAMED DAM, SAUCON CREEK, NORTHAMPTON, LOWER SAUCON, CITY OF BETHLEHEM
48- 37	40	38.9	75	22.8	43.5	*	*	2	MILL DAM, MONOCACY CREEK, NORTHAMPTON, HANOVER, J.E. MATHEWS
48- 38	40	39.3	75	22.9	44.5	*	*	5	MILL DAM, MONOCACY CREEK, NORTHAMPTON, HANOVER, K.L. GRIFFITH

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TABLE 19 (cont'd)
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FROM COMMONWEALTH OF PENNSYLVANIA INVENTORY

PERMIT+ NUMBER	COORDINATES LATITUDE DEG	LATITUDE MIN.	LONGITUDE DEG	LONGITUDE MIN.	DRAINAGE AREA SQUARE MILES	SURFACE AREA ACRES	STORAGE VOLUME MILLION GALLONS	DAM HEIGHT FEET	NAME AND LOCATION DAM OR RESERVOIR-STREAM-COUNTY-TOWNSHIP-OWNER
48- 43	40	40.8	75	29.4	42.0	*	13	12	SUPPLY DAM, HOKENDAUQUA CRK., NORTHAMPTON, NORTHAMPTON BORO., ATLAS PORTLAND CEMENT CO.
48- 85	40	38.5	75	22.9	47.7	5	*	10	ILLICKS MILL DAM, MONOCACY CREEK, NORTHAMPTON, CITY BETHLEHEM, CITY OF BETHLEHEM
48- 88	40	37.1	75	23.0	49.6	1	*	8	UNNAMED DAM, MONOCACY CREEK, NORTHAMPTON, CITY BETHLEHEM, W. AND D. ZUCKINBACK
48- 91	40	34.7	75	20.7	27.2	1	*	5	KULP DAM, SAUCON CREEK, NORTHAMPTON, LOWER SAUCON, H.E. KULP
48-110	40	44.8	75	28.9	2.4	*	*	8	UNNAMED DAM, TRIBUTARY HOKENDAUQUA CREEK, NORTHAMPTON, MOORE, BEERSVILLE GROVE, INC.
48-114	40	34.7	75	19.3	1.3	*	*	2	UNNAMED DAM, SILVER CREEK, NORTHAMPTON, LOWER SAUCON, VINCENT KOVACS
48-124	40	42.4	75	29.6	20.0	2	*	4	LAPPAWINZO DAM, HOKENDAUQUA CREEK, NORTHAMPTON, ALLEN, PA. FISH COMMISSION
48-129	40	46.7	75	31.1	1.8	1	*	3	INDIANOLA LAKE, INDIAN CREEK, NORTHAMPTON, LEHIGH, RUSSEL H. HAHN
48-132	40	34.6	75	17.9	0.1	*	*	20	NO. 2 DAM, OLD MINE PIT, NORTHAMPTON, LOWER SAUCON, BOROUGH OF HELLERTOWN
48-133	40	37.4	75	20.1	0.8	12	*	6	UNNAMED DAM, LEHIGH CANAL, NORTHAMPTON, FREEMANSBURG BORO., INTER-CLUB CANAL COMM., INC
48-135	40	46.3	75	26.5	1.7	*	3	18	UNNAMED DAM, TRIBUTARY HOKENDAUQUA CREEK, NORTAMPTON, MOORE, FAUST M. COPOBIANCO
54- 31	40	50.2	75	56.3	6.6	111	370	30	GREENWOOD DAM, NESQUEHONING CREEK, SCHUYLKILL, RUSH, PANTHER VALLEY WATER COMPANY
64- 6	41	16.4	75	25.3	1.5	133	130	10	POCONO PEAK LAKE, LEHIGH RIVER, WAYNE, STERLING, POCONO PEAK LAKE PRESERVE
64- 38	41	14.3	75	26.7	1.2	135	95	5	LAKE WATAWAGA, BRANCH LEHIGH RIVER, WAYNE, LEHIGH, MRS. D.S. LAUDERBAUCH
64- 51	41	14.9	75	28.0	16.0	30	58	12	LAKE LEHIGH DAM, LEHIGH RIVER, WAYNE, LEHIGH, WEST END ICE COMPANY
64-148	41	14.1	75	27.2	4.1	250	355	8	GOULDSBORO LAKE, OAKES SWAMP RUN, WAYNE, LEHIGH, PA. FISH COMMISSION
64-175	41	15.2	75	26.9	6.2	44	70	14	LOWER DAM, LEHIGH RIVER, WAYNE, LEHIGH, AMELIA SCOTT

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PROBLEMS, NEEDS, AND OPPORTUNITIES

Power related problems, needs, and opportunities have been identified during Stage 1 through coordination with the Federal Energy Regulatory Commission (FERC), the U.S. Department of Energy, other agencies, and the public. Other planning agencies have established an extensive data base of the water related problems within the basin. The Commonwealth of Pennsylvania is conducting planning efforts which will address many of the water resource problems in the Lehigh River Basin. The State Water Plan study deals with quantity aspects of flood control, water supply, sediment, erosion and recreation. The Comprehensive Water Quality Management Plan addresses, in part, water quality management problems in the Lehigh River Basin including areawide waste treatment management planning. The Lehigh Scenic River Study has addressed the preservation of the Basin's scenic value for recreational and conservational use. The Delaware River Basin Commission has addressed the potential contributions of the Lehigh with regard to low flow augmentation and salinity control.

As was indicated in the introduction to this Chapter, the primary cause of the energy problems facing the United States today is our dependence on uncertain and expensive sources of foreign oil. In the Mid-Atlantic Area Council (MAAC), FERC reports that 27.1% of the installed generating capacity is oil-fired fossil steam and an additional 16.6% is internal combustion and gas turbine. A major need in the MAAC area is to reduce this dependence on petroleum based fuels.

At the same time that we are attempting to cut back on use of petroleum, the power requirements of the MAAC area are continuing to increase. As was discussed earlier, the oil embargo, increases in the cost of fuel oil, adverse economic conditions, and a new emphasis by utilities on load management and conservation have brought about lower system growth rates since 1973. However, average annual peak load growth is still expected to be 2.4% during the remainder of the century. The current peak demand of 31,654 MW will have grown to 52,290 MW by 1999.

Approximately 39% of the new generating capacity planned to meet this increased demand is in nuclear plants. Construction and licensing of these new plants on the schedule originally intended is now in question as a result of last year's incident at the Three Mile Island nuclear plant near Harrisburg, Pennsylvania and the resulting public concern for nuclear plants.

Another 30% of the planned new generating capacity is in coal plants. Coal is in abundant supply in this region but the technology needed to prevent air pollution from coal plants is expensive. In view of current environmental regulations and public concern over acid rain created by coal-fired plants, it is unlikely that any such plants will be constructed in the future without expensive air pollution control systems.

There is an opportunity to utilize the water flowing in the Lehigh River and its tributaries to generate hydroelectric power for use within the MAAC. Development of this resource has the potential to lessen dependence on foreign oil and the need for new nuclear and coal-fired power plants. Hydroelectric plants offer several advantages over more conventional generator facilities. The principal advantages of hydroelectric generation are that it uses a renewable resource -- water, and produces few adverse environmental effects when installed at existing dams. In addition it can assist in long term price stability and reliability of service since it is undependent of rising world fuel prices and fuel shortages.

With the development of hydropower resources, there may also be an opportunity to meet other water resources needs such as those related to flood control, water supply, and recreation. Most flood control needs are currently met by the two existing Corps reservoir projects and the local protection works at Allentown and Bethlehem. There are, however, many flood plain areas in the Basin which are still subject to periodic flood damage. The locations and average annual damages suffered in these areas are documented in Pennsylvania DER's draft State Water Plan for Sub-basin 2. Hurricane Agnes was estimated to have caused about $1.9 million in flood damage in the Lehigh Basin in June 1972. There is the potential to provide some flood control storage in connection with the modification of existing dams or the construction of new hydropower dams.

Total water use in the Lehigh Basin in 1970 was approximately 440 million gallons per day (MGD) with over 75 percent of that use concentrated in the manufacturing industry of Lehigh and Northampton counties. The Pennsylvania Department of Environmental Resources (DER) has projected that in 1980 the total water use in the Basin would reach 475 MGD. Supplies for municipal, industrial, agricultural and other needs consist of a mix of ground water and surface water withdrawals and interbasin transfers, with direct surface water use being predominant. The draft State Water Plan for Sub-basin 2 contains further information on projected water needs and possible methods of meeting these needs. Modification of existing dams or construction of new dams for hydropower would provide the opportunity to meet some of these needs.

The Lehigh Basin is well endowed with facilities required for most types of water-related outdoor recreation, including picnicking, swimming, boating and fishing. The draft State Water Plan for Sub-basin 2 reports that power boating is the activity most in need of additional supply. There will be shortages by 1990 which will continue to grow after that time. Once again, projects investigated for hydropower production may have the ability to contribute to the solution of recreational problems.

Investigation of the hydropower potential of the Lehigh Canal and its associated locks and dams may provide the opportunity to continue the preservation and restoration of that historically and recreationally valuable resource. This is a need that has been identified by the Heritage Conservation and Recreation Service in their study.

PLANNING CONSTRAINTS

The formulation and evaluation of alternative plans, including the screening of potential hydropower sites, is constrained by technical, economic, environmental and institutional considerations. These considerations play an important role in the planning process and help to define the limits of what can be accomplished, and in conjunction with regional problems and needs form the background for the decision process.

Technical Constraints. One technical constraint is provided by the available technology for the manufacture of turbines and generators. Each turbine type is usable only under a finite range of heads and flows. There is a minimum combination of head and flow required at any site below which standard equipment is not available. The topography of a site is also a constraint because it will determine how much, if any, storage is available. This will affect the type of hydropower facility which may be considered at a particular site. A further technical constraint is that the supply of water in the basin is limited and has already been put to a variety of beneficial uses. This further limits the availability of water for producing hydroelectric power.

Economic Constraints. The development of a hydropower project is constrained by the economics of site development. If no consideration is given to hydropower's potential environmental and social contributions, such as preserving our nonrenewable resources, power must be generated at a cost recoverable through revenues over the projects economic life. As a result the less alteration that is needed at a site before power can be produced, the lower the cost of the power and the greater the chance of satisfying the economic constraints. Utilization of existing dams, requiring little or no modification other than construction of a powerhouse, is often necessary to satisfy this constraint. On the other hand, hydropower's contributions from an environmental and social standpoint, although unquantifiable in dollar terms, allow for a liberal evaluation of economic factors in determining a project's suitability for development.

Environmental Constraints. Project development is constrained by the existing environment of the site and the effects hydropower development would have on that environment. Significant environmental effects may prevent a project from ever being implemented due to stringent environmental protection legislation and public support for conservation of our natural environment. The types of projects most easily satisfying these constraints would be those utilizing existing dams and would be run-of-river plants as opposed to peaking plants. Inclusion of portions of the Lehigh and its tributaries in the Pennsylvania Wild and Scenic Rivers System will further constrain development within those reaches.

Institutional Constraints. The authorities, policies, and procedures of the various institutions involved in the planning and development of hydropower projects in the Lehigh basin can all constrain such projects. The constraints would be different for projects developed by the Corps of Engineers than for those developed by non-Federal interests since the extensive FERC licensing process must be adhered to by all non-Federal developers. Another set of institutions which may constrain hydropower development are the electric utilities which will purchase the power or wheel it from the plant to the user. The power produced must be marketable not only in terms of its cost but in its ability to fit into the utility's load pattern.

PLANNING OBJECTIVES

The following set of planning objectives have been established to guide study activities and future plan formulation efforts. It should be noted that these objectives will be re-examined throughout the study process and modified as appropriate. Study efforts that further identify the desires of local interests, define the power needs in the study area, and identify the possible environmental and economic impacts of alternative means of power generation will all contribute to firmly establishing the objectives of this study.

- Optimize the type and size of power plant which may be installed at each individual site within the Lehigh basin.

- Optimize the development of the basin's hydroelectric potential within a comprehensive planning framework, and contribute where possible to the solution of other water-related problems.

- Contribute to the conservation of the nations non-renewable resources.

- Contribute to the national goal of energy independence.

- Avoid degradation of the environmental, social and cultural resources of the study area.

CHAPTER IV

STAGE 1 FORMULATION

The formulation portion of this study involved exploring alternative methods of providing for future electric power within the Middle Atlantic Reliability Council area. It concentrated primarily on the evaluation of conventional and pumped storage hydroelectric generation. Other alternative measures were addressed to define the "State of the Art", their anticipated or potential role on the MAAC, and their relationship to the formulation of a detailed hydroelectric power development plan in the Lehigh Basin. This section summarizes a preliminary screening and evaluation of potential hydropower projects in the Basin including the rationale, criteria and procedures used. In addition, the criteria to be used and scope of projects to be evaluated in Stages 2 and 3, which have been identified from these preliminary investigations, is discussed.

MANAGEMENT MEASURES (ALTERNATIVES)

Based on the problems identified and the planning objectives defined in the preceeding section, several broad alternatives for meeting a portion of the power needs within the power marketing area have been identified. The following paragraphs describe in general terms each of these alternatives.

Conventional Hydroelectric Generation. Conventional hydroelectric developments convert the energy of natural or regulated streamflows falling through the head created by a dam to electric power.

Such plants may be classified as run-of-river or storage projects by the manner in which available streamflow is utilized and may be distinguished from pumped storage projects in that water comes to the plant as a result of natural means rather than by mechanical means such as pumping. The capacity of hydroelectric facilities of this type and the manner in which it is used depend on a number of factors. These include the available head and streamflow, reservoir storage capacity, and operating limitations imposed by other project purposes. The amount of capacity installed may also be limited by the electrical needs of the area within economical transmission distance.

Depending on the capacity of the facilities and their operating characteristics, the downstream discharge of water during generation may be of sufficient magnitude to create adverse environmental conditions. To mitigate this, it may be necessary to construct a downstream reregulating dam, which would serve to dampen the peak discharges that occur during generation to provide more uniform downstream flow.

Generally speaking, conventional hydropower facilities have both advantages and disadvantages. As contrasted to thermal power plants, hydropower plants neither consume nor heat the water in the river, nor do they contribute to air pollution. Because of their ability to be started quickly and to make rapid changes in power output, hydropower plants are well adapted for satisfying peak loads and for providing reserve capacity.

The maintenance costs of hydroelectric plants are relatively low, and in many instances, the plants can be designed for automatic or remote control operations.

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Long life, low depreciation expenses, and relatively predictable costs are additional advantages of hydropower plants. The generating units are more reliable than steam-electric units because they operate at relatively low speeds and the turbines are not subjected to temperature stresses. The total annual outage, both forced and for maintenance of hydroplants, is about one-fourth that for modern steam-electric plants.

The disadvantages often associated with hydropower developments include high capital costs, remote locations requiring long distance transmission lines, dependence on natural factors such as variable stream flows, operating restrictions imposed by other purposes of the project or competitive water uses, changes in aesthetic or scenic values associated with the plant itself and the transmission lines, and possible water quality problems associated with water discharged downstream from the dam.

Pumped Storage Generation. The basic components of a pumped storage project are a pumping generating unit and upper and lower storage reservoirs. The project generates electric power by releasing water from the upper to lower pool. During the off-peak hours, when the project capacity is not required by the system, water is pumped to the upper pool using energy generated by other sources, usually by large modern steam-electric units. A pumped storage project consumes more energy than it generates. Its economic advantage comes from converting low-value, low-cost, off-peak energy to high-value, on-peak capacity and energy and from the highly flexible peaking power it makes available.

Generally speaking, two types of pumped storage projects have developed. The first type is one in which pumped storage features are included in the design of a conventional hydroelectric installation. In this case, some of the streamflow is pumped back into the normal storage reservoir to provide greater capacity during peak-load periods. The second type is designed exclusively as a pumped storage project where power is generated by recirculating water between the lower and upper reservoirs. "Combined" projects in which water is pumped from a main stream reservoir to an upper pool and discharged into the stream channel below the main stream reservoir are also popular. An advantage of this design is that the pumping head is less than the generating head.

The combined pumped storage installation has several other significant advantages. A major increase in dependable capacity of a hydroelectric plant can be achieved by including pumped storage features. In many cases, sites having small stream flows and reservoir capacities can be economically developed as combined pumped storage installations, thus increasing significantly the number of sites which can be used for construction of hydroelectric peaking capacity. The upper reservoir of a combined project normally has a relatively large storage capacity and thus is capable of many more hours of generation than is feasible in pure pumped storage projects.

Pure pumped storage projects on the other hand offer some advantages unmatched by the combined projects. For example, large streams are not a prerequisite for pure pumped storage because the same water is recirculated between reservoirs. This feature opens up a wider selection of sites for possible development, some of which offer higher heads than those encountered in combination projects.

Pumped storage projects generally serve a dual purpose of providing system reserve and of storing excess thermal energy during off-peak hours and returning it to the system during peak hours. Storage time is normally a function of the project's assigned position in the system load curve and its planned reserve contribution.

A pumped storage plant, even with a very high head, can have the same favorable operating characteristics as a conventional hydroelectric plant--rapid startup and loading, long life, low operating and maintenance costs, and low outage rates. By pumping in the off-peak hours, the plant factor of the system's thermal units is improved, thus reducing severe cycling of these units and improving their efficiency and durability.

Pumped storage plants can play an important role in assuring system reliability, a factor of paramount importance. In addition, a pumped storage unit can be brought from partial load up to its full load in a matter of seconds. This provides a desirable source of spinning reserve capacity to protect a system where forced outages have caused the load to exceed the generation. In the event of an emergency on the system during the pumping cycle, the system load may be reduced quickly by dropping the pumping load to provide an effective form of quick load reduction. Pumped storage plants can also provide a source of startup power for steam-electric units.

Pumped storage capacity can be used to provide spinning reserve by operating the installation at partial load. When operated in this manner, the pumped storage plant in many cases can achieve overall system savings by reducing the portion of the required spinning reserves assigned to operating units and hot-standby in steam-electric plants.

While pumped storage capacity is expected to increase materially in the future, there are a number of factors which will limit the total capacity which might be developed. Pumped storage peaking projects are usually economical only when relatively high-head, high-capacity projects are developed. They are, therefore, best adapted to those areas where the terrain is favorable and where they can be used in large interconnected systems.

Since energy for pumping must be transmitted to the pumped storage installation and the peaking energy must be transmitted to load centers, the distance of a proposed site from the source of pumping energy and load centers may place a limit on the economic advantage of pumped storage as compared to alternative forms of peaking capacity.

There is ordinarily little need for development of pumped storage peaking capacity in systems which derive a large portion of their power supply from conventional hydroelectric sources since peaking capacity can usually be obtained at low cost by planning adequate initial capacity or utilizing opportunities to add capacity for peaking requirements.

There may also be limitations on the availability of adequate supplies of low-cost pumping energy since there are usually relatively few hours each week night when the more efficient base-load units are available to provide pumping energy.

In addition to the disadvantages mentioned previously for conventional installations, pumped storage projects require the creation of another reservoir which may increase two-fold the environmental and social problems associated with the overall project.

Nonstructural Measures. The Principles and Standards for Planning Water and Related Land Resources specify that a primarily nonstructural plan must be prepared and included as one alternative whenever structural project alternatives are considered. Energy related nonstructural measures would attempt to alleviate growth in energy demand through either voluntary or enforced conservation or through economic incentives. Nonstructural options as identified in the Principles and Standards may include (but not be limited to) reducing the level and/or time pattern of demand by time-of-day pricing; utility sponsored loans for insulation; appliance efficiency standards; educational programs; inter-regional power transfers; and increased transmission efficiency.

With regard to nonstructural measures, an important distinction must be made between measures that are currently or could reasonably be expected to be implemented through Federal, state and local policies and private actions in the absence of a project, and what a nonstructural project could additionally contribute to energy conservation. It is the current policy of utility planners to incorporate conservation measures in their energy forecasts, which are used to identify the need for additional electric power. A nonstructural alternative would have to take into account measures beyond what energy planners would otherwise forecast.

In addition to a nonstructural energy conservation plan, nonstructural options as related to flood control and possibly water supply can potentially impact on hydroelectric development. The Corps of Engineers Hydroelectric Engineering Center (HEC) under the National Hydroelectric Power Study is presently investigating the potential impact of providing nonstructural flood protection to lessen the need for reservoir flood control storage, and thereby provide the storage for additional hydroelectric generation. HEC has selected the Lehigh River Basin as one of several test cases to evaluate the validity of this alternative. Within a comprehensive framework this option could conceivably be expanded to consider the impact of water conservation to reduce the requirements for reservoir water supply storage.

Conventional Thermal Alternatives. Conventional thermal powerplants, both fossil (oil and coal) and nuclear fueled, will provide most of the added energy to the PJM system during the rest of the century. As noted in the previous chapter, one of the objectives of this investigation is to contribute to offsetting the use of non-renewable energy resources. With this view, conventional thermal developments will be used as a basis for evaluating the contributions of hydroelectric generation. Thermal plants are best suited to base load operation. However, they can also be used to produce power during peak demand periods, but at a reduced efficiency. Presently, the most probable alternative to hydropower peak hour operation would be conventional thermal power or combustion turbines.

Combustion Turbines. Combustion turbines burn high grade liquid fuels and natural gas. These units have a low first cost, offer quick starting, a wide choice of site locations, and can be readily automated, which make them particularly suitable as sources of peaking and emergency power. Within the PJM system, combustion turbines are extensively used for peaking operation. Due, however, to their requirements for high grade fuel, energy costs are high. As with thermal plants, because of their use of non-renewable fuel sources, combustion turbines will serve as an alternative to hydroelectric power development.

Unconventional Power Plants. Unconventional power sources include wind, solar, geothermal, tidal power and others. Although these sources have potential, in general, none appears to be a viable alternative at this time for large scale development. It is anticipated that further research will eventually provide the technology to make these sources cost competitive to the point where they can provide substantial conservation of non-renewable energy. However, this is not expected in the near future.

Other Hydroelectric Alternatives. In lieu of "conventional" hydroelectric development, hybrid systems such as a combination of hydroelectric facilities with wind or solar plants, and hydrogen producing hydroelectric plants offer a potential contribution. In addition, the concept of a no-head hydroelectric system has received some recent interest . "The State of the Art" of these systems, however, is in its infancy and the validity of these projects for large scale development remains to be tested.

In the last decade or so, thought has been given to the possibility of underground pumped storage. This approach requires the excavation of a large cavern at some depth below the ground surface. Recent research into this alternative has shown its competitiveness with "conventional" pumped storage schemes. It has the advantage of not being dependent on topographic considerations and eliminates the environmental consequences of a second surface reservoir. Should the concept be developed and proven within the time frame of this investigation it will be given consideration as an alternative measure

PLAN FORMULATION RATIONALE

The Principles and Standards for Planning Water and Related Land Resources require that Federal water and related land planning be directed to achieve National Economic Development (NED) and Environmental Quality (EQ) as equal national objectives. The selection of the most appropriate plan to meet these objectives, whether structural, nonstructural or a combination of both, requires a comparative evaluation using a select set of criteria.

Evaluation Criteria. The Principles and Standards specify four general evaluation criteria, including acceptability, completeness, effectiveness, and efficiency; and five others derived from the first four including, certainty, geographic scope, NED benefit-cost ratio, reversibility, and stability.

Acceptability of a plan is determined by analyzing its acceptance by concerned publics. A plan is acceptable if it is, or will likely be, supported by some significant segment of the public. However, during reiterations of the planning tasks, every attempt will be made to eliminate, to the extent possible, unacceptability to any significant segment of the public.

The completeness of a plan is determined by analyzing whether all necessary investments or other actions necessary to assure full attainment of the plan have been incorporated.

The effectiveness of a plan is determined by analyzing the technical performance of a plan and its contributions to the planning objectives.

The efficiency of a plan is determined by analyzing its ability to achieve the planning objectives and NED and EQ outputs in the least-cost way.

The certainty of a plan is determined by analyzing in general terms the likelihood that if the plan is implemented the planning objectives and the contributions to the NED and EQ accounts will be attained.

The geographic scope is determined by analyzing the relevancy of the geographic area encompassed by the plan; it must be large enough to encompass a full understanding of the problems and focused enough to make the proposed solutions effective.

The NED benefit-cost ratio of a plan is determined by analyzing the economic benefits in relationship to the economic costs.

The reversibility of a plan is determined by analyzing the capability, as public needs and values change or should unusual future circumstances so warrant, of restoring the partially or fully implemented plan to approximate the "without condition."

The stability of a plan is determined by analyzing the range of alternative futures, data and/or assumptions which can be meaningfully accommodated within the recommended plan or minor modifications thereof. Greater stability generally indicates a more desirable plan.

Formulation Of Screening Procedures. The primary purpose of this preliminary screening was to eliminate from further study those projects with no potential for economical development while maintaining projects for further study which have the characteristics for potential feasibility. In order to distinguish between the two, a set of criteria and procedures was developed based on sound engineering judgement and experience, and tested to assure the validity of results.

A two cycle screening procedure was selected for the Stage 1 analysis for conventional hydroelectric development. Cycle 1 was formulated to analyze only the 139 existing dams as identified by DER (see Table 19 in Chapter III). The selection of additional sites to be analyzed in Cycle 2, including breached dams, canal locks, undeveloped projects, and modified projects was based on the screening criteria established for Cycle 1. A separate evaluation of pumped storage projects was conducted and is presented in later paragraphs.

1. Cycle 1. The criteria and procedures established for Cycle 1 were based on discussions between Philadelphia District personnel and informal coordination with several individuals with recent experience in the field of small scale hydroelectric power development, including: Mr. Howard Mayo, Allis-Chalmers Corporation; Mr. Ed Gray, U.S. Department of Energy; and Mr. Darryl Davis, U.S. Corps of Engineers' Hydrologic Engineering Center.

Based on these coordination efforts two options were available to establish the screening criteria including: 1) A minimum capacity cutoff, and 2) a comparative assessment of sites available flow and head (physical characteristics) with other projects exhibiting economic feasiblity based on recent in-depth investigations. The first approach was considered as an expedient way to concentrate further efforts on these projects with larger kilowatt capacities and therefore of a larger value to a regional electrical system. However, in light of today's national energy situation the value of very small projects has increased either from a private use standpoint or when considering the potential effects of multiple project development in an electrical supply system. The second approach is more closely related to economic factors and was selected to establish the criteria for Cycle 1.

Criteria were developed based on a project that is considered marginally feasible. The project, which is currently under investigation, is located in Carlisle, Pennsylvania, with an eight foot power head and an average available flow of 300-400 cfs, or a combined head times flow value of 2400 to 3200. Using the Carlisle site as a basis, a head times flow value of 1000 was established as an absolute lower limit for the preliminary screening. As an estimate of average flows a value of 2 cfs/mi^2 was adopted which is representative of average runoff rates in the northeastern United States. This value was compared with gage data in the Lehigh Basin, verifying its applicability. Since 1000 cfs-ft $\div$ 2cfs/mi^2 = 500 mi^2-ft, the criteria established for Cycle 1 was a power head times drainage area value of 500.

2. Cycle 2. The purpose of the second screening cycle was to conduct a preliminary economic evaluation of the projects passing the physical

screening (Cycle 1), as well as an additional group of selected sites, and to estimate potential project capacity and energy. The economic evaluations were comparative rather than absolute. Economic evaluation criteria and procedures are established under The Principles and Standards for Planning Water and Related Land Resources and were in general adhered to in screening under Cycle 2.

The economic evaluations were conducted using a computer program developed by the Corps' Hydrologic Engineering Center ('HYDUR'). This program is an outgrowth of the program in use under the National Hydroelectric Power Study. The program utilizes streamflow duration techniques to calculate estimates of power and energy potential for run of river type projects and reconnaissance level costs at proposed hydropower installations. The technical procedures for estimating capacity and average annual energy are considered good for run of river projects, but inexact for storage projects because they do not analyze the sequential nature of flows and operating heads. However, the availability of storage at existing reservoirs or the potential use of storage at undeveloped projects for power production is an issue not easily defined, requiring more detailed investigations than could reasonably be accomplished in Stage 1.

Project cost estimates in the program were taken from a cost manual developed by the Corps' North Pacific Division for the National Hydroelectric Power Study. The procedures used were developed for reconnaissance level cost estimates of single-purpose power projects. The cost relationships, which are detailed in the NPD document were based on empirical curves associating project physical parameters to site component costs. All costs were in July 1978 dollars and required an update to current price levels, external to the program.

NPD developed cost curves for the powerplant, embankment, spillway, intake and outlet structures, waterway, and the reservoir acquisition and clearing costs. A provision to add any special cost items was also included. Investment costs consisted of a geographic factor, contingency factor, engineering overhead, and interest during construction. Annual project cost were determined by amortizing these costs and adding the annual operation, maintenance, and interim replacement costs.

Benefits, because of both the preliminary nature of the Stage 1 analysis and the relatively small size of all projects under investigation for conventional development (less than 25MW) were not measured by alternative generation costs. Project benefits will ultimately be determined by the amount for which the power can be sold to a local power utility or other purchaser on a site by site or systems basis taking into account operational character- istics, dependatility, and reliability. It is anticipated that project benefits will result primarily from energy production due to the inability of most run-of-river projects to produce dependable capacity, resulting from undependable streamflows. Therefore a generalized approach utilizing a possible sale value of energy was developed. The approach was geared to be optimistic and conservative in nature so as not to eliminate projects of value to any one or all potential customers, as well as to avoid overlooking project dependability if it exists, or the potential use of storage projects for peak power production which could potentially displace a more costly energy source.

A value of five cents per KWh (50 mills/KWh) of energy was selected as a measure of benefits for run-of-river projects. This value was based on discussions with member utilities of PJM, the Allegheny Electrical Cooperative, and the Corps' Institute for Water Resources who are currently conducting the National Hydroelectric Power Study (NHS). Billing rates in the PJM currently range from 15 mills/KWh, during baseload periods to approximately 80 mills/KWh, during peak demand periods, with an average rate of 27 to 30 mills/KWh. As most run-of-river projects would operate during baseload as well as peak periods the system average was considered most representative. The 50 mills/KWh was therefore derived by taking into account real fuel price escalation over the project life, as allowed by the Principles and Standards, and a contingency to allow for dependable capacity credits and uncertainty in future fuel price increases. Real fuel price escalation could potentially increase benefits by 40 or 50 percent in present worth terms based on data published by the Department of Energy in the Federal Register, 23 January 1980.

Due to the selection of a constant energy value as a measure of project benefits the Cycle 2 screening was conducted on a cost per KWh basis.

Economics. Economic evaluations were based on a Federal discount rate of 7-1/8 percent. All projects were evaluated in January 1980 dollars. A project life of 50 years was used for the assessment of conventional alternatives and a 100 year life was used for pumped storage projects. Pumped storage project costs were updated from the year of initial investigation using an average of indices from the Bureau of Reclamation and the Engineering News Record. This approach for project updating is outlined further in the NPD cost estimating manual for hydropower projects. Conventional project costs were updated from the July 1978 price level in the 'HYDUR' program using the same approach.

ANAYSIS OF PLANS CONSIDERED IN STAGE 1

The Stage 1 analysis concentrated on single site evaluations of existing dams and assessments of previously analyzed undeveloped projects for conventional and pumped storage hydroelectric generation.

A primarily nonstructural solution could not be evaluated during this preliminary stage due to the extensive requirements to identify measures currently in use, or which could be potentially implemented in the foreseeable future by other interests. Unconventional powerplants, due to technological limitations, were not considered viable alternatives in this investigation. Alternative hydropower systems such as underground pumped storage systems or hydrogen producing hydroelectric facilities were not evaluated during Stage 1 due to the limitations of available design and construction data. These alternatives, however, may be evaluated in subsequent stages of this study if futher research on the "State of the Art" indicates potential feasibility. Both thermal and combustion turbines represent the least cost alternatives to hydro development and through a generalized approach formed the basis for economic evaluations.

Cycle 1. Of the 139 existing dams in the Lehigh Basin, twelve passed the cycle 1 screening with a head times drainage area value greater than 500.

Table 20 lists those projects. In addition to the twelve projects, three projects were selected which failed to meet the criteria by various degrees in order to test the validity of the approach. These projects are listed in Table 21.

TABLE 20

PROJECTS PASSING CYCLE 1 SCREENING

Project Name	Head	Drainage Area	Head x D.A.
F. E. Walter Dam	62	288.0	17,856
Beltzville Lake	128	96.3	12,327
Wild Creek Reservoir	98	22.0	2,156
Penn Forest Reservoir	111	16.5	1831.5
Pocono Lake	26	75.2	1955.2
Pohopoco Creek Dam	18	105.0	1890.0
Bear Creek Dam	17	35.2	598.4
Easton Dam (No. 8)	11.5	1373.0	15,790
Allentown Dam (No. 6)	8.2	1129.0	9,258
Treichler's Dam (No. 4)	11.0	892.0	9,812
Little Lehigh Creek Dam	8	187.0	1496.0
Hokendauqua Creek Supply Dam	12	42.0	504

TABLE 21
TEST PROJECTS

Project Name	Head	Drainage Area	Head x D.A.
Mahoning Creek Dam	11	36.3	399.3
Illicks Mill Dam	10	47.7	477.0
Lake Hauto	33	9.7	320.0

Cycle 2. All projects listed in Tables 20 and 21 were evaluated using the 'HYDUR' program in Cycle 2. In addition 18 other sites were selected as listed in Table 22 including six locks and six breached dams along the Lehigh Canal (one dam was recently reconstructed and did not appear on the

DER inventory), one lock along the Delaware canal, one undeveloped project previously analyzed by FERC, three undeveloped Corps projects, and one authorized Corps modification. These projects are located on Plate 5.

TABLE 22
ADDITIONAL PROJECTS CONSIDERED IN CYCLE 2

Site	Head (Ft)	Drainage Area (mi^2)
Lehigh Canal Dams		
Mauch Chunk Dam	12.6	577.0
Parryville Dam	10.8	727.0
Lehigh Gap Dam	5.6	855.0
Laury's Station Dam	13.1	928.0
Hokendauqua Dam	7.2	975.0
Chain Dam (rebuilt 1973)	10.6	1,323.0
Lehigh Canal Locks		
Lock # 2	21.8	-
Lock #15	20.1	-
Lock #23	16.9	-
Lock #39	11.2	-
Lock #41	19.7	-
Lock #47	22.0	-
Delaware Canal Locks		
Lock #23	30	-
Undeveloped Projects (FERC)		
Penn Haven	130	459
Undeveloped Projects (Corps)		
Aquashicola	63	66
Trexler	98	51
Tobyhanna	125	224
Modified Projects		
F.E. Walter Dam	188	288

The level of detail of Cycle 2 analysis was of necessity constrained by the availability of site data and therefore required certain project related assumptions. From an economic standpoint the only costs included in the analysis were those of the powerplant, including the turbine, generator, switchyard, and related civil, mechanical, and electrical costs. Costs for intake and outlet works, penstocks, and transmission lines were excluded from the preliminary analysis due to the detailed effort that would be required to identify these site specific costs. In the case of undeveloped projects, embankment and other costs were not included unless the dam was a single-purpose hydro project and the other data was readily available as in the case of the Penn Haven Reservoir, previously analyzed by FERC.

Project flow duration curves were developed by selecting a gage with flow characteristics representative of the project area, and using the 'HYDUR' program, adjusting gage flows to the site by a simple drainage area ratio. Project capacity and energy were calculated for a range of design flows, and preliminarily sized on a minimum cost per KWh basis. Use of project storage was not taken into consideration and could significantly alter project sizing under more detailed investigations, for those projects having a large amount of storage available for use in hydropower operations. In order to assess the potential power development within the Lehigh and Delaware canals it was assumed that the original channel capacity of the canal could be reestablished. (Costs for reconstruction were not included.)

The original Lehigh canal had a forty-five foot base width, a sixty foot top width and was five foot deep. Historically the canal velocity was limited to two fps to allow barges pulled by mules to travel upstream. It was assumed that the velocity under current circumstances could be increased to four fps., taking into account both structural considerations (avoiding the need for rip-rap protection) and aesthetic factors. Therefore the maximum canal flow would be limited to 1050 cfs. During low flow periods canal flow would be limited by mainstem requirements. Minimum flow requirements in the mainstem Lehigh River were estimated by extrapolating the seven-day 10-year low flow (Q 7-10 flow) requirements below the F. E. Walter Reservoir and Beltzville Lake to the canal area by simple drainage area adjustment with a 20 percent factor of safety. Q 7-10 requirements below Walter and Beltzville were both, on a drainage area basis, about 0.2 cfs/mi^2. Throughout the canal length these flows ranged from 140 to 330 cfs and were considered unavailable for diversion to the canal for power production.

Power production in the Delaware canal was evaluated under similar assumptions. The original canal had a 30 foot base width, 40 foot top width with a five foot depth. Assuming a four fps velocity the maximum canal flow would be 700 cfs. Minimum mainstem flows however, were not considered due to the discharge over Easton Dam directly into the Delaware River. In addition to the general assumptions discussed above certain site specific assumptions were required as follows:

- F. E. Walter & Beltzville: Reallocation of overall project costs were not considered.
- F. E. Walter (Modified) Project: No modification costs were allocated to power.
- Trexler & Aquashicola: No construction costs were allocated to power.
- Penn Haven: Q 7-10 flows would be maintained below the reservoir. Dam and tunnel costs were updated from FERC estimates.

The results of the Cycle 2 screening are presented in Table 23. It should be noted that those projects selected to test the Cycle 1 criteria had energy costs ranging from 206 to 280, well above the 50 mills/KWh criteria required for further study.

TABLE 23
RESULTS OF CYCLE 2 SCREENING

Site	Design Flow (cfs)	Capacity (KW)	Energy (MWH)	Energy Cost (mills/KWh)
F. E. Walter (existing)	564	2136	14610	15.50
F. E. Walter (modified)	282	3325	28686	13.74
Beltzville	110	888	7133	22.19
Wild Creek	47	339	2208	47.15
Penn Forest	33	270	1819	43.76
Pocono Lake	152	287	1897	64.14
Pohopoco Cr. Dam	189	248	1535	85.16
Bear Cr. Dam	80	99	624	136.87
Easton Dam	1955	1636	11784	36.34
Allentown Dam	1888	1126	7517	49.59
Treichler's Dam	1627	1302	8733	44.11
Little Lehigh Cr. Dam	191	111	846	133.13
Hokendauqua Cr. Supply Dam	62	54	320	254.19
Mohoning Cr. Dam	108	86	463	211.80
Illicks Mill Dam	69	50	301	279.59
Lake Hauto Dam	34	67	320	205.93
Mauch Chunk Dam	1010	925	6341	47.82
Parryville Dam	1431	1125	7309	49.59
Lehigh Gap Dam	1636	666	4380	65.03
Laury's Station Dam	1545	1473	10303	36.80
Hokendauqua Dam	1652	865	6023	54.15
Chain Dam	1962	1513	10678	39.70
Lock # 2	838	1329	8767	31.56
Lock #15	822	1203	8746	30.93
Lock #23	943	1160	8319	34.89
Lock #39	926	754	5740	50.37
Lock #41	925	1325	10239	28.13
Lock #47	905	1449	11805	24.48
Lock #23 (Delaware Canal)	615	1343	12993	18.32
Penn Haven Dam	1868	17670	63663	33.45
Trexler Lake	78	559	2951	44.13
Aquashicola Lake	112	513	3425	44.56
Tobyhanna Dam	213	1942	16299	16.77

Pumped Storage Evaluation. As identified in Chapter I, several pumped storage projects have been evaluated by both the Corps and FERC within the Lehigh River Basin. The purpose of this Stage 1 analysis was to reinvestigate the economic feasibility of these projects to determine if further studies are warranted.

Previous Corps investigations in the Basin centered on the development of either a pumped storage or conventional system utilizing some combination of the Tobyhanna, Beltzville, Stoney Creek, Mud Run, Bear Creek (tributary reservoir), and Francis E. Walter Reservoirs. Investigations conducted during the Comprehensive Survey of the Water Resources of the Delaware River Basin in the late 1950's narrowed the alternatives to four pumped storage schemes using Tobyhanna, Stoney Creek and Beltzville Lake. These four schemes were selected due to relatively more favorable economics and a significant increase in capacity and energy production over the other alternatives evaluated. For Stage 1, these four alternatives, for which detailed project data was available, were selected to test the current economics of the proposed alternatives.

Tables 24 and 25, and Plates 6 through 11 describe the pertinent characteristics of the projects under investigation, including four additional projects previously investigated by FERC. No attempt was made during this preliminary analysis to investigate alternative project sizings or alternative configurations. It should be noted that all previous investigations were conducted at a preliminary level of detail. The projects investigated by FERC did not take into account environmental or social constraints and are considered to be sized at a maximum level.

TABLE 24
FERC PUMPED STORAGE INVESTIGATIONS
LEHIGH RIVER BASIN
PROJECT CHARACTERISTICS

Project Data	PROJECT Kunkletown	Pohopoco Mtn # 1	Pohopoco Mtn # 2	Pohopoco Mtn # 3
Upper Reservoir: Elev. bottom	1,540	1,640	1,500	2,000
Elev. Max. Power Pool	1,596	1,736	1,566	2,085
Elev. Min. Power Pool	1,548	1,680	1,504	2,004
Gross Storage, Ac-Ft	29,000	28,400	1,400	7,000
Usable Power Stor. Ac-Ft	27,000	25,600	7,000	6,700
Hours full load use	8	8	8	8
Dead Storage, Ac-Ft	2,000	2,800	400	300
Lower Reservoir: Elev. bottom	500			1,120
Elev. Max. Power Pool	626	1,040	840	1,200
Elev. Min. Power Pool	540	1,000	820	1,132
Gross Storage, Ac-Ft	28,000	25,600	7,000	6,800
Usable Power Stor. Ac-Ft	27,000	25,600	7,000	6,700
Dead Storage, Ac-Ft	1,000			100
Waterway				
Type	lined tun.	lined tun.	lined tun.	lined tun.
Size - length & diam.	2,600	5,900	6,600	7,600
Static Head,. Ft.:				
Maximum	1,056	736	746	953
Minimum	922	640	684	804
Average	983	690	723	881
Installation, KW:				
Conventional				
Reversible	2,970,000	1,950,000	553,000	648,000
Capability at Min. Hd.	2,801,000	1,843,000	539,000	455,000
Generation, 1000 KWh:				
Average Annual	6,180,000	4,060,000	1,150,000	1,350,000
Pumping Energy	9,270,000	6,090,000	1,725,000	2,025,000

TABLE 25

TOBYHANNA-BELTZVILLE PUMPED STORAGE PROJECT
SUMMARY OF PERTINENT DATA

	Plan I With Tobyhanna plus Pumping at Beltzville	Plan II Without Tobyhanna 100% Pumping at Beltzville	Plan III Without Tobyhanna 100% Pumping at Beltzville	Plan IV Without Tobyhanna 100% Pumping at Beltzville
Installed Capacity - Pumped Storage Plant				
Generation - KW	300,000	300,000	200,000	400,000
- cfs	4,520 @ 74 hrs/wk	4,520 @ 74 hrs/wk	3,013 @ 74 hrs/wk	6,026 @ 71 hrs/wk
Pumping - KW	350,000	455,000	304,000	607,000
- cfs	3,560 @ 71 hrs/wk	4,650 @ 71 hrs/wk	3,100 @ 71 hrs/wk	6,200 @ 71 hrs/wk
Gross Head Feet	965	955	963	960
Annual Output - Million KWh				
2. From natural flow	239	-	-	-
3. From pumping	476	715	477	953
4. From fuel	-	-	-	-
5. Total	715	715	477	953
6. Annual - Pumping Energy - Million KWh	749	1,036	692	1,382
Tobyhanna Reservoir				
Full pool elevation, feet	1,542	-	-	-
Minimum pool elevation, feet	1,490	-	-	-
Usable storage, 1,000 acre-ft.	85.0	-	-	-
Minimum flow cfs	230			
Average flow, cfs	462			
Capacity factor, percent -				
minimum flow	20.9			
average flow	38.0			
Pumping energy required to Stoney Creek, KWh	57,500,000	-	-	-
Tunnel - Tobyhanna to Stoney Creek				
Length - miles	9.7	-	-	-
Inside Diameter, feet	9.5			
Velocity, fps	750			

TABLE 25 (Cont'd)

TOBYHANNA-BELTZVILLE PUMPED STORAGE PROJECT
SUMMARY OF PERTINENT DATA

Stoney Creek Reservoir				
Storage required, acre-ft.	20,000	20,000	13,500	27,000
Full pool elevation, feet	1,560	1,560	1,547	1,565
Tunnel - Stoney Creek to Powerhouse				
Length, miles	4.1	4.1	4.1	4.1
Diameter, feet	20	20	16.7	23.6
Velocity, fps	14	14	14	14
Friction loss, feet	55	55	66.5	45.8
Tailrace Channel				
Length, feet	4,580	4,580	4,580	4,580
Bottom width, feet	40	40	30	55
Water depth, feet	20	20	20	20
Beltzville Reservoir				
Pondage required, acre-ft.	12,800 Weekly Pondage	17,000 Weekly Pondage	11,300 Weekly Pondage	22,700 Weekly Pondage

Project evaluation consisted of an update of project first costs from the year of initial investigation to a January 1980 price level plus a contingency of 25 percent and E&D/S&A costs of 17.5 percent. In addition, total investment costs were calculated to include interest during construction based on a six year construction period.

Annual costs were calculated based on an ammortized investment cost plus O&M&R expenses estimated from the North Pacific Division cost estimating manual for hydropower evaluations. Annual pumping costs were estimated based on the price of energy from coal-fired plants in the PJM system. Estimates of pumping energy requirements for the FERC projects were based on a three to two ratio of energy produced from the projects, consistent with the requirements of existing pumped storage facilities. Annual project benefits were evaluated utilizing generalized capacity and energy values for peaking power, based on an annual capacity factor of 25 percent. These generalized values based on capacity factor and the alternative displaced were supplied by FERC and are shown in Table 26. Pumping energy based on this table was valued at 15.5 mills/KWh for the preliminary investigation, based on discussions with FERC. Stage 2 investigations will require a more extensive analysis to define both the amount of energy available for pumping in the PJM area and its actual value. However, due to the abundance of coal resources and the heavy utilization of coal fired units in the PJM, and based on discussions with FERC, 15.5 mills/KWh was considered a reasonable value for preliminary investigations. Peaking energy and capacity based on a capacity factor of 25 percent were valued at 49 mills/KWh and $42/KW respectively.

(revised 12/80)

TABLE 26
FERC CAPACITY AND ENERGY VALUES
JANUARY 1980

Hydro Capacity Factor	Capacity Value ($/KW-yr) 1/	Energy Value (mills/KWh) 1/
	Combustion Turbine Alternative	
0	32	-
5	21	78
10	21	65
15	21	61
	Combined Cycle Alternatives	
20	42	48
25	42	49
30	42	50
	Nuclear Alternatives	
40	63	6
50	97	6
60	120	6
70	120	7
80	120	8
90	120	9
100	120	8
	Coal Fired Alternative	
40	92	7
50	92	15
60	92	16
70	92	17
80	92	17
90	92	17
100	92	15

1/ Based on the Federal Discount Rate

(revised 12/80)

Table 27 presents the results of the updated economic evaluation. All of the projects investigated exhibited at least marginal feasibility due primarily to the high value of peaking energy.

STAGE 1 CONCLUSIONS

Based on the analysis of existing dams, breached dams, locks and undeveloped projects for conventional development, and an analysis of previously evaluated pumped storage projects the 29 sites listed in Table 28 have been identified for further investigation during Stage 2. It should be noted that during the early portion of Stage 2 a location study will be undertaken to identify other potential new locations for hydroelectric development, particularly with regard to pumped storage power.

The following paragraphs present a summary of the projects investigated during Stage 1, and discuss pertinent issues which could potentially impact or play an important role during further study stages.

Nine dams originally constructed in connection with the Lehigh Canal were investigated. The Allentown Dam will be reconstructed shortly by the Commonwealth of Pennsylvania. At the request of the City of Allentown, consideration is being given to installing a small hydropower unit at the time of reconstruction. Easton and Chain Dams are in good condition as a result of reconstruction. Both are being investigated for hydropower additions by private interests. All three of these, plus Triechler's Dam, show good potential for hydropower additions with no major work on the dams themselves (other than the referenced reconstruction of Allentown Dam).

TABLE 27
PUMPED STORAGE PROJECTS
ECONOMIC EVALUATION

ITEM	KUNKLETOWN	POHOPOCO MOUNTAIN PLAN # 1	PLAN # 2	PLAN # 3	TOBYHANNA - [illegible] PLAN # I	PLAN # II	PLAN # III	PLAN # IV
PROJECT COST ESTIMATE:								
Power Plant Cost (FERC)	381,863,700	278,144,200	79,050,700	88,433,600	70,818,600	[illegible]	[illegible]	49,[illegible]
Total First Cost (FERC)	512,150,000	388,699,600	134,646,100	176,125,000	277,426,560	167,249,010	118,588,430	219,541,200
Contingency (25%)	153,040,000	97,166,650	33,661,500	44,030,800	69,356,640	41,812,250	[illegible]	54,882,800
E&D S=A (17.5%)	133,910,000	85,020,800	29,453,800	38,526,900	60,687,060	36,583,720	[illegible]	48,[illegible]
Total Project Cost	899,100,000	570,854,100	197,761,500	258,680,700	407,470,260	245,646,980	174,514,430	322,519,000
Interest During Construction	198,548,000	126,061,700	43,671,000	57,124,500	89,981,700	54,246,220	35,560,100	71,177,700
Total Investment Cost	1,097,648,000	696,915,800	241,433,200	315,805,200	497,451,960	299,893,200	213,174,530	393,496,700
ANNUAL COSTS:								
Ammortized Cost	78,288,000	49,706,000	17,219,800	22,524,200	35,480,000	21,384,000	15,204,000	28,965,000
O&M Costs	4,000,000	2,700,000	900,000	1,000,000	550,000	550,000	400,000	700,000
Replacement Costs	5,966,600	4,346,000	1,235,200	1,381,800	3,125,000	2,913,270	1,557,600	3,428,900
Pumping Costs (@$15.5/MWh)	143,690,000	94,395,000	26,737,500	31,387,500	11,609,500	16,058,000	10,726,300	21,421,000
TOTAL ANNUAL COSTS	231,945,000	151,147,000	46,092,500	56,293,500	50,764,500	40,910,000	28,185,000	55,515,000
PROJECT BENEFITS:								
CAPACITY BENEFIT (@$42/KW-yr)	124,740,000	81,900,000	23,226,000	27,216,000	12,600,000	12,600,000	8,400,000	16,800,000
ENERGY BENEFIT (@$49/MWh-yr)	302,820,000	198,940,000	56,350,000	66,150,000	35,035,000	35,035,000	25,375,000	46,697,000
TOTAL ANNUAL BENEFIT	427,560,000	280,840,000	79,576,000	93,366,000	47,635,000	47,635,000	31,775,000	63,497,000
BENEFIT COST RATIO	1.85	1.86	1.73	1.66	0.94	1.17	1.13	1.15

(revised 12/80)

TABLE 28
SITES SELECTED FOR FURTHER
STUDY IN STAGE 2

Lehigh Canal Dams	Allentown Dam
	Easton Dam
	Chain Dam
	Treichler's Dam
	Mauch Chunk Dam
	Parryville Dam
	Laury's Station Dam
Lehigh Canal Locks	Lock No. 2
	Lock No. 15
	Lock No. 23
	Lock No. 41
	Lock No. 47
Delaware Canal Locks	Lock No. 23
Existing Corps Projects	Beltzville Dam
	F. E. Walter Dam
Authorized Corps Projects	F. E. Walter Dam (modified)
	Aquashicola Dam
Non-Federal Dams on Tributaries	Wild Creek Dam
	Penn Forest Dam
Undeveloped Sites (conventional)	Tobyhanna Site
	Penn Haven Site
Undeveloped Sites (Pumped Storage)	Kunkletown
	Pohopoco Mountain No. 1
	Pohopoco Mountain No. 2
	Pohopoco Mountain No. 3
	Tobyhanna-Beltzville No. I
	Tobyhanna-Beltzville No. II
	Tobyhanna-Beltzville No. III
	Tobyhanna-Beltzville No. IV

The other five canal dams, at Mauch Chunk, Parryville, Lehigh Gap, Laury's Station, and Hokendauqua, would require considerable repair or complete reconstruction in order to be usable for hydropower generation. The Lehigh Gap and Hokendauqua dams do not appear to be economical sites. The other three have potential for hydropower development since there is some interest in repairing or rebuilding the dams for historical and recreational reasons.

Generation of power at six locks along the Lehigh Canal and one along the Delaware Canal was considered. All except one were found to be economical. Lehigh Canal Locks 2, 15, 23, 41, and 47 and Delaware Canal Lock 23 are in watered canal segments but may need some work on the dams diverting the water into the canals (in the cases of Lehigh Canal Locks 2, 15, and 23), some work to increase the capacity of the canal itself, and some repair and modification of the locks to allow them to accept a hydropower addition. Some of this work would be beneficial from the aesthetic, historical, and recreational viewpoints. Lock 39 is in a dewatered canal section which could be rewatered only if the Hokendauqua Dam were reconstructed. In addition, its energy cost slightly exceeds the 50 mills/KWh cutoff. This lock along with the Lehigh Gap and Hokendauqua dams as well as the Pohopoco Dam and Pocono Lake, which are discussed in later paragraphs, had energy costs ranging up to 85 mills/KWh. Although these projects will not be considered further in this investigation they represent the most likely long range hydro alternatives in the Basin should energy costs substantially increase to justify their development.

Two existing Corps of Engineers projects were considered: Beltzville and Francis E. Walter Dam. The authorized water supply modification to Walter

Dam was also considered. All three showed favorable economics. If developed as run-of-river hydropower plants, impacts on authorized project purposes would be minimal.

If developed as hydro-peaking projects utilizing reservoir storage, the value of the generating capacity would be increased considerably, but only at the expense of other purposes such as water supply, recreation, and flood control. Evaluation of this trade-off will necessitate reservoir reregulation studies using a sequential routing analysis.

Two Federal projects which were authorized but never constructed were evaluated. Neither the Trexler site not the Aquashicola site were found to be good sites for single purpose hydropower projects due to the relatively small streamflows at both sites and the large costs for construction of new dams and reservoirs. In both cases, however, hydropower development does show promise when considered as an add-on to the authorized multi-purpose project. Inclusion of run-of-river type hydropower plants in these projects during construction would have only minimal impacts on the authorized project purposes. In view of the strong opposition to the Trexler project which was encountered during Engineering and Design, including a referendum vote opposing the project by Lehigh County voters; the continued opposition as expressed at the 29 January 1980 Lehigh Hydropower Study public meeting; and the decision to remove the project from the State Water Plan, due to alternative water supply solutions, the generation of hydroelectric power in connection with the Trexler project will not be considered further in this study. In regard to the Aquashicola project, there is the potential to allocate some storage to hydropower and use the facility as a peaking plant.

Evaluation of this will require a reservoir reregulation study using a sequential routing analysis. It should be noted that construction of either the Trexler or Aquashicola projects would likely have significant environmental and social impacts.

Ten non-federal dams located on tributaries of the Lehigh River were considered. The Little Lehigh Creek Dam, Hokendauqua Creek Supply Dam, Illick's Mill Dam, Lake Hauto Dam, Mahoning Creek Dam, Pohopoco Creek Dam, and Pocono Lake Dam were found to be uneconomical for hydropower development. Wild Creek and Penn Forest Reservoirs show potential for hydropower additions and will be considered further in Stage 2. The City of Bethlehem, owner of both reservoirs, has initiated hydropower studies on Penn Forest Rerservoir. Both are used for municipal water supply and any hydropower developments would have to avoid conflicts with that use.

Two undeveloped sites that have been proposed for development previously, the Tobyhanna and Penn Haven sites, were considered for conventional hydropower development. Both show the potential for economic justification and will be studied further. It should be noted however, that these projects may have considerable environmental and social impacts. The Penn Haven project is in a reach expected to be designated as a scenic river by the Commonwealth of Pennsylvania. Both projects, and particularly the Tobyhanna project with its greater storage, would have multi-purpose potential. Storage could possibly be utilized for flood control, recreation, water supply, and other uses. This will be investigated during Stage 2.

Eight previously proposed pumped-storage hydropower projects were considered and found to be potentially feasible based on updates of benefits and costs previously reported.

The Kunkletown project would use a new reservoir on Aquashicola Creek as a lower reservoir with an upper reservoir atop an adjacent mountain. The first two Pohopoco Mountain projects would require modifying existing Penn Forest and Wild Creek Reservoirs, respectively, as lower reservoirs with new upper reservoirs on high ground nearby. The third Pohopoco Mountain project would be located in the same area but would require two new reservoirs. The Tobyhanna-Beltzville project (Plan No. I) would also include construction of two new reservoirs with releases being made into Beltzville Lake. It should be noted that an analysis during Stage 2 will be conducted to assess the utilization of the modified Francis E. Walter project in lieu of the Tobyhanna Reservoir in Plan No. I. Plans II, III, and IV are variations of this project requiring construction of only one additional reservoir. All of these projects would involve the construction of one or two additional reservoirs with all of the potential environmental and social impacts associated with such projects. Those utilizing existing reservoirs will have to be carefully evaluated to ensure that incorporation into the pumped-storage project would not interfere with the existing reservoirs' uses.

CHAPTER V

VIEWS OF CONCERNED INTERESTS

During the course of the investigation, the Philadelphia District maintained a coordination effort with other Federal agencies, State agencies, local government, and private interests. The study initiation was formally announced by public notice in November 1979. Subsequently an initial public meeting was conducted on 29 January 1980 in order to permit a full expression of opinions concerning water related issues and the development of hydroelectric power in the Lehigh basin.

The meeting began with a presentation by Col. James Ton, District Engineer, and John Tunnell, Chief, Basin Planning Section. This presentation included an overview of the Corps of Engineers role in the development of hydropower nationally, a general discussion of what hydropower is, a synopsis of previous and current hydropower and related studies in the Lehigh River Basin, and a discussion of Corps planning procedures. Those in attendance were then given an opportunity to deliver prepared statements, give their opinions on hydropower, and ask questions about the study. Strong support for development of hydropower in the Lehigh Basin was evident, particularly with regard to hydropower additions. A number of local and county officials objected to DRBC's decision to file for preliminary permits on F.E. Walter and Beltzville Dams. As a result of several misleading news reports, many Lehigh County residents attended for the purpose of expressing their continued opposition to the Trexler Dam and lake project. Table 29 presents a summary of the views expressed at the initial public meeting. Selected correspondence received in connection with the study initiation and the public meeting are included in Appendix A.

Additional views were obtained through informal discussions and a formal coordination meeting. The meeting was held in Philadelphia on 30 May 1980 with the U.S. Department of Energy (DOE) and all feasibility study loan applicants in the Lehigh basin. These loans are being made under DOE's Small Scale Hydro Program. Applications have been made for loans to conduct hydropower studies on Francis E. Walter Dam, Beltzville Dam, Penn Forest Dam, and Chain Dam. The purpose of the meeting was to review the ongoing hydropower work in the Lehigh basin and to discuss ways to coordinate the various efforts and avoid duplication of effort. The purposes of and current status of the National Hydroelectric Power Study were summarized. The Lehigh Hydropower Study and its relationship to non-federal site specific studies was discussed. The applicants generally expressed their desire for their site specific studies to procede as quickly as possible, particularly at non-federal dams. All attendees agreed that each hydropower site should be developed to its optimum. The formation of a progress and information exchange committee for the Lehigh Study was discussed and generally agreed to.

During Stage 1, the Philadelphia District has reviewed preliminary permit applications that FERC had received on Beltzville, F.E. Walter, and Chain Dams. Competing applications were filed by the Borough of Lehighton and the DRBC - Pennsylvania Department of Environmental Resources (DER) on Beltzville Dam. Competing applications were filed by the Borough of Lehighton, DRBC-DER, the Borough of Weatherly, and the Pennsylvania Hydroelectric Development Corporation on F.E. Walter Dam. The Chain Dam Hydroelectric Corporation filed an application on Chain Dam. These applications were reviewed and comments were forwarded to FERC by the Office of the Chief of Engineers.

TABLE 29
DIGEST OF COMMENTS 1/
29 JANUARY 1979 INITIAL PUBLIC MEETING

- Mike Krajsa, a Congressional candidate, expressed support for the development of hydroelectric power in the Lehigh Basin and expressed opposition to the construction of Trexler Dam.

- Bruce Conrad, Planning Director for the Carbon County Planning Commission, expressed support for Lehighton and Weatherly Boroughs' proposals to develop the hydroelectric power potential at F.E. Walter and Beltzville Dams. He opposed DRBC development of hydroelectric power facilities.

- Mortimer Smedley, Borough Manager of Lehighton, reviewed Lehighton's past efforts to have the Corps study hydropower in the Lehigh Basin, reviewed the communications between Lehighton and DRBC concerning hydro additions at F.E. Walter and Beltzville Dams, and expressed Lehighton's continued interest in hydropower development.

- David Altrichter, Mayor of Slatington, stated that Lehigh County residents voted 3 to 1 against construction of Trexler Dam.

- Paul McHale of the Lehigh Valley Sierra Club called for the deauthorization of the Trexler Dam project and expressed support for development of hydroelectric power at existing dams.

- John McSparren, Director of the Bureau of Resources Planning of the Pennsylvania Department of Environmental Resources, stated that they applied for preliminary permits on F.E. Walter and Beltzville in conjunction with DRBC because of the large investment the State has already made in these projects.

- Larry Gleeson, President of Pennsylvania Hydro Development Corporation expressed concern that the Lehigh Study may delay his firm's implementation of a hydropower addition at Easton Dam.

- Joseph Zeller, a Pennsylvania State Legislator, expressed opposition to the construction of Trexler Dam.

- John Thomas, Business Representative for the Operating Engineers Union, expressed support for the hydropower study.

- Jeffry Schmidt of the Pennsylvania Sierra Club expressed opposition to the construction of Trexler Dam and expressed support for the development of hydroelectric power at existing dams.

1/ Comments are summarized from "Transcript, Initial Public Meeting, 29 January 1980, Lehigh River Basin Hydropower Study," which is available to the public at the cost of reproduction.

TABLE 29 (Cont'd)
DIGEST OF COMMENTS 1/
29 JANUARY 1979 INITIAL PUBLIC MEETING

- Robert Miller of the Northwestern Lehigh Citizens Coalition expressed support for hydropower development in the Lehigh Basin and opposition to the Trexler project.

- Joseph Nester, Planning Coordinator for the Lehigh Canal Recreation Commission expressed support for Lehighton's hydropower plans, opposition to DRBC's plans, and requested that the Corps consider the Lehigh Canal in their study.

- William Buskirk, Jr., representing the Lehigh-Pocono Committee of Concern, expressed that organizations opposition to the construction of Trexler Dam.

- Michael Bednar, a resident of Whitehall, Pa., expressed opposition to any study of hydropower at the Trexler site, but suggested consideration of the Allentown, Hokendauqua, Cementon, Laury's Station, Bowmanstown, Treichlers, and Lehigh Gap sites.

- David Fink of the Lehigh County Farmers Association requested that farmers needs of water for irrigation be considered in investigating any hydropower projects.

- Eugene Pattishall, Vice President of the Northwestern Citizens Coalition of Lehigh County, expressed support for development of hydroelectric power at existing dams and opposed any consideration of the Trexler site.

- Arlene Wallach, representing Citizens of Lehigh County Against the Dam, expressed opposition to the construction of Trexler Dam.

- Robert Zovak, President of the Carbon County Sportsman's Association, commented that fish ladders should be provided on main stem dams that are rebuilt for hydropower and also expressed opposition to fluctuations in river flow for either hydropower or white water rafting purposes.

- Jim Ord, a resident of Palmerton, Pa., expressed support for producing hydroelectric power at existing dams and expressed opposition to construction of new dams, particularly the proposed Aquashicola Dam.

- Willard Kresge of Utility Engineers, Inc., an engineering consultant to the Borough of Weatherly, expressed support for the Borough of Lehighton's position regarding hydro development of F.E. Walter Dam.

- Keen Holland of Berger Associates, Architects, Engineers, and Planners requested that the Corps consider the possible value of hydroelectric power to municipalities as well as to utility companies.

CHAPTER VI

STUDY MANAGEMENT

INTRODUCTION

The management of the Lehigh River Basin Hydroelectric Power Study is the responsibility of the Planning/Engineering Division, Philadelphia District. The study is currently scheduled for completion in Fiscal Year 1986 at a cost of $1,796,000 at September 1980 prices.

The planning process employed in the study will be consistent with the Water Resources Council's Principles and Standards. The Corps' water resources planning guidelines (ER series 1105-2-2XX and related regulations) will be followed in conducting the study. The study planning process will be an iterative one consisting of four functional tasks: problem identification; formulation of alternatives; impact assessment; and evaluation of alternatives.

The initial iteration of the planning process (Stage 1) has been completed and the results are presented in Chapter IV. From the initial screening, [illegible] alternatives were identified to be evaluated in future iterations of the [illegible]. From this nucleus, other plans which attempt to address a [illegible]'s planning objectives will be identified. A National [illegible] (NED) plan, an Environmental Quality (EQ) plan, and a [illegible] structural plan will be developed.

[illegible] will concentrate on the formulation and evaluation of [illegible] progressing through the iterations of Stage 2, efforts will [illegible] in order to accurately determine project feasibility [illegible] of various alternative plans.

The third and final stage of this study will concentrate on detailed planning and final formulation toward a recommended plan. For those alternatives selected for detailed study, emphasis will be placed on defining the economic, social, environmental, and regional development impacts of each alternative and presenting a detailed evaluation of each by the System of Accounts. This stage will end with the preparation of a feasibility report and a recommendation to Congress.

WORK PACKAGES

This section provides brief descriptions on the tasks that will be required in Stages 2 and 3. The costs for each task, by stage and by Fiscal Year (FY) are presented in Appendix D on Engineering Form 2204 (PB-6) and Table D-1, respectively.

Public Involvement. Stage 1 efforts in public involvement have included coordination with various institutions as well as conducting an initial public meeting.

An attempt will be made in Stages 2 and 3 to establish and maintain a continuous dialogue between the planners and the affected and interested agencies, groups, and individuals. The public involvement program itself will be carried out with the use of four basic tools: information bulletins published throughout the course of the study, workshop meetings, public meetings, and continuous informal meetings and contacts with agencies, groups and the general public who are actively involved in the study. All parties will be encouraged to participate and will be provided with opportunities to have their ideas incorporated in the study.

In addition, a progress and information exchange committee will be established consisting of local, Federal, State, and private hydropower interests to coordinate the various ongoing hydropower studies in the Lehigh Basin. This is the result of the intense interest in hydropower development in the Lehigh Basin. The primary purpose of this committee will be to avoid duplication of effort by the various interested parties and to exchange appropriate technical information as it is developed.

Institutional Studies. A survey of the public institutions in the study area which affect or will be affected by the implementation of a hydroelectric development plan will be conducted during Stage 2. In addition, efforts will be made to identify the relationships and interrelationships that all of the institutions have in regard to the planning and implementation of the hydroelectric plan. An assessment of the factors constraining and promoting hydroelectric development is currently being conducted under the National Hydroelectric Power Study. This effort will serve as a guide to the scope of the study required to outline the institutional framework affecting the Lehigh area. Some additional institutional studies will be accomplished in Stage 3 in connection with evaluating the implementability of detailed plans.

Social Studies. Involvement to date has included a gathering and review of existing data and a description of the study area and its social composition. Stage 2 studies will center around an evaluation of the effects that alternative plans will have both locally and regionally. In Stage 3 local and regional effects will be studied in further depth.

Cultural Resources Studies. Stage 1 efforts concentrated on a preliminary inventory of cultural and historic sites and scenic areas in the basin. During Stage 2 a cultural resources overview for the entire basin will be prepared which will identify important historic and archeological areas. The overview study will be used to assist in defining alternative plan impacts and project screening. In Stage 3 a cultural resouces reconnaissance investigation will be conducted on a site by site basis to further define the potential impacts of favorable plans.

Environmental Studies. During Stage 1, data collection and review was initiated and a preliminary overview of environmental features in the study area was made. Stage 2 will include further collection of environmental data to establish a base for preliminary impact evaluations. Emphasis in Stage 2 will be placed on plan evaluations as a background to detailed efforts in Stage 3. In Stage 3 an Environmental Impact Statement will be prepared utilizing revised CEQ guidelines and ER 200-2-2. Emphasis will be placed on a discussion and impact review of alternatives. Discussions will include an analysis on non-Federal conventional and unconventional power generation. The detail of site discussion will be proportional to the expected effects of implementation.

Fish and Wildlife Studies. Coordination with the Fish and Wildlife Service has taken place throughout the development of this report and will continue through Stages 2 and 3. Efforts will consist of the development of mapping concerning the location of various fish and wildlife resources and the determination of the impact on these resources by alternative plans. In addition, the Fish and Wildlife Service will report on the selected plans.

Marketability Studies. Studies will be conducted to assess the marketability of hydroelectric power in the basin, and to define its role and value in the regional transmission system. FERC has indicated that all hydropower development in the Lehigh could potentially be absorbed in the large interconnected bulk supply system. Consistent with the Principles and Standards a load-resource analysis will be undertaken for single projects or systematic plans in excess of 25 megawatts of capacity. During Stage 2 a survey of existing rate structures, power resources, and load patterns will be undertaken using DOE and FERC data as a basis for marketability. Future generating resources and system imports will be projected based on available data and system studies. Stage 3 activities will concentrate on refining project marketability and, from a preliminary standpoint, outlining the operation and impacts of the proposed projects on the supply patterns of the regional electrical system.

Economic Studies. Economic studies will consist of base studies to establish existing and future economic and social resources and the relation of these characteristics to the anticipated growth in energy demand. Annual benefits and costs will be calculated based on the energy and capacity values established as a result of the marketability studies for each plan under consideration. Stage 2 studies will be sufficient to establish project feasibility and will include for multi-purpose projects an assessment of additional benefits and an allocation of costs among project purposes. More detailed economic studies will be conducted during Stage 3. In addition, an evaluation of a primarily non-structural alternative will be undertaken in both Stages 2 and 3. Costs for defining the impacts of a non-structural plan on the region's future electrical needs as well as the other alternatives under consideration are included here.

Surveying and Mapping. Work efforts to date have included general data collection and the preparation of preliminary base maps for the study area. Future efforts in this area will be done in connection with specific project proposals to collect information for technical evaluations. In the Stage 2 effort there is no intent to generate new surveys and mapping. Readily available mapping such as USGS quadrangle sheets and existing aerial photography and topography will be obtained. It is anticipated that adequate surveying and mapping will be provided by private interests currently studying several damsites under consideration in this study. Site specific surveys and aerial topographic mapping of sites will be conducted where required during Stage 3.

Hydrology and Hydraulics Investigations. Efforts in Stage 1 consisted of establishing preliminary streamflow duration data for power computations and preliminary economic evaluations. In Stage 2, more detailed hydrologic and hydraulic data will be gathered and run-of-river sites will be reevaluated. A preliminary assessment will be made of storage-type projects. The existing HEC-5 model of the Lehigh Basin will be expanded and refined. It will be used to evaluate the effects of storage projects on downstream run-of-river sites. Evaluations of potential pumped storage projects will also be made. Pure pumped storage projects will be analyzed individually while combined pumped storage projects and those involving diversions from one watershed to another will be included in the HEC-5 model to identify impacts on other sites downstream. In Stage 2, the HEC-5 basin model will also be used to analyze systems of hydropower dams. In Stage 3, the basin model will be refined further to allow more detailed analysis of basin-wide alternatives. Power generation will be optimized to the extent practical, as will peaking capabilities. Stage 3 refinements of the HEC-5 model will be based primarily on the impacts of more detailed topography and other physical data.

Foundations and Materials Investigation. Foundations and materials efforts for Stage 2 will be limited to a review of available geological and soils information. No subsurface exploration or testing is anticipated in this stage. Design will include preliminary studies of existing data to develop probable embankment cross sections with site specific foundation and spillway treatment required. The level of detail in Stage 3 will be based on site specific subsurface explorations and soils testing, resulting in a higher degree of reliability than obtained in Stage 2.

Design and Cost Estimates. Design and cost estimates for Stage 2 will be of a preliminary nature based on existing topography and subsurface information. The level of detail in Stage 2 will be limited to conceptual type layout plans and typical cross sections for the embankment and relocations at each site, with similar efforts for additional features such as the powerhouse, tunnel, conduits, tailrace, etc. Drawings and sections will be primarily for sizing, with structural dimensions based on engineering judgement rather than detailed analysis. Cost estimates will be of a preliminary nature based on generalized unit and lump sum prices with no development of site specific prices. The level of detail in Stage 3 will be based on site specific subsurface explorations and soils testing together with new aerial surveys. Investigations and designs will provide a high degree of assurance as to engineering feasibility and project costs. More detailed layouts and additional and more detailed sections will be provided than in

Stage 2. Design details will be based on preliminary analysis in Stage 3 rather than the conceptual and judgemental approach in Stage 2. Estimates for Stage 3 will be based on site specific unit prices and reflect more accurately the quantities involved.

Real Estate Studies. These include determination of land costs, easements, rights-of-way, and possible damages due to the various alternative plans. Real Estate data utilized during Stage 2 will be preliminary and based on contacts with local brokers. Stage 3 estimates will be based on gross appraisals developed by the Real Estate Division of the Baltimore District.

Study Management. Study management is concerned with the efficient conduct of the study including the allocation of and management of funds and personnel. Study Management activities include monitoring the progress of the study as specified in ER 18-2-2 entitled "Intensive Management Milestone System", as modified by North Atlantic Division. This includes preparation of SSPR's, 1632's, and PERT networks. Due to the size and complexity of this study a significant portion of the work will be accomplished by contract. A major study management activity will be coordination of work between contractors and District elements, monitoring the progress on contracts while they are underway, and reviewing the contractors' work. Study management also includes coordination between the District's technical elements and preparation of Budget Data for higher authority and the Congress.

Plan Formulation and Evaluation. Plan formulation efforts in Stage 1 included preliminary individual project evaluations, and coordination meetings to outline the scope of further study. Future efforts will entail plan development, evaluations and assessment based on an iterative screening process. Formulation will be aimed at optimizing the use of basin resources as well as developing implementation strategies for proposed alternatives. Stage 2 will begin with a field review of all sites under consideration, followed by a site-by-site evaluation using flow duration analyses. This will include run-of-river, storage, and pumped storage sites. An HEC-5 model will then be used to assess storage impacts and to evaluate the inter-relationships between storage projects, pumped storage diversion projects, and downstream run-of-river projects. Individual projects will be formulated into basin-wide plans. These plans will be evaluated during Stage 3.

Report Preparation. Efforts to date, under this task, have resulted in the preparation of this Stage 1 Reconnaissance report. Future work under this task will include assembling, writing, editing, typing, drafting, reviewing, revising, reproducing and distributing the Stage 2 and 3 documents. Many elements of the District and other agencies will play a part in the development of these documents.

Supervision and Administration. Work under this task has and will continue to involve the supervisors who oversee the study and provide guidance where needed. In addition, the cost estimates for supervision and administration requirements include other indirect costs which cannot be allocated directly to other tasks.

FUNDING AND MANAGEMENT SCHEDULE

Study Cost Estimate. For the purposes of developing the study cost estimate, and based on an evaluation of Stage 1 results, it has been assumed that ten conventional sites and 5 pumped storage projects will survive Stage 2 screening to be considered in detail during Stage 3. Cost estimates for

Stage 2 were based on a preliminary analysis of all projects except for the Penn Forest Reservoir, Easton Dam, Chain Dam, Allentown Dam, Lock No. 23 (Delaware Canal), and Locks No. 41 and 47 which are alternatives to the Allentown and Chain Dams, respectively. These projects are currently being analyzed by private interests. Study costs are based on a review of these efforts and the identification of potential impacts caused by the implementation of other plans under a comprehensive framework.

The study costs were derived from estimates furnished by the pertinent office elements that would be involved. Discussions were conducted with the Corps North Pacific Division, District offices, and the Hydrologic Engineering Center (HEC) to validate the study cost estimates based on their experience in planning and conducting hydroelectric feasibility studies. The study costs have been distributed among the accounts and sub-accounts as established in OCE ER 11-2-220 entitled "Civil Works Activities, General Investigations," dated 29 July 1977. A detailed breakdown of study costs by accounts and sub-accounts is presented on Engineering Form 2204 (PB-6) which is included in Appendix D. Also included in this Appendix is a proposed detailed breakdown of study costs by Fiscal Year (Table D-1).

The estimated cost of the study is $1,796,000. This cost estimate includes anticipated cost of living increases at 6% per year and a general contingency of 10 percent. This is an increase of $1,446,000 over the previously approved estimate of $350,000, submitted in 1977. Stage 1 investigations determined that hydropower investigations of varying types appear appropriate at many more locations than the 5-7 conventional sites considered in the previous estimate. This is partially a result of the recent escalation of energy costs which has made sites previously believed to be "too small", now to appear worthy of further investigation. There has also been some advancement in the "State of the Art" with regard to development of low head hydropower sites. Consequently, many small, low head sites which were never considered previously now show potential for economical development. Many of these sites are interrelated and will have to be evaluated as a system. Recent changes in the Principles and Standards will also require additional effort, particularly for major projects.

The costs indicated are entirely direct Federal costs to the study and include funds to be transferred to the U.S. Fish and Wildlife Service. The study cost estimate reflects the total study effort.

Study Conduct and Scheduling. The study is being conducted in three stages. Work is scheduled for completion in April 1986. Stage 1 will be complete upon approval of the Stage 1 Reconnaissance Report. Public meetings will be held to present the findings of Stages 2 and 3 in October 1983 and January 1986, respectively. If the findings of Stage 2 at the time of the checkpoint conference are favorable, work on Stage 3 will begin following the Stage 2 public meeting.

The proposed study milestones are shown in Table 30 and displayed on the study schedule network in Appendix D.

TABLE 30

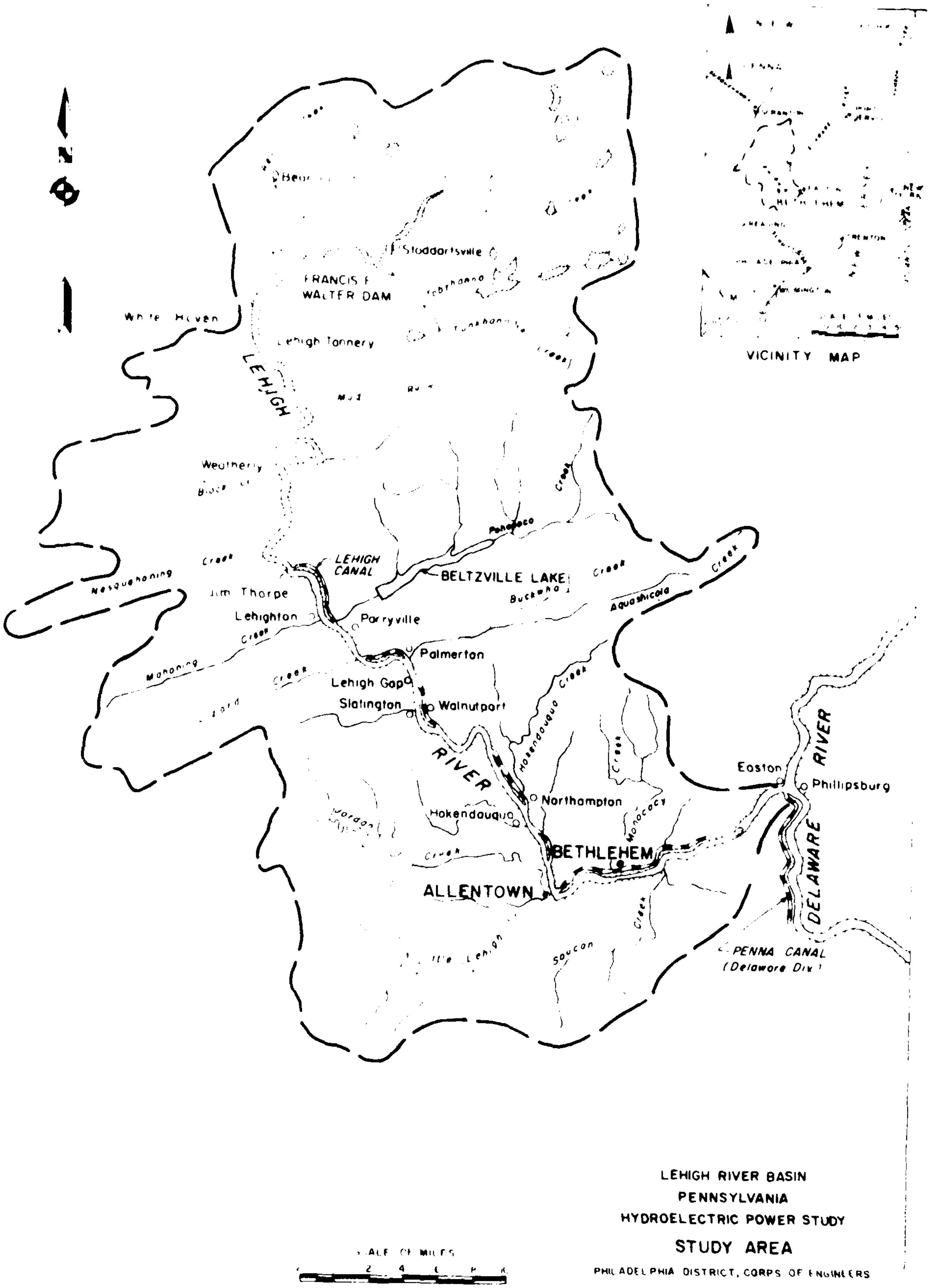
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
STUDY MILESTONES

Number	Milestone	Scheduled Date
1	Study Initiation	Nov 79 (completed)
2	POS Approval	Oct 80
3	Stage 2 Report Submittal to NAD	Jun 83
4	Stage 2 Checkpoint Conference	Aug 83
5	Completion of Action MFR	Sep 83
5a	Stage 2 Public Meeting	Oct 83
6	Submit Draft Report & Draft EIS to NAD	Jun 85
7	Stage 3 Checkpoint Conference	Aug 85
8	Completion of Action of MFR	Sep 85
9	Coordination of Draft Report & Draft EIS	Nov 85
9a	Stage 3 Public Meeting	Jan 86
10	Submission of Final Report & Revised Draft EIS to NAD	Mar 86
11	Release of Division Engineer's Public Notice & Submission of Report to BERH	Apr 86

RECOMMENDATION

It is recommended that the Stage 1 Reconnaissance Report for the Lehigh River Basin Hydroelectric Power Study be approved.

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

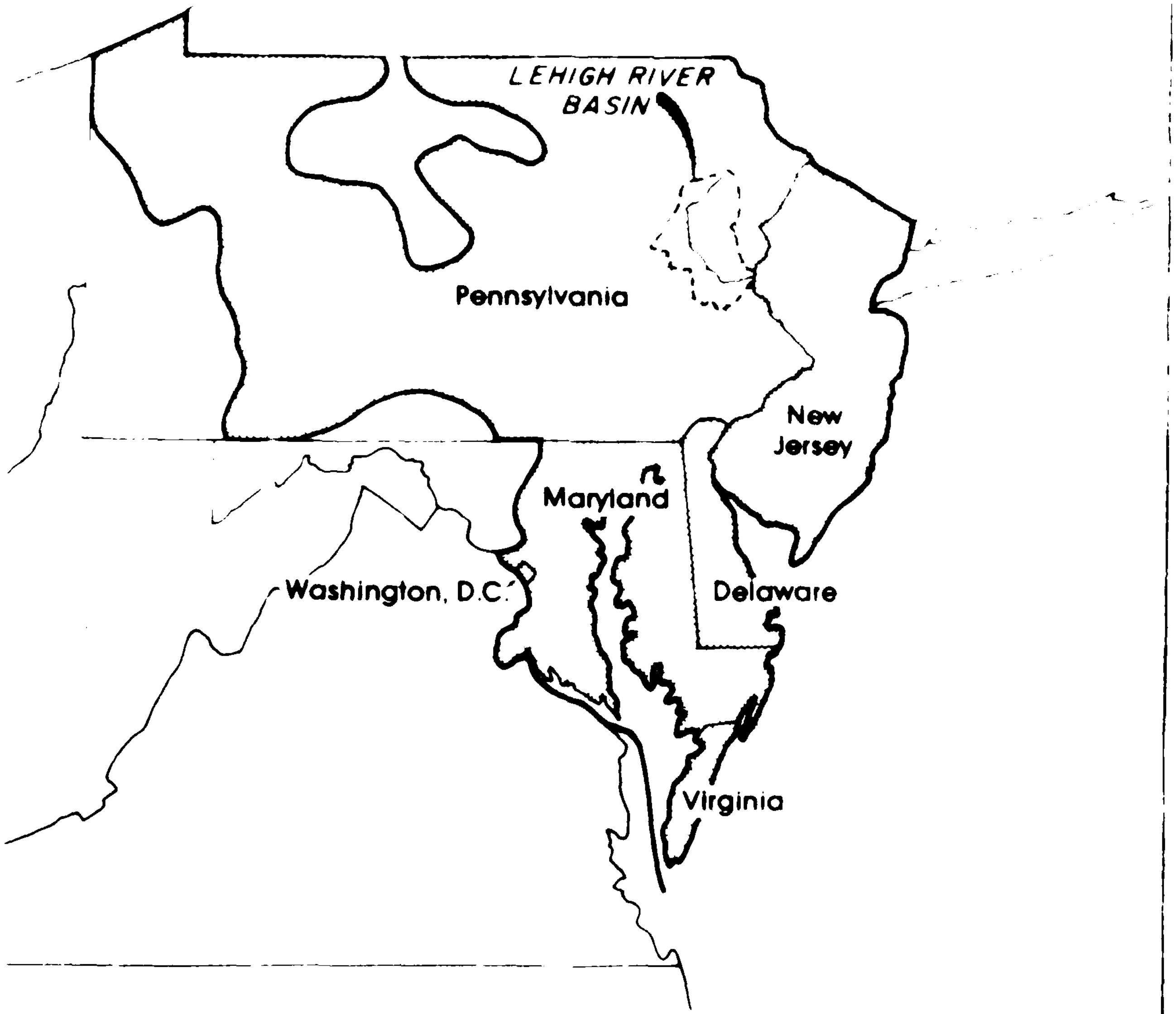


LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY

STUDY AREA

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PLATE I

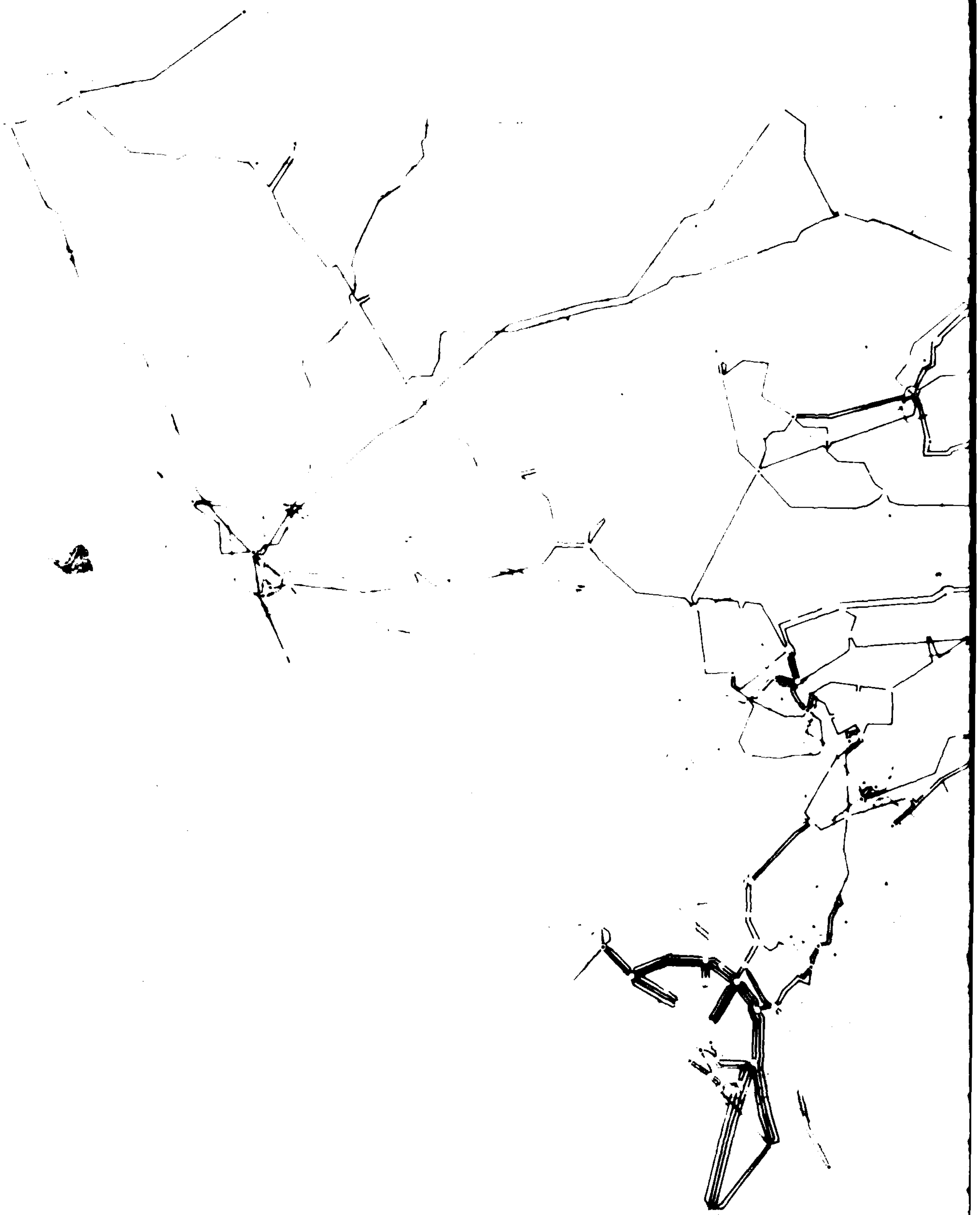


LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY

MIDDLE ATLANTIC AREA COUNCIL

PHILADELPHIA DISTRICT CORPS OF ENGINEERS

PLATE 2



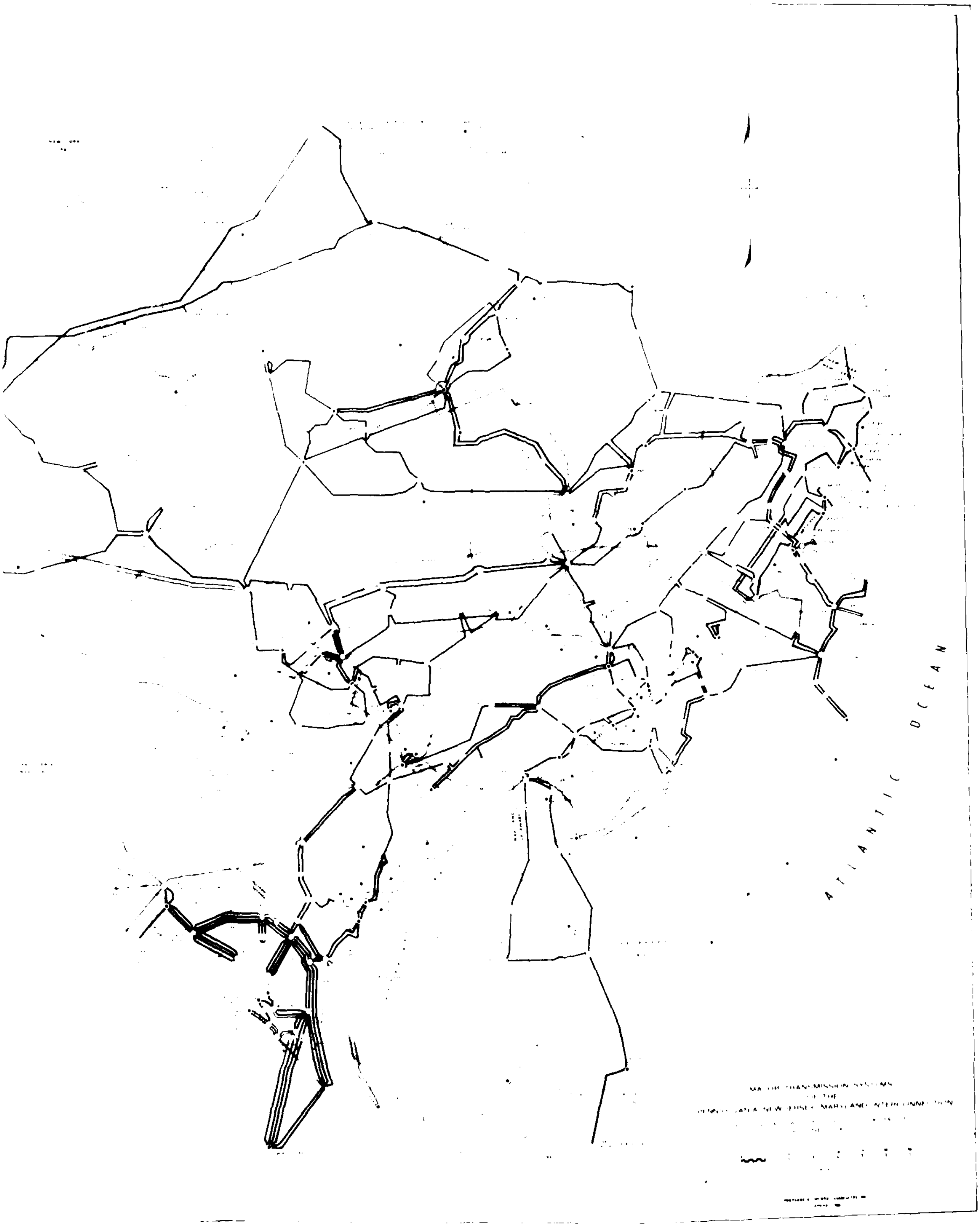
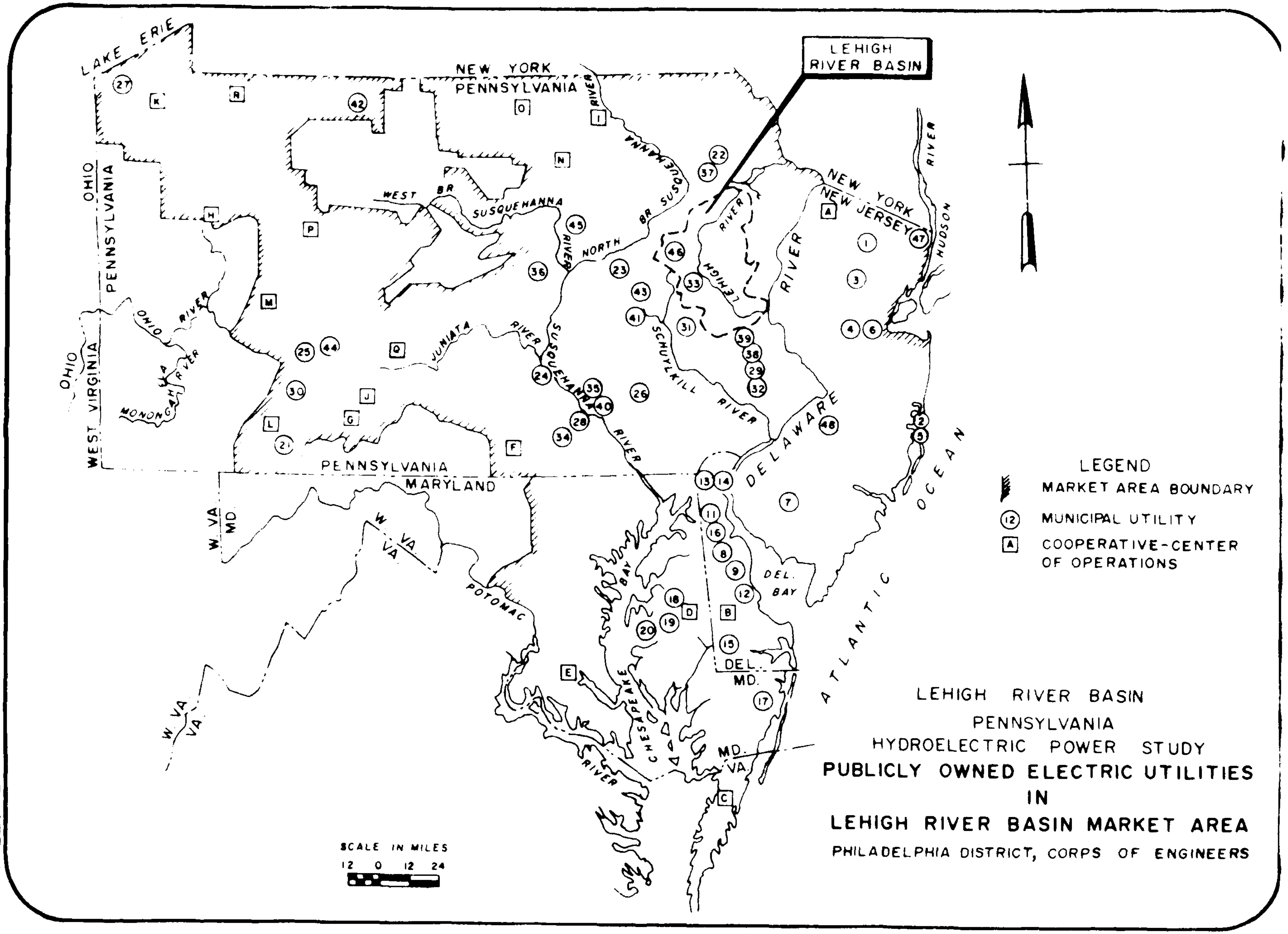
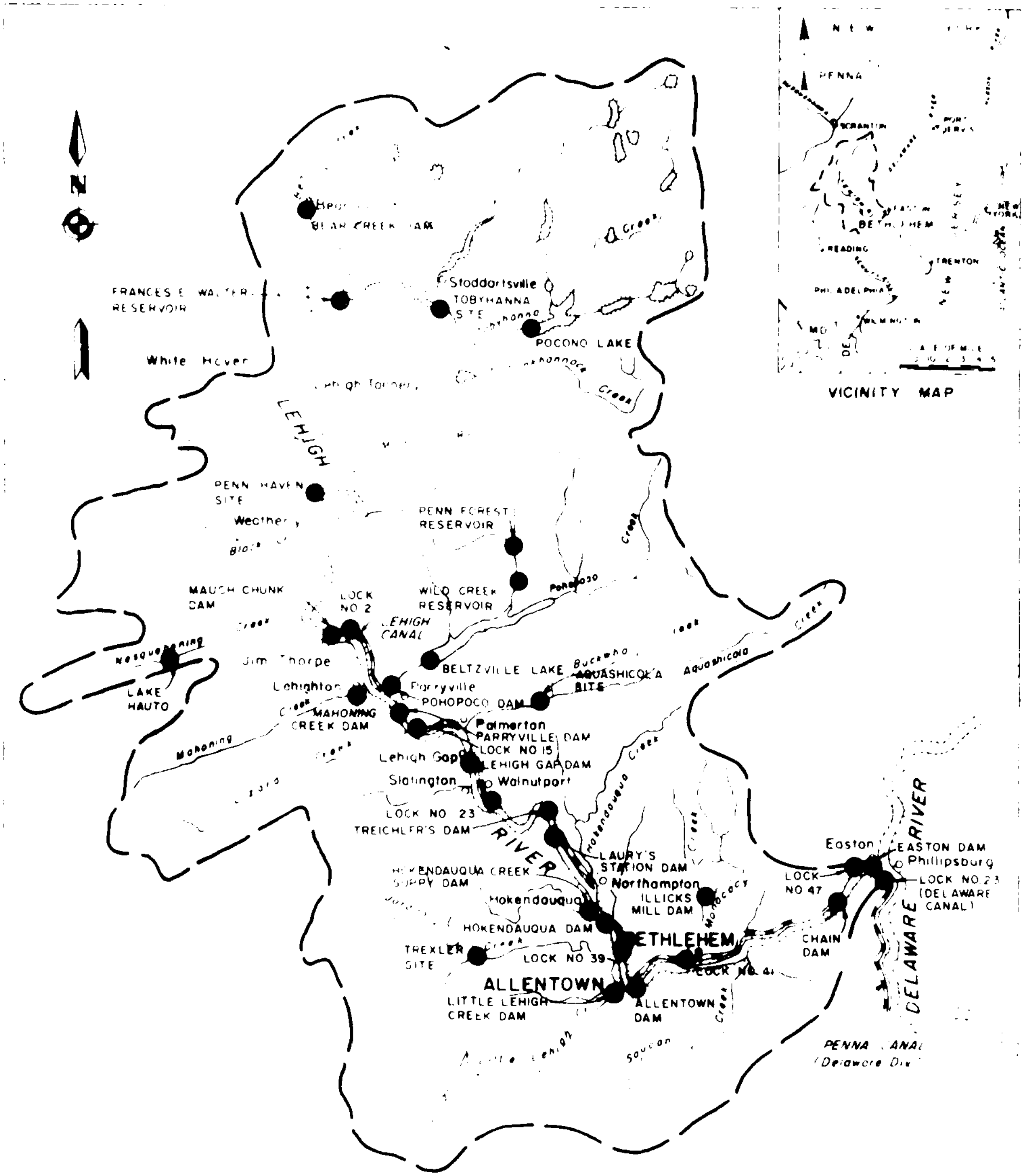


PLATE 3



LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY
PUBLICLY OWNED ELECTRIC UTILITIES
IN
LEHIGH RIVER BASIN MARKET AREA
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PLATE 4



LEHIGH RIVER BASIN

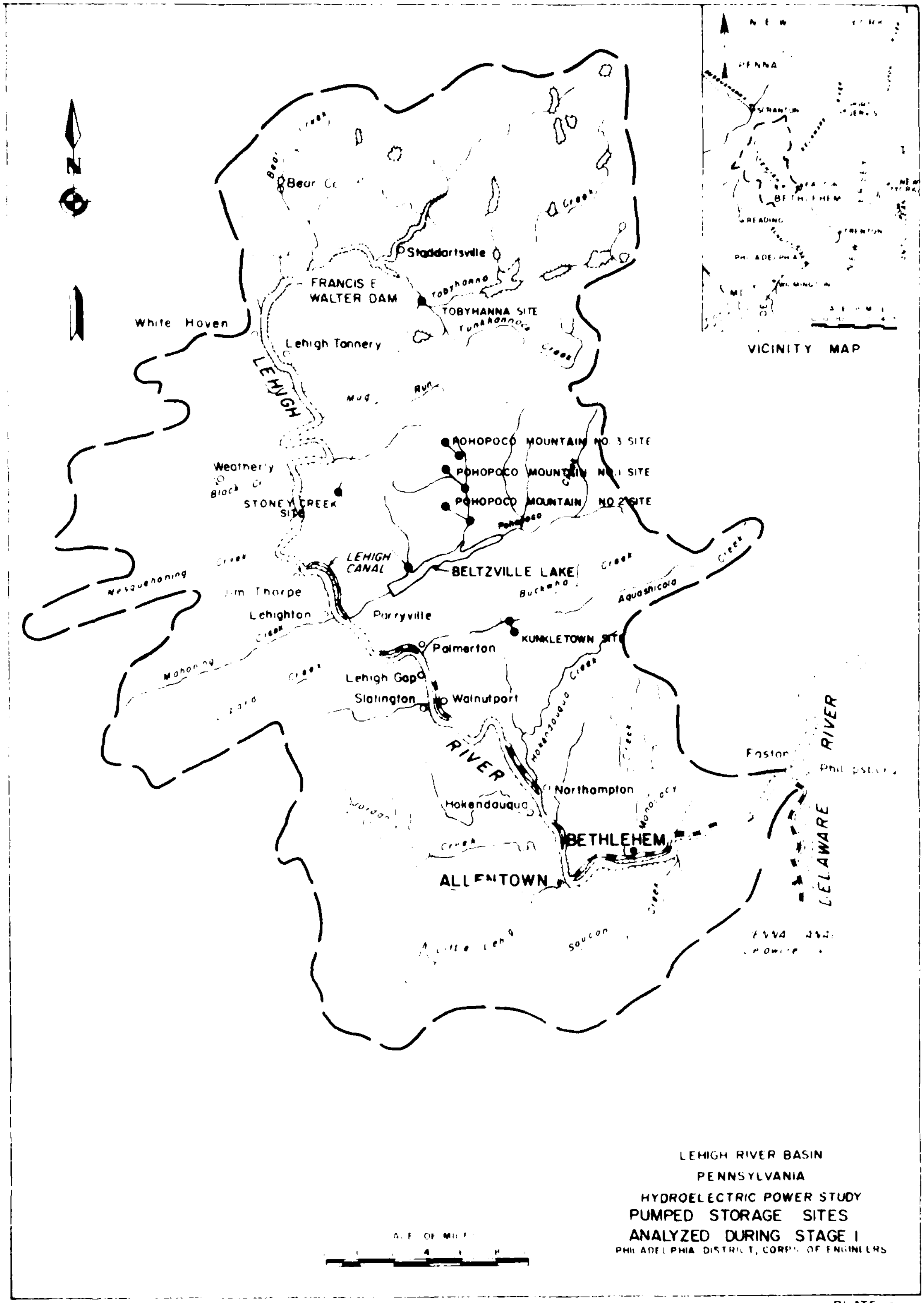
PENNSYLVANIA

HYDROELECTRIC POWER STUDY

CONVENTIONAL HYDROPOWER SITES ANALYZED DURING CYCLE 2

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PLATE 5



LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY
PUMPED STORAGE SITES
ANALYZED DURING STAGE I
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PLATE 6

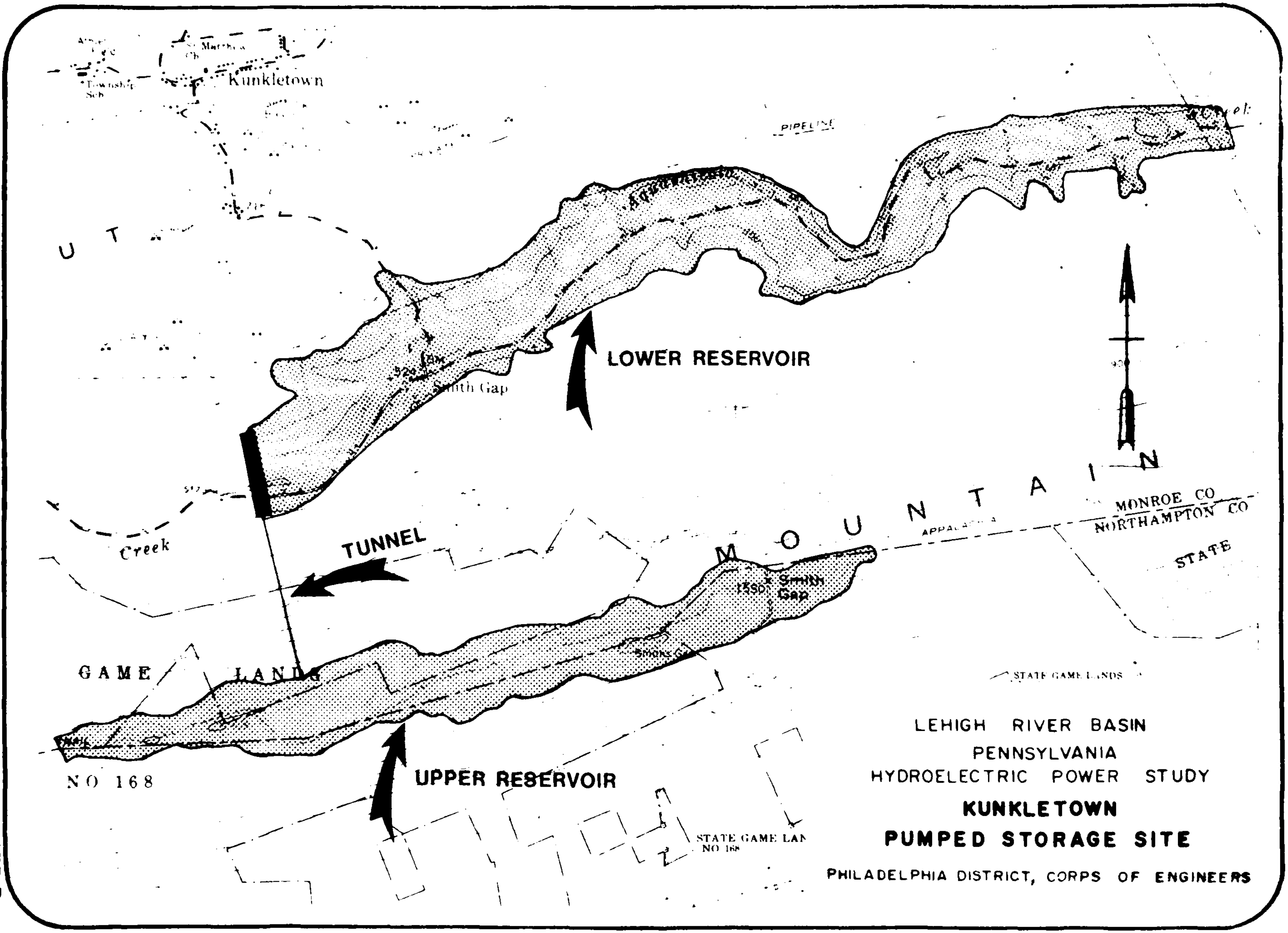
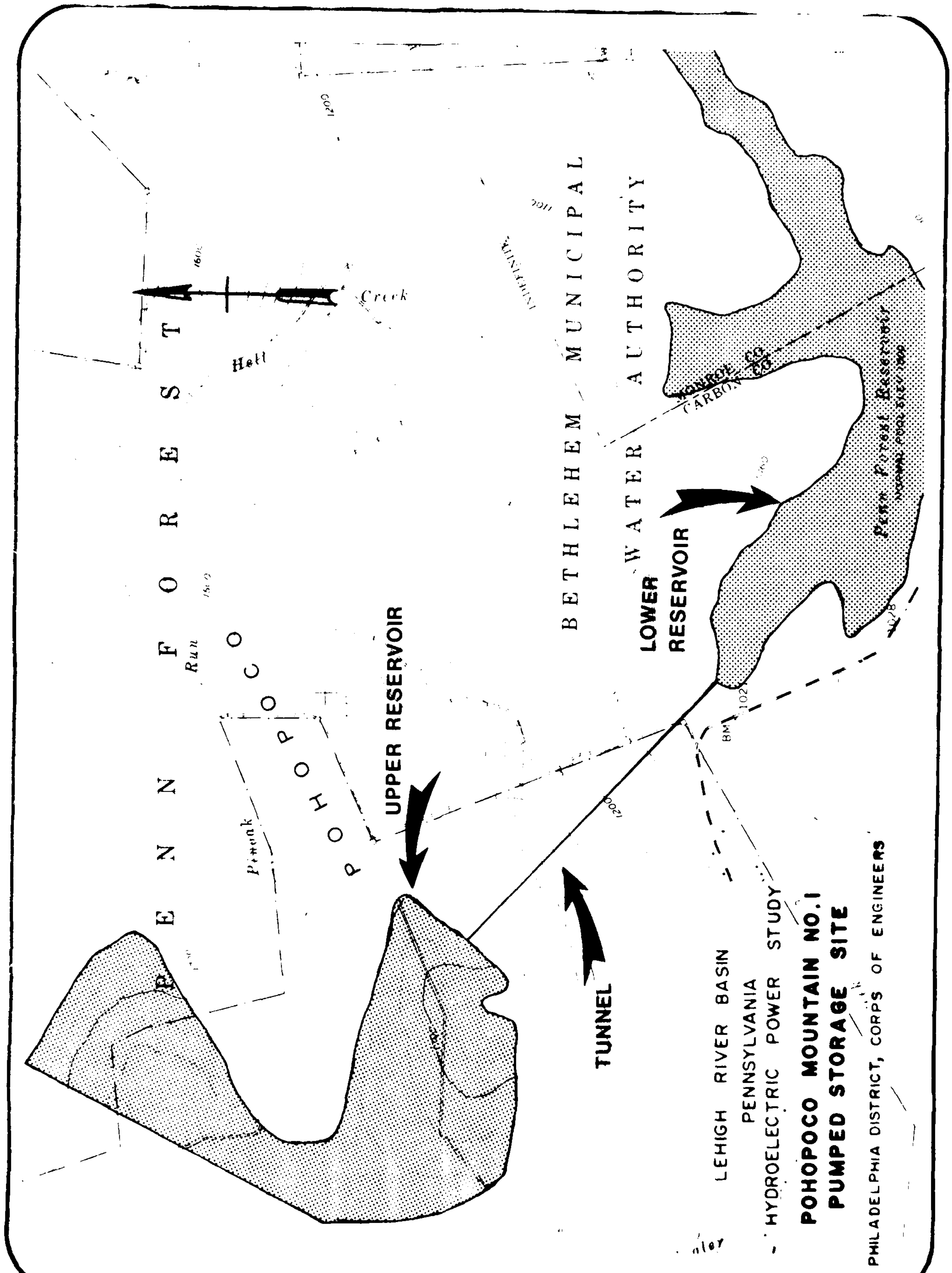
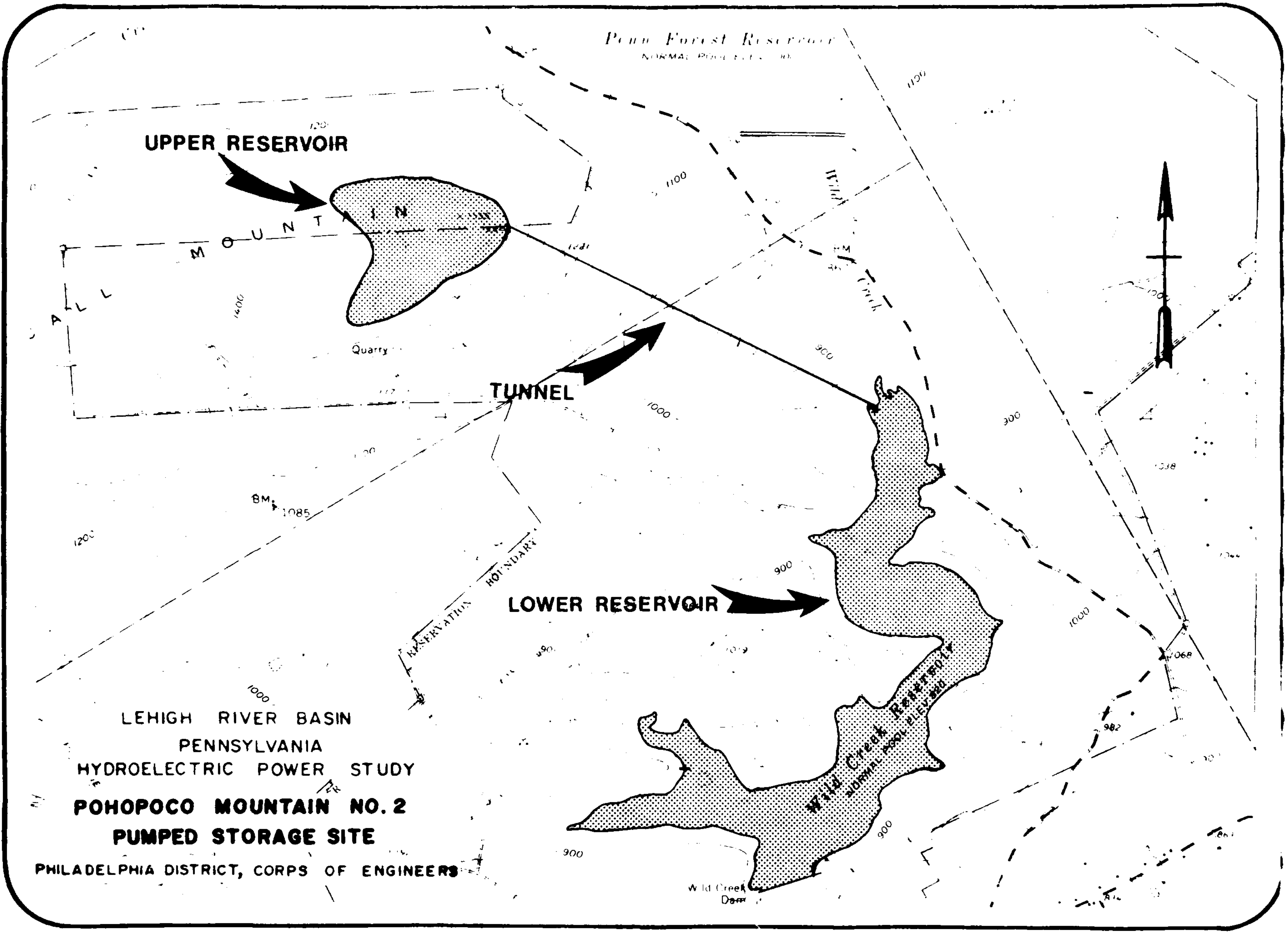

Kunkletown
PIPELINE
LOWER RESERVOIR
Smith Gap
N
M O U N T A I N
MONROE CO
NORTHAMPTON CO
STATE
TUNNEL
Creek
Smith Gap
GAME LAND
NO 168
STATE GAME LANDS
UPPER RESERVOIR
STATE GAME LAN
NO 168
LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY
KUNKLETOWN
PUMPED STORAGE SITE
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PLATE 7



PENN FOREST
POHOPOCO
UPPER RESERVOIR
TUNNEL
LOWER RESERVOIR
BETHLEHEM MUNICIPAL WATER AUTHORITY
Hell Creek
Run
MONROE CO.
CARBON CO.
Penn Forest Reservoir
1200
LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY
POHOPOCO MOUNTAIN NO. 1
PUMPED STORAGE SITE
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

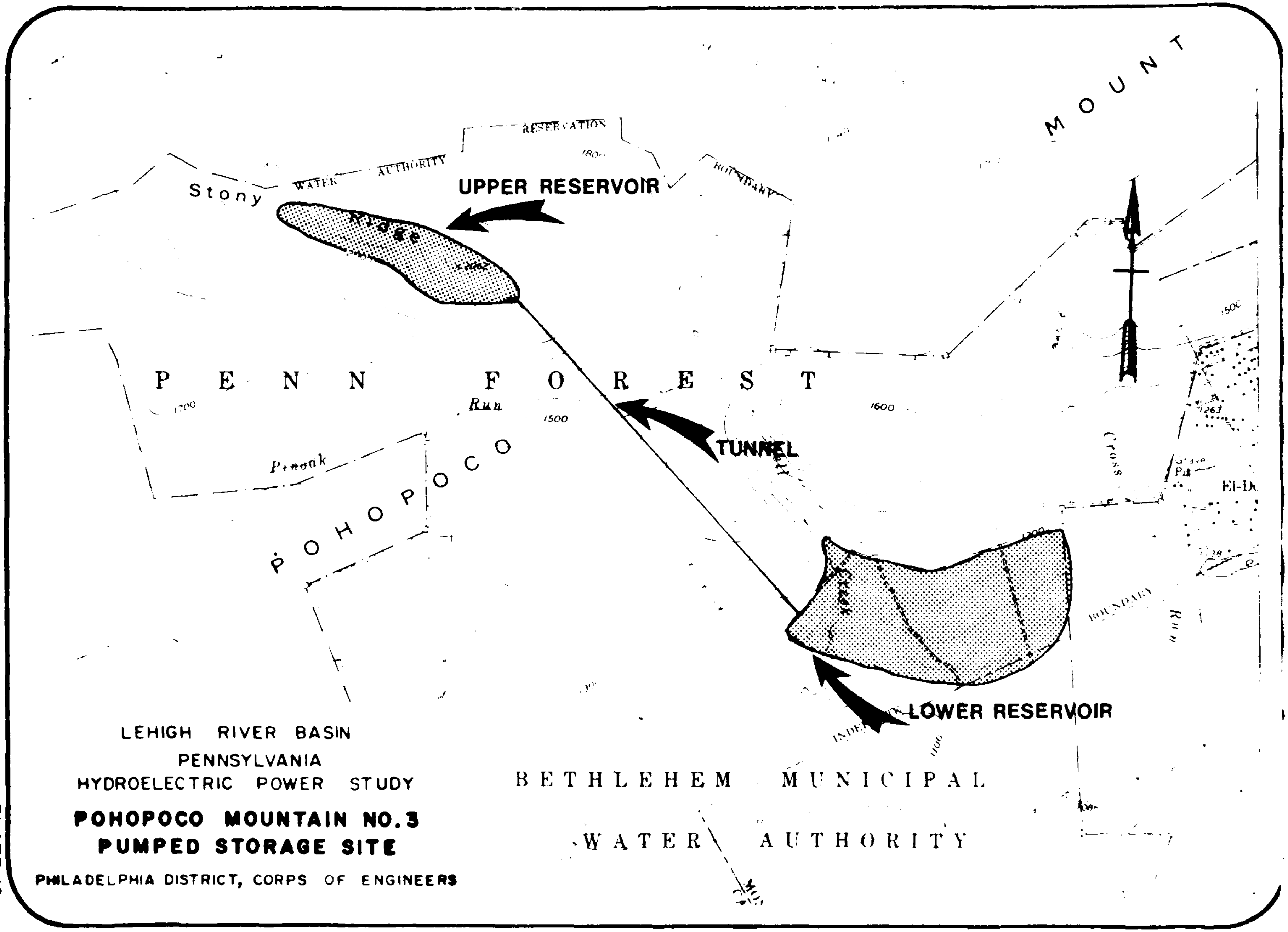
PLATE 8



LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY

POHOPOCO MOUNTAIN NO. 2
PUMPED STORAGE SITE

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS



LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY

POHOPOCO MOUNTAIN NO. 3
PUMPED STORAGE SITE

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PLATE 10

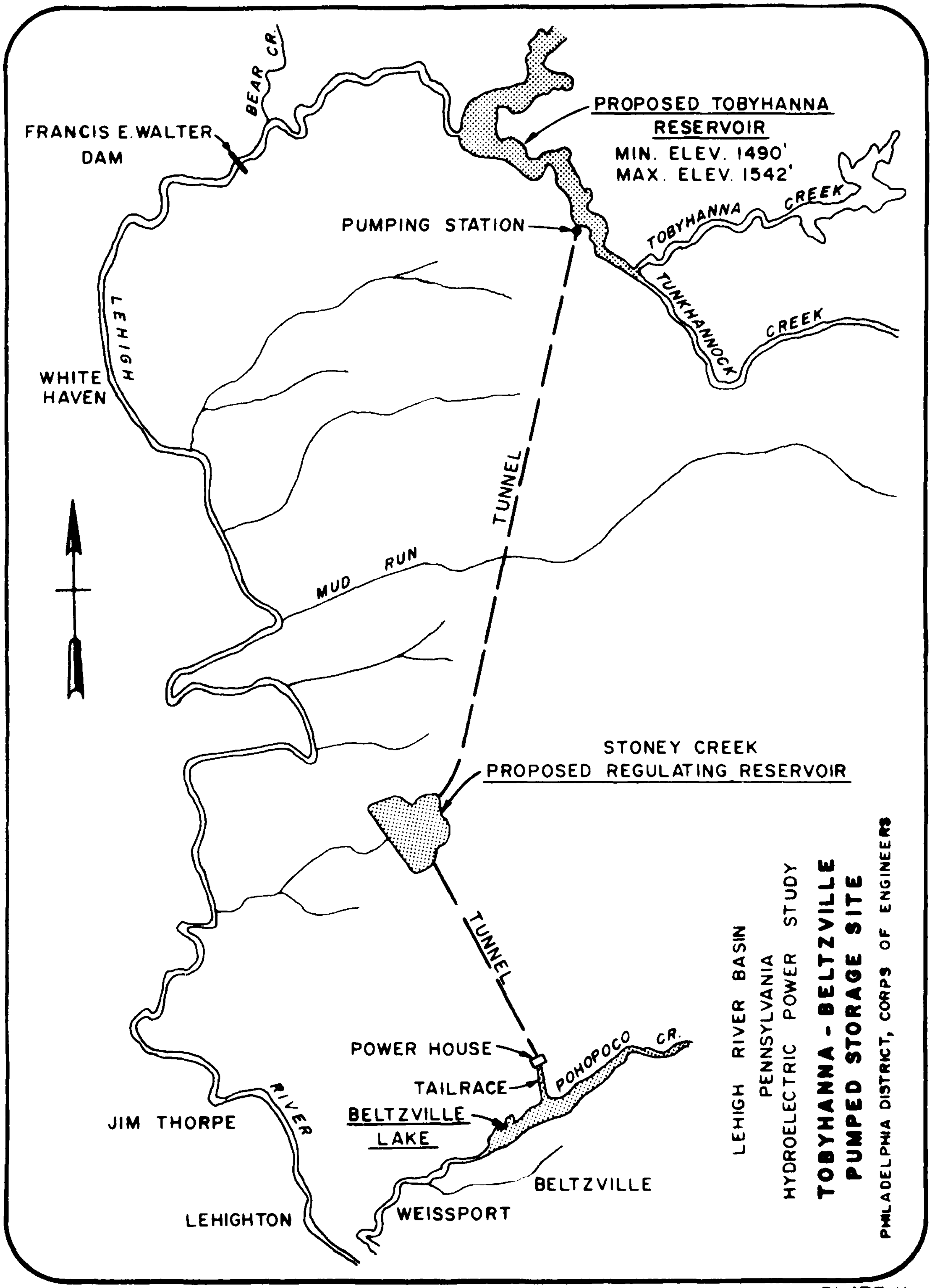

PROPOSED TOBYHANNA RESERVOIR
MIN. ELEV. 1490'
MAX. ELEV. 1542'
FRANCIS E. WALTER DAM
BEAR CR.
PUMPING STATION
TOBYHANNA CREEK
TUNKHANNOCK CREEK
LEHIGH
WHITE HAVEN
TUNNEL
MUD RUN
STONEY CREEK
PROPOSED REGULATING RESERVOIR
TUNNEL
POWER HOUSE
TAILRACE
POHOPOCO CR.
BELTZVILLE LAKE
JIM THORPE
RIVER
BELTZVILLE
WEISSPORT
LEHIGHTON
LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY
TOBYHANNA - BELTZVILLE
PUMPED STORAGE SITE
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PLATE 11

APPENDIX A

PERTINENT CORRESPONDENCE

APPENDIX A

PERTINENT CORRESPONDENCE

APPENDIX A
PERTINENT CORRESPONDENCE

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

OTHER CORRESPONDENCE

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C.

RESOLUTION

Resolved by the Committee on Public Works and Transportation of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report on the Delaware River Basin, New York, New Jersey, Pennsylvania, and Delaware, published in House Document 522, 87th Congress, 2nd Session, and other pertinent reports, with a particular view to determining whether any modifications of the recommendations contained therein are advisable at the present time in the interest of hydroelectric power and allied purposes in the Lehigh River Basin.

Adopted: May 10, 1977

ATTEST:

Chairman

U.S. GOVERNMENT PRINTING OFFICE

Requested by: Hon. Daniel J. Flood

MAILING LIST

[illegible] PARTY LIST

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SE[illegible]ATE [illegible]
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GOVERNOR
STATE OF PENNSYLVANIA
MAIN CAPITOL BUILDING
HARRISBURG, PA 17120

STATE LEGISLATURE

PENNSYLVANIA STATE SENATE

HON. [illegible]
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1[illegible]TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. MICHAEL A. O'PAKE
PA. STATE SENATE
11TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. MARTIN L. MURRAY
PA. STATE SENATE
14TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA 17120

HON. HENRY G. MESSINGER
PA. STATE SENATE
1[illegible]TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. JEANETTE F. REIBMAN
PA. STATE SENATE
18TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. FRANK J. O'CONNELL
PA. STATE SENATE
2[illegible] DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. ROBERT J. MELLOW
PA. STATE SENATE
22ND DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. JOSEPH R. [illegible]
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115TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA 1712

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PA. STATE HOUSE OF REPRESENTATIVES
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MAIN CAPITOL BLDG.
HARRISBURG, PA 17120

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117TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA 1712

HON. RAPHAEL MUSTO
PA. STATE HOUSE OF REPRESENTATIVES
118TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. BERNARD F. O'BRIEN
PA. STATE HOUSE OF REPRESENTATIVES
121ST DISTRICT
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HARRISBURG, PA 1712

HON. THOS. J. MCCALL
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HARRISBURG, PA. 17120

HON. JAMES A. [illegible]
PA. STATE HOUSE OF REPRESENTATIVES
123RD DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 1712

HON. WM. K. KLINGAMAN, SR.
PA. STATE HOUSE OF REPRESENTATIVES
124TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

PENNSYLVANIA STATE HOUSE OF REPRESENTATIVES

HON. JAMES S. DAVIES
PA. STATE HOUSE OF REPRESENTATIVES
129TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. LESTER K. FRYER
PA. STATE HOUSE OF REPRESENTATIVE
130TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. JAMES R. RITTER
PA. STATE HOUSE OF REPRESENTATIVES
131ST DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. KURT ZWIKL
PA. STATE HOUSE OF REPRESENTATIVES
132ND DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. [illegible] J. [illegible]
PA. STATE HOUSE OF REPRESENTATIVES
133RD DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. JOSEPH R. ZELLER
PA. STATE HOUSE OF REPRESENTATIVES
134TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. [illegible]
PA. STATE HOUSE OF REPRESENTATIVES
[illegible] DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. EDMUND J. SIEMINSKI
PA. STATE HOUSE OF REPRESENTATIVE
135TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. LEONARD [illegible] GRUPP[illegible]
PA. STATE HOUSE OF REPRESENTATIVES
137TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. RUSSELL KOWALYSHYN
PA. STATE HOUSE OF REPRESENTATIVES
138TH DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

HON. [illegible] F[illegible]STER
PA. STATE HOUSE OF REPRESENTATIVES
[illegible] DISTRICT
MAIN CAPITOL BLDG.
HARRISBURG, PA. 17120

FEDERAL AGENCIES

DEPARTMENT OF AGRICULTURE

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DEPUTY SEC. FOR ENVIR.
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DEPUTY SECRETARY FOR ENGINEERING
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PENNSYLVANIA DEPT. OF TRANSPORTATION

SECRETARY
COMMONWEALTH OF PENNSYLVANIA
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HARRISBURG, PA 1712[illegible]

PENNSYLVANIA COMMISSIONS

EXECUTIVE DIRECTOR
PENNSYLVANIA FISH COMMISSION
HARRISBURG, PA 1712[illegible]

EXECUTIVE DIRECTOR
PENNSYLVANIA GAME COMMISSION
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SECRETARY
COMMONWEALTH OF PENNSYLVANIA
[illegible] UTILITY COMMISSION
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[illegible]
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COUNTY REPRESENTATIVES

BERKS COUNTY

CHAIRMAN
BERKS COUNTY COMMISSIONERS
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READING, PA 19601

CHIEF CLERK
BERKS COUNTY
COURTHOUSE
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DIRECTOR
BERKS COUNTY [illegible] COMMISSION
COURTHOUSE
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COUNTY PLANNER
BERKS COUNTY
COURTHOUSE
READING, PA 19601

COUNTY [illegible]
BERKS COUNTY
COURTHOUSE
READING, PA 19601

COUNTY SURVEYOR
BERKS COUNTY
COURTHOUSE
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DIRECTOR
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R.D. NO.5
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COUNTY CLERK
BUCKS COUNTY
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[illegible]
[illegible] ISSION
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COUNTY PLANNER
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[illegible]
[illegible]
[illegible] SERVATI [illegible]
[illegible]
[illegible], PA [illegible]

[illegible]

[illegible]
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CHIEF CLERK
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[illegible]
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[illegible]
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COUNTY CLERK
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NEW TRIPOLI, PA. 18066

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT. CORPS OF ENGINEERS
CUSTOM HOUSE – 2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-R

27 NOV 1979

Dear Sir:

I am pleased to inform you that we have initiated the Lehigh River Basin Hydroelectric Power Study. This Congressionally authorized study will investigate the potential for developing hydroelectric power in the entire Lehigh Basin by considering both existing and potential dam sites. This study was authorized on 10 May 1977 by the U.S. House of Representatives Committee on Public Works and Transportation.

During the coming year, the Corps will concentrate on developing a Reconnaissance Report which will detail how the study will be conducted. We will also hold a public meeting, establish an extensive public involvement program, collect data, evaluate hydropower potential and identify any issues which conflict with optimum basin hydropower development.

Public participation is especially important during our preliminary investigation to ensure that the study and its recommendations reflect the needs and desires of basin residents. Prior to our initial public meeting, an information bulletin will be issued containing further information on hydropower in general and on our study in particular.

We welcome any contributions that you can make to this study. Please direct them to Mr. John Tunnell of my staff, either at the address above or by telephone at (Area Code 215) 597-4714.

We look forward to your assistance. As the study progresses we will inform you of all major developments and solicit your views on them.

Sincerely,

James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DELAWARE RIVER BASIN COMMISSION
P. O. BOX 7360
WEST TRENTON, NEW JERSEY 08628

(609) 883 9500

GERALD M. HANSLER
EXECUTIVE DIRECTOR

HEADQUARTERS LOCATION
25 STATE POLICE DRIVE
WEST TRENTON, N. J.

December 4, 1979

Colonel James G. Ton
District Engineer
U. S. Army Corps of Engineers
2nd and Chestnut Streets
Philadelphia, Pennsylvania 19106

Dear ~~Colonel~~ Jim Ton:

I have your letter, NAPEN-R, dated November 27, 1979 announcing that you have initiated the Lehigh River Basin Hydroelectric Power Study.

We stand ready to cooperate with you during the conduct of the study. I have designated Mr. Robert L. Goodell of my staff to act as liaison contact man for this effort. Please direct all inquiries to Mr. Goodell.

Sincerely,

Jerry Hansler

Gerald M. Hansler

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P. O. Box 1467
Harrisburg, Pennsylvania 17120

In reply refer to
RM-WR

December 10, 1979

Col. James G. Ton
District Engineer
Philadelphia District - Corps of Engineers
Custom House - Second and Chestnut Streets
Philadelphia, PA 19106

Dear Colonel Ton:

Governor Thornburgh has requested that I acknowledge your letter of November 27, announcing the initiation of the Lehigh River Basin Hydroelectric Power Study.

We are pleased to see that this important study is now underway, and look forward to working with you and the members of the district staff in this effort.

I am requesting that R. Timothy Weston, Associate Deputy Secretary for Water Resources, help coordinate any assistance which you need from the Department in pursuing this study. Mr. Weston can be contacted at P. O. Box 1467, Harrisburg, Pennsylvania 17120, or by telephone at (717) 78[illegible]-2315.

You can be assured of our continued support and cooperation in this important work.

Sincerely,

C. H. McConnell

C. H. McConnell, Deputy Secretary
Resources Management

U.S. DEPARTMENT OF AGRICULTURE
ECONOMICS, STATISTICS, and COOPERATIVES SERVICE
1974 Sproul Road (4th Floor)
Broomall, PA 19008

December 10, 1979

Mr. John Tunnell
Department of the Army
Philadelphia District, Corps of Engineers
Custom House - 2nd & Chestnut Streets
Philadelphia, PA 19106

Reference: NAPEN-R

Dear Mr. Tunnell:

I recently received a letter from a Colonel Ton regarding the hydroelectric feasibility study in the Lehigh River Basin. I appreciate being informed of your impending work. This office would be more than happy to review the Reconnaissance Report which you will be developing this year.

At a recent Soil Conservation Society of America meeting (William Penn Chapter) we heard from John Liu Associates - an engineering firm specializing in lowhead hydro. Their discussion on lowhead hydro included recent technological innovations and was a very interesting talk. Although I have no specific ideas on what your Reconnaissance Report is going to deal with, if there is any work looking at lowhead hydro feasibility, I would suggest that you contact Mr. Liu and his associate. I suspect that they may have a great deal of information that would be useful to your Report if you are planning to look at lowhead feasibility. If you are interested, please drop a line or phone me (FTS 596-5772) and I will forward to you their address.

Again, thank you for your letter informing us of your impending study.

Sincerely,

Mark R. Bailey

DR. MARK R. BAILEY
Assistant Leader
Northeast Section

JOSEPH R. ZELLER, MEMBER
P. O. BOX 272
EMMAUS, PENNSYLVANIA 18049

ROOM 604, P. O. BOX [illegible]
HARRISBURG, PENNSYLVANIA 17120
PHONE (717) 787-5[illegible]

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COMMONWEALTH OF PENNSYLVANIA
HARRISBURG

December 12, 1979

Colonel James G. Ton, District Engineer
Corps of Engineers
Department of the Army
Custom House
2 D and Chestnut Streets
Philadelphia, Pennsylvania 19106

Dear Col. Ton:

I am in receipt of your letter of November 27, 1979, announcing the Lehigh River Basin Hydroelectric Power Study.

Could this be a round-about way of saying that the proposed Trexler Dam project has again been activated?

You know as well as I that this proposal was soundly defeated on a Lehigh County referendum. We are currently fighting to save open space and farmland in our County. With the arrival of the Dam, we can only see the immediate end to agriculture in our northern Lehigh County as it would be simple to blame the upstream farmer for any chemical traces.

Although the Corps may have added a new frosting, we still see the same old rotten cake. The citizens of Lehigh have rallied in the past against this project and I have no doubt that this time around the forces will be even stronger and more numerous in numbers.

Sincerely,

Joseph R. Zeller
Member

gaw

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-P

22 January 1980

Honorable Joseph R. Zeller
Pennsylvania House of Representatives
P. O. Box 93 - Room 604
Harrisburg, PA 17120

Dear Mr. Zeller:

This is in response to your letter of 12 December 1979 concerning our initiation of work on the Lehigh River Basin Hydroelectric Power Study.

Your letter concerned the possible reactivation of the proposed Trexler Dam project. The purpose of our current study is to investigate the hydroelectric power potential of the Lehigh River basin. The only context in which the study will consider the Trexler Lake project is to investigate the possibility of including hydroelectric power generation as an additional purpose of the dam should it ever be constructed for its authorized purposes. Although the project remains classified as "inactive" we must consider the site to fully respond to the Congressional resolution which has provided the authority for the study.

I trust that this has allayed your concerns regarding the Trexler project. Should you have any further questions concerning the purpose of our Lehigh Study, please do not hesitate to contact me.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Lackawanna County

REGIONAL PLANNING COMMISSION

200 ADAMS AVENUE, SCRANTON, PENNSYLVANIA 18503

December 12, 1979

Mr. John Tunnell
Philadelphia District, Corps of Engineers
Custom House - 2 D and Chestnut Streets
Philadelphia, Pa. 19106

Dear Mr. Tunnell:

In reply to your office's letter with regard to the Lehigh River Basin Hydroelectric Study (NAPEN-R), the Lackawanna County Regional Planning Commission would like to contribute its findings with regard to its research on the "energy fall" concept. Even though Lackawanna County is not in the Lehigh River Basin and the "energy fall" study was conducted with Lackawanna County as the focal point, our findings could become an added perspective in your study of the Lehigh River Basin.

Sincerely,

Rocco L. Campagna

Rocco L. Campagna, AICP
Executive Director

RLC/py
Enclosure

* THE FOLLOWING IS EXCERPTED FROM A RECENT *
ENERGY REPORT MADY BY THE LCRPC.

While varying philosophies view and define energy differently, it is universally conceded that energy is a genus consisting of various elements or forms and must be so considered. Man's modern day requirements usually demand the change of one form of energy to another (e.g., chemical energy to electrical energy, etc.) so that is we can conserve energy in one form it may well result in an increase of energy in yet another form.

It is this writer's opinion that since electricity can be produced by the simple expedient of providing a conductor, a magnetic field and relative motion between the two, this form of energy has great potential for meeting a fair share of the energy needs of man at a most reasonable cost.

Let us now touch upon the production of electricity using water power. Hydroelectric generating plants are still considered to be the most economical and safest of all the methods of producing electricity since all that is required is moving water and a generator. There are too few natural waterfalls available to be put to this use. But what about the possibility of creating a waterfall ("energy fall"?) under certain conditions?

Consider the following:

1. A river or stream etc. winds it's way along the earth's surface, curving wherever it runs into a mountain or hill, etc.

2. The elevation at the initial point of curvature is 1300 feet above sea level.

3. The course of the waterway around the mountain and along a valley forms a rough semi-circle.

4. The elevation at the terminal end of the curvature is 1,100 feet.

Question: Why cannot the waterway be channeled to the obverse side of the mountain so that it reaches an elevation of 1,280 or so feet, from which point sufficient earth could be moved to clear a plant site at a 1,120 foot elevation causing a vertical water drop of 160 feet?

The kinetic energy so created can be harnessed to generate electricity in several different ways. The accompanying graphic illustrates the possibility described above with the plant site engineered to accommodate an appropriately sized turbine.

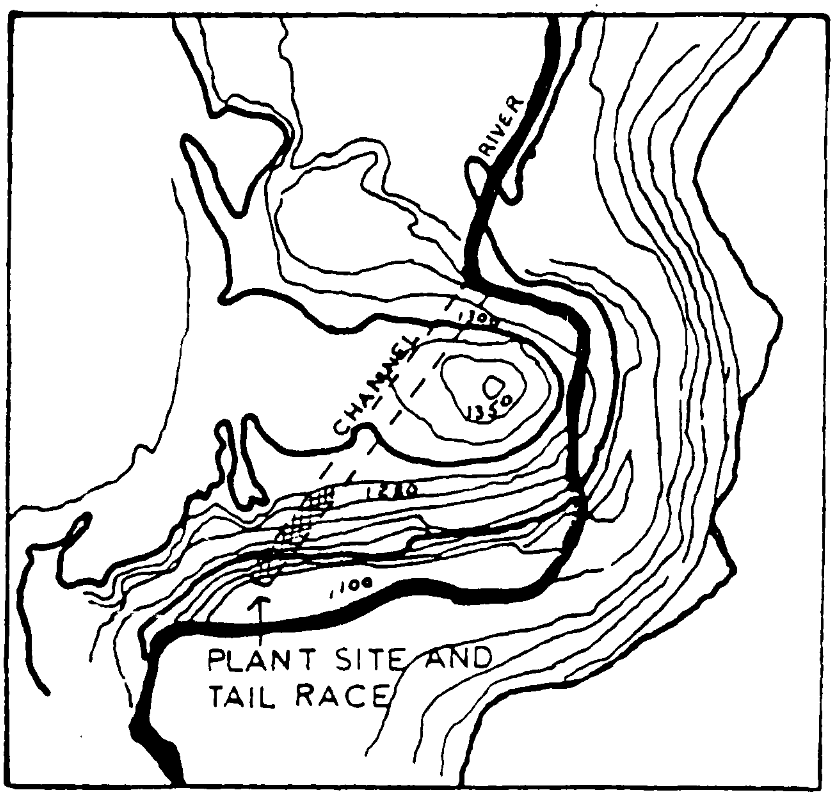
Virtually every major waterway (and many minor ones) has one or more locations similar to that described above which permits the waterfall to be used and provides for a re-entry into the waterway after use.

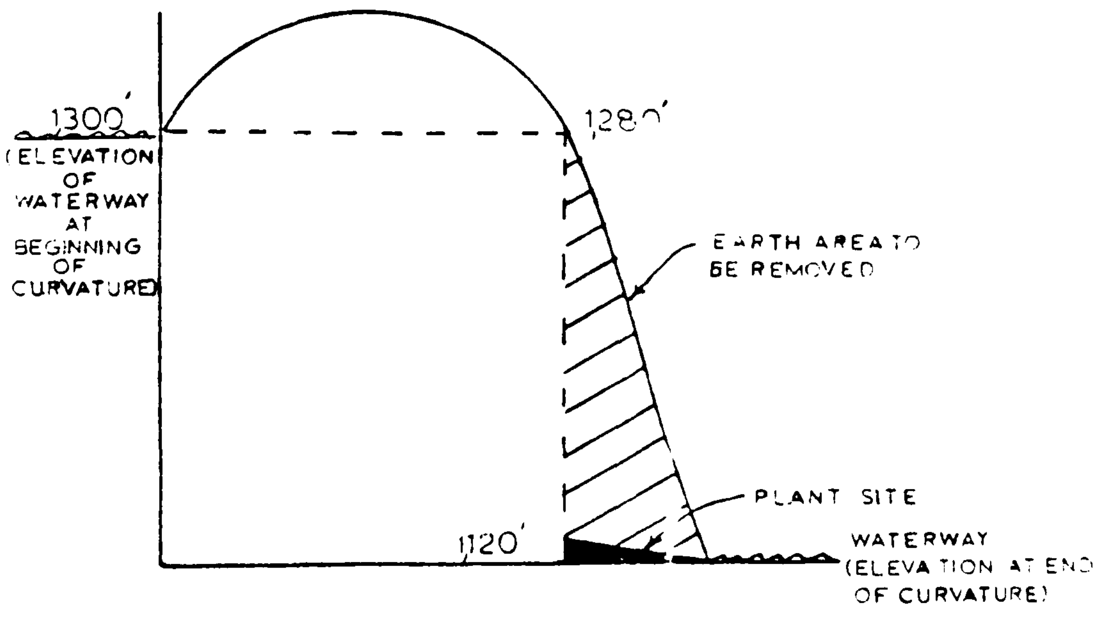
Control of flow could be accomplished in many ways (e.g., valves, etc.). A highly desirable location would be near an existing dam which would be ideal for the control of flow. (See flowing illustrations.)

Hopefully, after reviewing the above information, an interest will develop to further study the "energy fall" concept. Please feel free to contact me with regard to this concept.

Rocco L. Campagna, AICP
Executive Director
Lackawanna County Regional Planning Commission
200 Adams Avenue
Scranton, Pa. 18503

ENERGY FALL


RIVER
1300
CHANNEL
1350
1280
1100
PLANT SITE AND
TAIL RACE


1300'
(ELEVATION OF WATERWAY AT BEGINNING OF CURVATURE)
1280'
EARTH AREA TO BE REMOVED
PLANT SITE
1120'
WATERWAY (ELEVATION AT END OF CURVATURE)

United States Department of the Interior

GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
P. O. Box 1107
Harrisburg, Pennsylvania 17108

December 14, 1979

James G. Ton
Colonel, Corps of Engineers
District Engineer
Philadelphia District, Corps of Engineers
Custom House, Second and Chestnut Streets
Philadelphia, Pennsylvania 19106

Attention: Mr. John Tunnell

Dear Colonel Ton:

We received your notice of initiating a study of developing hydroelectric power in the Lehigh Basin. Please be advised that we of the Pennsylvania District, U.S. Geological Survey, Water Resources Division are willing to discuss any assistance we could give to the study in areas where we have expertise. Our local contact would be Mr. John Murphy of our Malvern Subdistrict Office. He may be contacted by phone at 215-647-9008, or the address is:

Great Valley Corporate Center
35 Great Valley Parkway
Malvern, Pennsylvania 19355

Sincerely,

David E. Click

David E. Click
District Chief

ONE HUNDRED YEARS OF EARTH SCIENCE IN THE PUBLIC SERVICE

R. D. #2
Palmerton, Pa. 18071
December 15, 1979

Mr. Gerald M. Hansler
Delaware River Basin Commission
P. O. Box 7360
West Trenton, New Jersey 08628

Dear Mr. Hansler:

As a follow-up to my comments at the November 15th hearing at East Stroudsburg on the Final Draft Report of the Delaware River Basin Comprehensive (Level B) Study, I wish to reiterate the concerns of the Aquashicola Valley Action Committee, comprising residents who will be affected by the proposed Aquashicola Dam.

Frankly, we were considerably disturbed that the data on the Aquashicola project had not been updated from the original information compiled by the Army Engineers in the early 1960's. This outdated information appeared in the February 1979 Level B Study Report, was brought to the attention of the Study Staff at the April 4th Allentown hearing, was confirmed in writing to Mr. David Longmaid on April 25th, but again appeared unchanged in the October Final Draft Report.

We wish to know if it is possible to revise this information for the final publication of the Level B Study Report to reflect the actual facts as of 1979, and to present the realistic economic, environmental and social impacts. We feel that a study lasting one and one-half years and costing $1,500,000 should certainly present the true facts on all proposed projects lest the credibility of the entire study be questioned.

Avoiding the usual emotional objections predominantly aired at hearings, we wish to confine the following items to tangible economic issues which should, by all reason, remove the Aquashicola Project from the list of proposed facilities as shown in Table 6 on page 13 (October report).

On page 100 it is stated that 100 homes would be lost or relocated. An up-to-date count shows about 250 homes. There has been unusual building activity in the Valley between Little Gap and Smith Gap, much of it inspired by the desirable environment of this section of the Aquashicola Creek. The count of 10 farms and 15 businesses shown in the report is essentially correct. However, one business, Scotty's Fashions, has greatly expanded, now employing 160 prople.

The greater number of homes will certainly affect the Purchase Cost of Land Acquisition shown at $7.6 million on page 100, increasing it substantially. The average purchase price on 250 homes would only be $30,400 without consideration of the 2440 acres involved. By today's values this figure is ridiculously low.

Should a realistic purchase allowance be made, this will impact on the benefit-cost ratio, making this project less favorable than the 1.2 indicated on page 100.

We must question how the 1.2 benefit-cost ratio was obtained in view of the information on Cost of Flow Augmentation on page 104. There it is stated that capital cost per cfs new yield is $720,000 - more than double the cost of any of the other projects listed in that category. Furthermore, is the $70 million allocated capital realistic in this day of grossly overspent projects?

Of great concern to us is the impact on the tax revenue, most of which supports the local school systems already restricted to tight budgets. The loss of 250 homes could represent the loss of as much as 5% of the tax revenue.

Following are a number of other factors that should not be overlooked:

1. The report does not take into account a natural gas pipeline passing through almost the entire length of the proposed impoundment. This line was installed after the Corps of Engineers' initial study.

2. A new ski area located on the north face of Blue Mountain opposite Little Gap promises to be one of the finest in Pennsylvania when fully developed. The Aquashicola Dam Project will limit its development along with the economic benefits.

3. Stoney Ridge bounding the north side of the impoundment area is honeycombed with old mine tunnels from the mining of iron ore used in making red pigments. These tunnels pose the threat of serious leakage and flooding hazards with the high water levels proposed.

4. The stress on the local facilities and services by the influx of 156,000 visitors annually is to be viewed with alarm. Narrow secondary roads serve this area, unlike Beltzville which is just off the Northeast Turnpike. Police service is minimal in our area, and increased crime invariably follows in recreation areas.

5. The Bethlehem City water supply and Buckeye petroleum pipelines will have to be relocated as well as portions of the P. P. & L. power distribution system.

6. In view of the steep terrain surrounding the proposed impoundment, we question the suitability of any part of this area for land recreational activities.

7. The 19[illegible] plan of the Corps of Engineers did not provide a roadway along the north side between the dam and Little Gap Village. The property between the impoundment area and the top of Stoney Ridge remaining in private hands would be inaccessible to the owners.

8. It has been pointed out by the Carbon County Planning Commission that presently 40% of the land area of this County is public domain. Further removal of private property can have a depressing effect, especially in the Aquashicola area where remaining lands will not be particularly suited to residential or commercial development.

Please acknowledge this letter, stating whether or not the Study Staff will incorporate the updated facts in the final Level B report.

It is the general feeling of the Aquashicola group that, because we have not made a lot of noise in public on emotional issues and have chosen to deal with facts in an objective manner, our message has not been given serious consideration.

Copies of this letter will be released to concerned State and Federal legislators and local newspapers.

Very truly yours,

Aquashicola Valley Action Committee (AVAC)

cc: Mr. David Longmaid

PP&L

TWO NORTH NINTH STREET, ALLENTOWN, PA. 18101 PHONE: (215) 821-5151

December 17, 1979

Mr. James G. Ton
Colonel, Corps of Engineers
Philadelphia District
Custom House-2D & Chestnut St.
Philadelphia, PA 19106

LEHIGH RIVER BASIN
HYDROELECTRIC POWER STUDY
CCN 775225

Dear Mr. Ton:

We appreciate receiving your November 27, 1979 letter and being informed of the Corps' Lehigh River Basin Hydroelectric Power Study. PP&L welcomes the opportunity to participate in the proposed study and would be pleased to provide helpful information for its successful completion.

If the need arises, I can be contacted at (215) 821-5641.

Very truly yours,

WN Strobel

W. N. Strobel
Principal Civil Engineer

WNS/PLG/RJT:po
616690

ALLIS-CHALMERS

BOX 712 • YORK, PENNSYLVANIA 17405 / 717 792-3511

YORK PLANT
HYDRO-TURBINE DIVISION

January 3, 1980

Department of the Army
Philadelphia District
Corps of Engineers
Custom House - 2D & Chestnut Streets
Philadelphia, Pennsylvania 19106

ATTENTION: James G. Ton
Colonel, Corps of Engineers
District Engineer

REFERENCE: NAPEN-R

Dear Sir:

In response to your letter of 27 November 1979, we are very pleased to be advised you are proceeding with the Lehigh Basin Hydropower Study. The most current information which we have had available is the Delaware River Basin "Planning Status Report" published by the Federal Power Commission in 1966. This lists storage reservoirs, exisiting hydro projects and potential storage and hydroelectric projects on the Lehigh River.

We are currently working with the City of Allentown, Pennsylvania, and the Pennsylvania Hydroelectric Development Corporation who are each proposing to develop sites. We are enclosing two (2) copies of our standardized hydroelectric generating unit bulletin which may be useful to you in "ballparking" the equipment size and type most suitable for the low head sites. This line of standard units is being expanded into higher heads for the small sizes and another line of equipment for sites with heads less than 20 ft.

We trust that you have on hand the Department of Forest and Water's inventory as well as the two or three others that are available. Please do not hesitate to contact us if we can be of assistance.

Sincerely,

Howard A. Mayo

Howard A. Mayo, Jr., P.E.
Manager, Market Development

HAM/jb
Enclosure

cc: Mr. John Tunnell, Department of the Army, Philadelphia District

LEHIGH VALLEY SECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS

January 7, 1980

Col. James G. Ton, District Engineer
Philadelphia District, Corps of Engineers
Custom House - 2 D & Chestnut Streets
Philadelphia, Pennsylvania 19106

RE: NAPEN-R

Dear Colonel Ton:

Your letter of November 27, 1979 addressed to the Executive Director of the American Society of Civil Engineers (ASCE) on the Lehigh River Basin Hydroelectric Power Study was referred to the Board of Directors of the Lehigh Valley Section, ASCE. The contents of the letter were discussed at the January 7, 1980 meeting of the Board. The Board is extremely interested in the forthcoming activities, and would like to be kept informed, if possible.

In the very near future section-wide committees dealing with the environmental, and energy areas will be activated. I am sure these committees would be greatly interested in interacting with this project and providing input, where possible. Until the identification of the individuals who will be charged with these technical activities, I would greatly appreciate it if you can direct future correspondence to me at the above address.

We would like to express our appreciation for the opportunity given to us to interact on this important project.

Sincerely yours,

Celal Kostem

Dr. Celal N. Kostem, Secretary
Lehigh Valley Section, ASCE

CNK:km

Commonwealth of Pennsylvania

DEPARTMENT OF AGRICULTURE

PENROSE HALLOWELL

January 11, 1980

Colonel James G. Ton
District Engineer
Department of the Army
Philadelphia District, Corps
of Engineers
Custom House--2D & Chestnut Street
Philadelphia, PA 19106

Dear Colonel Ton:

Thank you for informing me that the Army Corps of Engineers has initiated the Lehigh River Basin Hydroelectric Power Study to investigate the potential for developing hydroelectric power. The study, which will consider both existing and potential dam sites in the entire basis for the production of electricity, is of interest to the Department.

I have designated Mr. Daniel K. Cook, Director of the Office of Planning, Research and Economic Development of my staff to represent the Department in the Lehigh River Basin Study. Please direct further correspondence concerning the study to Mr. Cook at the address below, or by telephone at 717-787-1788.

Sincerely yours,

Penrose Hallowell

PENROSE HALLOWELL

2301 North Cameron St. Harrisburg, Pa 17120 717-787-4737

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-P

27 DEC 1979

INVITATION TO A PUBLIC MEETING
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY

...to be held on 29 January 1980
at 7:30 p.m. in the Auditorium
of Lehighton Area High School
Beaver Run Road, Lehighton, Pennsylvania

I would like to take this opportunity to invite you to a public meeting to discuss our study concerning the development of hydroelectric power in the Lehigh River Basin. This study is being made at the request of the Committee on Public Works and Transportation of the U.S. House of Representatives.

At this initial public meeting, we are particularly interested in learning about prior non-Federal hydropower studies, your views on energy problems, the basin's hydroelectric generation potential, and the possible problems its development might cause. During the meeting we will present slides on previous Corps of Engineers hydroelectric power studies, discuss current studies by Federal, state and private interests, and outline the general framework for Corps of Engineers' planning activities.

Your help is needed to determine the extent of our investigations and to set the stage for an effective study. You can begin to help us by planning to attend the public meeting and encouraging others to do the same. A map of the meeting location is inclosed.

It would be particularly helpful if lengthy presentations were submitted in writing to me prior to the meeting and only summarized at the meeting itself. These documents will be made part of the record, but summarizing them at the meeting will allow more time for everyone to participate.

I am looking forward to seeing you at the meeting.

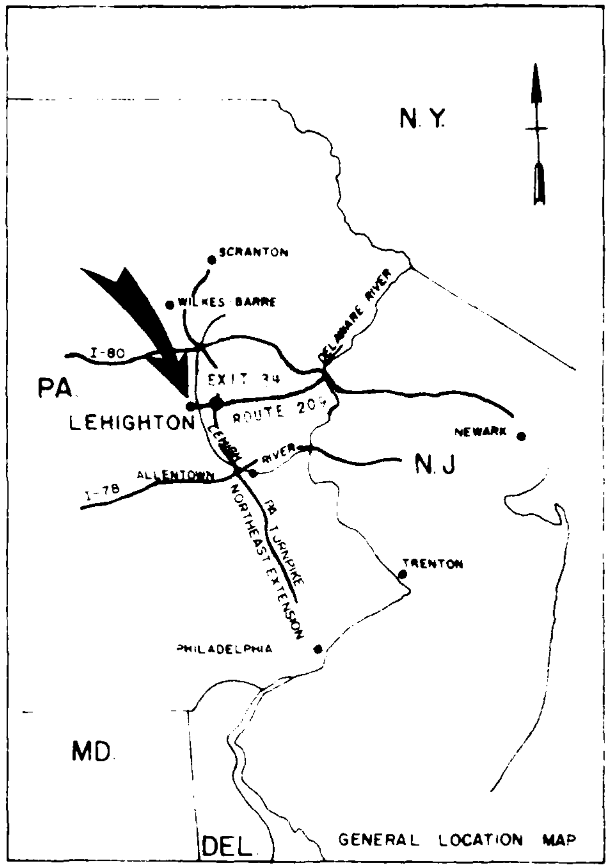
Sincerely,

James G. Ton

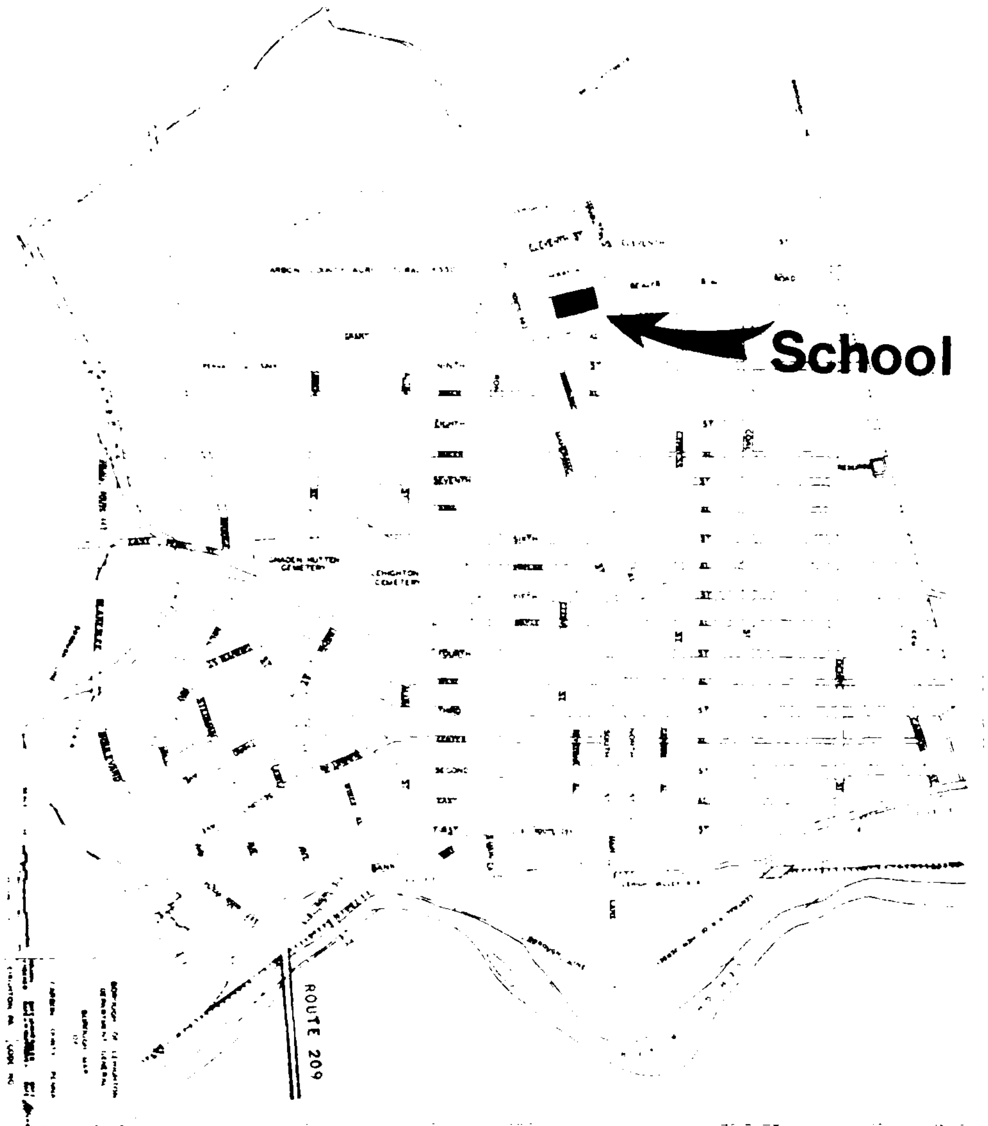
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
Map of meeting location

General Location Map



Meeting Site Map



9 Jan 80

[illegible]

Thank you for your invitation to the public meeting [illegible], at [illegible] [illegible] Leighton, [illegible] study [illegible] the level [illegible] [illegible] Guadalupe River [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] I [illegible] [illegible] [illegible].

In response to your invitation to comment on the [illegible], I must [illegible] that I have distinct misgivings on any plan that [illegible] have [illegible] [illegible] [illegible] on the [illegible] River. Since it has been [illegible] "[illegible] river" [illegible] Dam to [illegible] Thorne by legislative [illegible], this [illegible] to have adequate protection [illegible] [illegible].

[illegible] areas of concern include the dam itself and the river [illegible] [illegible] it. Information I have received indicates that studies of hydro [illegible] [illegible] tied at least in part to [illegible] of the [illegible] [illegible] which [illegible] flooding of the [illegible] between the [illegible] and [illegible].

I [illegible] I [illegible] the [illegible] to [illegible] to this scenic [illegible] for [illegible] [illegible] [illegible] proportions for [illegible] in [illegible] [illegible]. It [illegible] the function for which it [illegible] intended as safeguard [illegible] [illegible] destructive flooding. It has also been used [illegible] [illegible] influence [illegible] level in the [illegible] River [illegible].

[illegible] electrical [illegible] of [illegible] energy problem, it [illegible] [illegible] could be solved through conservation. [illegible], I [illegible] why so much electricity is [illegible] in [illegible] [illegible] [illegible], [illegible], [illegible] [illegible] [illegible].

[illegible] River Region

[illegible] would be conducted in [illegible], [illegible] of [illegible] interests, [illegible] nearly [illegible].

[illegible] justify [illegible]. In the event of hostilities with a foreign [illegible] would be an inevitable target of enemy aircraft. [illegible] holding back countless thousands of gallons of water [illegible] of water down the Lehigh Valley to knock out [illegible] U.S. defense industry.

[illegible] venture needed to develop the Lehigh's hydro potent- [illegible] area's anthracite resources, the coal [illegible] source of fuel for expanded regional elect- [illegible] badly needed shot in the arm for the [illegible].

[illegible] environmentalist, it is surprising [illegible] to the destruction of this incomparably beautiful stretch [illegible] of unique [illegible] habitat would be a tremendous loss when so much [illegible] taken for ever expanding building development.

Sincerely

Tim Hunt

Thomas E. Hunt

January 15, 1980

Attention: Col. James G. Ton, Philadelphia District Engineer

Subject: Hydro-electric power in the Lehigh River Basin

Dear Colonel Ton:

I am writing in reference to the proposed hydroelectric power for the Lehigh River Basin.

Coincidentally, I recently viewed a television special called "Weather Report 1980" and one matter presented was a hydroelectric power project in Africa. It focused on the plight of the animals in the flooded lands. A rescue operation was initiated by the S.P.C.A. Many of these animals were already drowned or starving in the branches of the trees.

The newspaper article I read concerning the project made no mention of wildlife and what would happen due to the flooding of game lands.

Can you answer my question?

Thank you.

Barbara Langel

Barbara A. Langel
319 So. River St.
Plains, Penna. 18705

Star Route #1 Box 44
Blakeslee, Penna. 18610
Jan. 15, 1980

Col. James G. Ton
Phila. Dist. Engineer
Army Corps of Engineer, Custom House
Second and Chestnut Sts.
Phila. Pa. 19106

Dear Colonel Ton,

I am writing to you in reference to an article printed in our local newspaper; regarding the Francis E. Walter Dam. I am not sure if your plan is in reference with the Level B Study put together by the Delaware River Basin Commission. But, in either case, I must state my objections to your plan.

I have been a resident and/or a visitor of Stoddartsville, the small group of houses, located around the falls where Route 115 crosses the Lehigh River, for the past fifteen years. The Lehigh River and the surrounding area, has been a great delight to me for all of this time. And at this time, my parents are now permanent residents.

For all these many years, I have enjoyed the Lehigh River as what I've always considered my own "private library".. Many a summer, I have spent hour upon hours, sitting on the rocks in the sun, reading a good book, sunbathing, or even just enjoying the scenery or going for a swim. I tell you this first, to profess my deep devotion for the Lehigh.

My main objection and concern to this particular study, is what your possible intentions could do to the surrounding area, including the permanent property damage that would most definitely result. If indeed, the dam were enlarged and the land flooded.

First of all, FEW Dam, is an earth-works dam, which to the best of my knowledge, has yet to be filled to capacity. Not even during the [illegible] of the 60's, was filled to its capacity. If you will, let me project ahead for a minute, and this, I'll admit is only speculation. What if, [illegible], after the dam *were* enlarged and something were to [illegible]

B-11

cause it to let go. Have you considered then, the property [illegible] that would indeed result? Most definitely, White Haven and Easton, not to mention the little communities, would literally be wiped out. I'm sure your saying to yourself now, that in the enlargement, you will take every precaution to safeguard this from occuring. But, how safe can you make an enlargement of an earth-works dam? The slightest error and unfortunately there would be a disaster, costing [illegible]ions.

The Lehigh River Basin is a sanctuary for wildlife, including the White-tailed Deer, Black Bear, Otters, Beavers, etc.. Not to mention the many species of Birds, that have been sighted by one or more observers. (see attached list--sighted by Lee T. Pearcy Jr.-relation by marriage.). If your project were to become a reality, it would take away this sanctuary for the wildlife. The Stoddartsville Falls itself, has been a popular attraction for many traveling visitors each year and a popular setting for artists. Most recently, Ranulph Bye, the well known Bucks County artist. The Stone Ruins, once believed to be a working mill, that stand beside the falls, are well known enough to be depicted on a $20 draft bill of the Susquehanna Bank of Wilkes-Barre.

So in final saying, if the Hydroelectric Power Plan were indeed to become a reality, it would destroy this gorgeous property of which we are all so fond.

Sincerely,

Deborah M. Eyre

Deborah M. Eyre

Birds seen in [illegible]

by Lee I. [illegible]

Red-shouldered Hawk
Broad-winged Hawk
Mourning Dove
Yellow-billed Cuckoo
Yellow-shafted Flicker
Downy Woodpecker
Eastern Phoebe
Least Flycatcher
Eastern Wood Pewee
Barn Swallow
Cliff Swallow
Tree Swallow
Bank Swallow
Purple Martin
Blue Jay
Common Crow
Tufted Titmouse
White-breasted Nuthatch
Brown Creeper
Black-capped Chickadee
House Wren
Winter Wren
Catbird
Robin
Wood Thrush
Hermit Thrush
Veery
Cedar Waxwing
Starling
Red-eyed Vireo
Philadelphia Vireo
Blue-gray Gnatcatcher
Black-and-White Warbler
Blue-winged Warbler
Tennessee Warbler
Yellow Warbler
Chestnut-sided Warbler
[illegible]
Canada Warbler
Osprey
Cooper's Hawk
Ruby-throated Hummingbird
Belted Kingfisher
Hairy Woodpecker
Traill's Flycatcher
Ovenbird
Louisiana Waterthrush
Yellowthroat
American Redstart
Red-winged Blackbird
Common Grackle
Baltimore Oriole
Cardinal
Purple Finch
Pine Siskin
Rufous-sided Towhee
Vesper Sparrow

[illegible]
Field Sparrow
Song Sparrow
[illegible]
[illegible] *
Wild Turkey *
[illegible] *
[illegible] *
[illegible] *
[illegible] *
[illegible] *

* Seen by [illegible] M. [illegible]
[illegible] years.

DELAWARE RIVER BASIN COMMISSION
P. O. BOX 7360
WEST TRENTON, NEW JERSEY 08628

609 88 9500

January 17, 1980

Colonel James G. Ton
District Engineer
Philadelphia District, Corps of Engineers
Custom House - 2nd and Chestnut Streets
Philadelphia, Pennsylvania 19106

Dear Colonel Ton:

I have your letter NAPEN-P dated December 28, 1979 and the invitation to a public meeting on January 29, 1980 regarding the Lehigh River Basin Hydroelectric Power Study. As suggested in your invitation, in order to save time at the public meeting, I am submitting the following comments for the record at this time.

The Delaware River Basin Commission encourages the development of hydroelectric power by private and public agencies as a beneficial use of the basin's water resources and as an addition to the nation's renewable energy supply. By Resolution No. 79-24 (copy enclosed) adopted on October 16, 1979, the Commission declared its policy to encourage development of small-scale hydroelectric power and energy at existing and proposed impoundments in the Delaware Basin. It also declared that the development of such power and energy shall be coordinated with other water uses and consistent with policies in the Comprehensive Plan. The Commission is now reviewing its hydroelectric power policy and it is expected that there will shortly be further policy adopted for guidance of hydropower developers.

In addition, Resolution No. 79-24 identified the Commission's fundamental interest in certain projects in which it has served as a project sponsor, purchased water supply storage in such projects, or indicated a commitment to participate in such projects. In order to achieve maximum multiple benefits from the major existing and proposed projects in the Basin, the Commission considers it imperative that their operations be coordinated and integrated.

As noted in the draft Level B Plan, the Delaware River basin confronts serious flow management problems, relating to control of salinity intrusion in the Delaware estuary, protection of public water supplies, and provision for important power, industrial and agricultural diversions. Storage available for flow maintenance releases must be marshalled from a number of projects in the [illegible] joint operation of the [illegible] reservoirs [illegible] Commonwealth [illegible] Decree, coupled with [illegible] lower [illegible] section and regulation [illegible] the existing Beltzville and Blue Marsh [illegible] [illegible] ps of Engineers [illegible] [illegible] with [illegible] to be constructed [illegible] the direction of [illegible] the existing [illegible] the Pennsylvania Department of Environmental [illegible] emergency conditions at [illegible] parties to the Supreme Court Decree and [illegible] currently working on [illegible] projects in order to maintain [illegible] minimum desirable low flow at Trenton, at the [illegible] water quality and [illegible] compensate for consumptive uses in the basin and [illegible] provide acceptable flows below the projects [illegible] fish habitat and recreation.

[illegible] reaches of the Lehigh and Schuylkill Rivers have been [illegible] will soon be designated by the Commonwealth of Pennsylvania as scenic and/or recreational rivers under its Scenic River Act of 1972. These designations have been approved by the DRBC as a part of its Comprehensive Plan. Rapid fluctuations in releases and extreme ranges in maximum and minimum releases could have a negative impact on the scenic River and its recreational uses. Releases from water supply storage at projects under the control of DRBC, will be available for the production of hydroelectric power, if feasible. Accordingly, as set forth in Resolution No. 79-24, the Commission plans to undertake feasibility studies of the hydroelectric power potential at several projects, two of which are located in the Lehigh River Basin, namely the proposed modified Francis E. Walter Dam and Reservoir and the Beltzville Dam and Reservoir. A joint application for a preliminary permit (copy previously furnished to you) for the proposed Francis E. Walter water power project was filed with the Federal Energy Regulatory Commission (FERC) on November 23, 1979 by the DRBC and the Commonwealth of Pennsylvania, acting through the Department of Environmental Resources. It is expected that joint applications for support of similar studies at the Beltzville, Blue Marsh and Prompton (modified) projects will be filed with FERC by the end of January 1980. Obviously, all of these proposed hydropower studies would need to be closely coordinated with your office and we intend to do so.

Finally, if the Commission staff can assist you in your study of the Lehigh River Basin, please do not hesitate to contact me.

Sincerely,

Gerald M. Hansler

cc: [illegible] Commissioners, Advisors, Mr. F. Plumb, [illegible], Mr. [illegible] Gleeson, Pa. Hydroelectric Corp., Mrs. R. Knepper, Weatherly, Pa., Mr. M. [illegible], Lehighton, Pa., M. Duke Pepper, PaDER

RESOLUTION NO. 79-24

A RESOLUTION relating to small-scale hydroelectric power policy.

WHEREAS, Section 1.3 of the Delaware River Basin Compact recognizes that the various uses of the water resources of the basin - including water supply, flood control, water quality enhancement and hydroelectric power generation - are functionally interrelated and interdependent; and

WHEREAS, there are presently existing or planned a number of dam and reservoir projects in the basin constructed and operated by agencies of the signatory parties, including the U. S. Army Corps of Engineers, the Soil Conservation Services and the Commonwealth of Pennsylvania Department of Environmental Resources, and

WHEREAS, such projects serve multiple uses recognized and protected by the Delaware Basin Comprehensive Plan; and

WHEREAS, the Delaware River Basin Commission has a fundamental interest in such projects, and for several of the projects has served as a project sponsor, purchased storage in such projects or indicated a commitment to participate in such projects, and

WHEREAS, in order to achieve maximum multiple benefits from the major existing and proposed reservoir projects in the basin, it is imperative that their operations be coordinated and integrated, and

WHEREAS, the Compact assigned to the Commission the lead responsibility to provide the necessary coordination and integration of project development, management and operation, in concert with the signatory parties; and

WHEREAS, several of the existing and proposed dam projects sponsored by agencies of the signatory parties have the potential to provide hydroelectric power generation as an additional and complementary benefit to other project purposes, and

WHEREAS, Articles 9 and 12 of the Compact authorizes the Commission to sponsor, finance, develop and operate facilities for the purpose of hydroelectric power generation and transmission, and to market such power; and

WHEREAS, development of hydroelectric facilities at those dams constructed and operated by agencies of the signatory parties by other private or public entities would further complicate project operations and hinder achievement of coordinated and integrated project management; and

WHEREAS, development of hydroelectric facilities at such dams by the Delaware River Basin Commission, in concert with the affected signatory party agencies, would enhance the coordinated and efficient operation and management of the major basin projects and maximize the achievement of multiple project benefits in the public interest; now therefore

BE IT RESOLVED, by the Delaware River Basin Commission:

1. It shall be the policy of the Commission to encourage development of small-scale hydroelectric power and energy at existing and proposed impoundments in the Delaware Basin. The development of such power and energy shall be coordinated with other water uses and consistent with policies in the Comprehensive Plan.

2. Subject to the availability of funds, the Commission will undertake feasibility studies of the hydroelectric power potential at the following projects:

   a. Francis E. Walter Reservoir (and proposed modification)

   b. Beltzville Dam

   c. Blue Marsh Dam

   d. Prompton Dam (and proposed modification)

e. Any project owned or operated by an agency or subdivision of a signatory party when the signatory party has requested the Commission to undertake a feasibility study.

Where appropriate, the Commission shall undertake such feasibility studies in concert with interested agencies of the signatory parties in which the particular project is located and agencies which own or operate the particular project.

3. The Executive Director shall file with the Federal Energy Regulatory Commission documents constituting a proper application for preliminary permits to study those projects listed in or authorized pursuant to paragraph 2 of this resolution. The Executive Director is further authorized to apply as necessary to the Department of Energy for one or more loans under Title IV of the Public Utilities Regulatory Policies Act of 1978. Such applications shall be filed, where appropriate, in concert with the interested agencies of the signatory parties.

4. The Commission will oppose the issuance of preliminary permits or licenses by the Federal Energy Regulatory Commission to sponsors other than the Delaware River Basin Commission or agencies of the signatory parties relating to the projects listed in or authorized pursuant to paragraph 2 of this resolution, or any project now owned or operated by an agency of a signatory party, unless otherwise approved by the Delaware River Basin Commission and included in the Comprehensive Plan. The Executive Director and General Counsel are authorized and directed to take such action as necessary to communicate and enforce this policy.

5. The Executive Director is directed to notify appropriate federal agencies of the Commission's interest in small-scale hydroelectric power development in the Delaware Basin and to advise them of the requirements relating thereto contained in the Delaware River Basin Compact.

s/Dirk C. Hofman
Dirk C. Hofman, Vice Chairman pro tem

s/ W. Brinton Whitall
W. Brinton Whitall, Secretary

Adopted: October 16, 1979

CITIZENS
NORTHWESTERN LEHIGH
COALITION

Box 13, New Tripoli, PA 18066

January 22, 1980

Colonel James G. Ton, District Engineer
c/o Mr. John Tunnell
Corps of Engineers, Department of the Army
Custom House, Second and Chestnut Streets
Philadelphia, PA 19106

Dear Colonel Ton:

Re: Lehigh River Basin
Hydroelectric Power Study

Please include this letter in the record of public comments presented at your Lehighton, Pennsylvania meeting on the Lehigh River Basin Hydroelectric Study. It represents the position of the Northwest Lehigh Citizens Coalition only insofar as the study relates to the proposed Trexler Dam Project in Lehigh County, Pennsylvania.

We tentatively endorse a study of the possible development of hydropower in the Lehigh River Basin providing this development is within sound environmental and economic guidelines and does not involve the loss of homes and farms or otherwise disrupt the people of the area. We strongly oppose the construction of additional dams anywhere in the Delaware River Basin.

The inclusion of the Trexler Project in this study is reprehensible. As you have been advised as early as 1966 by Mr. John H. Spellman, Acting Regional Engineer, Federal Power C[illegible]ission, who wrote:

> "Based on the results o[illegible] review, it is concluded that the relatively small power potential associated with the Trexler multiple-purpose reservoir project would not be economically feasible of development."

You are fully aware that this project was rejected unconditionally by the voters of Lehigh County by an overwhelming 3 tol majority, and that the State Congressmen of Lehigh, the City of Allentown, the County of Lehigh, U. S. Representative Donald Ritter and Senators Richard Schweiker and John Heintz have all called for congressional deauthorization of the project. Currently, in this session of Congress, there are pending, in both the House and Senate, bills to deauthorize the Trexler Project.

Being in full knowledge of these facts you are now proposing to use public money to reactivate this project under the guise of a hydroelectric study. We can only view this as an attempt to contravene the wishes of the voters and their elected officials and representatives, and is clearly contrary to the wishes of the Congress.

After the general election of 1977 when the project was defeated, the people of Lehigh County were promised by the United States Congress and President Carter that there would be no further funding for studies or construction of Trexler Dam. If the Corps insists on including this project in its hydroelectric study, we have no recourse but to petition the House Committee on Public Works and Transportation to honor their pledge to the people of Lehigh County and withdraw all current and future funding for this study.

If your program is to have any chance of success, it is essential, therefore, that you respect the mandate of the people and delete the Trexler Project from all further consideration.

In a democracy, we, the people, not you, will decide our own destiny.

Very truly yours,

Bob Miller

J. Robert Miller
Water Resources Chairman
R.D. 1, Box 212
Schnecksville, PA 18078

cc: Representative Donald Ritter
Senator Richard S. Schweiker
Senator H. John Heintz
Mr. Donald L. Dillon

302 W. Susquehanna St
Allentown, Pa. 18103

January 29, 1980

Dept. of the Army
Philadelphia District
Corps of Engineers
Custom House, 2nd & Chestnut St
Philadelphia Pa. 19106

Subject: Ref NAPEN-P

Dear Colonel James G. Ton:

Our committee wishes to advise if your Hydro Power Project incorporates Tocks Island Dam Lake Project, we shall continue to request Tocks Island Dam issue be deauthorized from the DRBC Comprehensive Plan.

Very sincerely yours,
Harry Toner Chairman of
the "Growth" Committee of
Allentown Community Neighborhood
Organization Inc Environmental Committee

Army Corp of Engineers

Several years ago we joined two organizations to fight the building of Trexler Dam for diverse reasons that evolved from a great deal of study and information gathering.

We are appalled that despite the 3 to 1 referendum vote in Lehigh County against the building of Trexler Dam this project has again raised its ugly head.

The Army Corps has been the single largest supporter of pork barrel projects foisted on us by vote seeking congressmen.

Our area desperately needs to preserve our remaining farmland which is rapidly falling prey to unbridled growth. I firmly believe that building dams actually encourages the consumption of water. What we need to recognize is the role of conservation as a viable and economical alternative. I urge the Corps to seriously consider the adverse effects that will result from resurrecting the issue of Trexler Dam

Arlene B. Wallach
2352 S Carlton St
Allentown, Pa 18103

C.L.A.D.
Citizens of Lehigh Against the Dam - Treasurer

Box 49, Star Route
Blakeslee, Pa. 18610

February 7, 1980

Col. James G. Ton
Philadelphia District Engineer
Army Corps of Engineers
Customs House, Second & Chestnut Streets
Philadelphia, Pa. 19106

Dear Col. Ton:

I am a property owner at Stoddartsville, Pa. overlooking the Lehigh River. I learned that a hearing was to be held in Lehighton on January 29th concerning the possible use of the Francis E. Walter Dam for hydroelectric power. Since I was not able to attend the hearing, I feel compelled to write this letter.

First of all, I, and many others, are in extreme opposition to raising the F. E. Walter Dam above its present height for numerous reasons previously outlined to the Delaware River Basin Commission. I fully realize the complexities of the situation confronting the DRBC. I have gone on record with them, and wish to do so with you, that it is far more important to encourage conservation of water and power downstream than it is to turn one of our few remaining natural assets into an automatic faucet for others to waste away with no conception of its value and what is involved at its origin.

As to a possible hydroelectric project on the dam, it would certainly seem more worthwhile than impounding water for a possible drought, the likes of which only occurs about once every 500 years (according to DRBC statistics). I have lived by and watched the flow of the Lehigh River past Stoddartsville in all seasons for about 50 years. My common sense alone tells me that the flow of that river, even with Bear Creek and the Tobyhanna added to it, could not possibly maintain an ample flow for a project such as I understand is presently under consideration. The hydroelectric installation at Hawley on Lake Walenpaupack is a perfect example of what would happen on the Walter Dam. Once again we are faced with a terrible waste of money and the prospect of looking at a mud hole full of dead trees.

I urge you and all others involved to let the Walter Dam do what it was constructed to do in the first place -- flood control. It can still supplement flow on the Delaware River, when needed, at its present height. Surely the preservation of the God-given falls of the Lehigh River and the gorge below at Stoddartsville is just as important to future generations as what is presently contemplated on the Walter Dam. Man can not continue to wipe out in a short time what God has taken millions of years to provide--especially where a compromise is possible--and I truly believe in this situation there is a compromise that should receive reasonable and very serious consideration.

There is only one earth, our earth; there is only one race, the human race; there is only one future, our common future based on harmony among ourselves and with nature.

Respectfully submitted,

Miriam E. Eyre

Miriam E. Eyre

SYNERGIC RESOURCES CORPORATION

February 7, 1980

Colonel James G. Ton, District Engineer
Department of the Army
Philadelphia District Corps of Engineers
Custom House, Second & Chestnut Streets
Philadelphia, PA. 19106

Dear Colonel Ton:

I was pleased to accept your invitation to your public meeting on the Lehigh River Basin Hydroelectric Power Study in Lehighton, Pa. on January 29, 1980. In the interest of time I did not make a statement. This letter represents the essential points that I would have raised at the meeting. Please include this letter in the public record.

The Lehigh River Basin Hydroelectric Power Study by the U.S. Corps of Engineers is both timely and necessary. The hydroelectric resources of this basin are extensive including both existing dams and potential new projects. While the total generation of all the potential projects in the basin would not replace the need for electric generation using other technologies, hydro can make a significant contribution to the power requirements of the region. Not all these projects should be undertaken, however, since economic, environmental, and social costs at a given site may outweigh the benefits of development. For this reason, the Corps' study process should evaluate the hydroelectric projects on a site-by-site basis within the context of their current and best alternative use.

The interest in water resource management in general and hydroelectric power in particular in the Lehigh River Basin is evident from the attendance and response at the public meeting in Lehighton. Another indication of this interest is expressed in the number of public and private sponsored studies of the hydroelectric development potential at various sites in the basin. Attention has been focused on the Francis E. Walter dam since four competing applications for preliminary [illegible] permits have been filed with the Federal Energy Regulatory Comm[illegible]. Other permit applications have been filed or are anticipated [illegible]eltzville, Penn Forrest, Wild Creek, Allentown and [illegible] Dam. [illegible]liminary power permit has been issued by the FERC for the [illegible] Ground Hog Locks to Pennsylvania Hydroelectric Development Corp.

. . . continued . . .

ONE BALA-CYNWYD PLAZA, SUITE 630 • BALA-CYNWYD, PA 19004 • 215-667-2160

[illegible] 2

February 7, 1986

The Corps of Engineers should make use of existing evaluations made on these sites to accomplish your study's objectives which are ". . to determine if any improvements to the Lehigh basin in the interest of hydroelectric power and related purposes are advisable." These objectives do not preclude development of hydroelectric power by parties other than the Corps of Engineers and in fact suggests that the Corps [illegible] hydropower development by others in the basin. I would suggest that the Corps of Engineers take an active role to expedite the development of hydroelectric power resources at existing dams in the basin that have been thoroughly and objectively evaluated by reputable independent consultants and engineering firms. This approach would provide the benefits of sound projects to the community at the earliest possible date. Projects that can put power on line today at a reasonable cost and provide a net benefit to the [illegible] should not be delayed until all the other potential sites in the basin are identified, evaluated, proposed and approved by the Corps of Engineers. To delay development of projects at existing dams is to deny the public use of their resources. Any delay would raise both the ultimate cost of construction and therefore electric costs to all consumers in the region.

The simple solution to the potential problem of delays introduced by the Corps of Engineers' study would be to allow development at existing dams where sufficient study has been done. Some have argued that new dams would have an impact on the engineering design for other sites. New dams would help regulate stream flow, thereby improving the capacity utilization of any power plant located downstream. The effect of new dams would make hydroelectric generation more efficient and would improve the economics of projects at existing dams that were already justified using existing stream flow patterns.

The Corps of Engineers has an important role to play in the future of Lehigh River Basin. Its study should lead to a rational plan for developing the hydroelectric potential of the basin. This study should not impose needless delays and added costs to well planned projects at existing dams.

Thank you for providing the opportunity to present my views on the intent of your study. I have been in contact with your project manager Mr. [illegible] and his staff to present information on the hydroelectric projects that my firm, Synergic Resources Corp. has already studied. I will continue to cooperate with your study. I offer my assistance in the hope that the hydroelectric power resources of the Lehigh River Basin are developed in a timely way for the maximum benefit of region.

Sincerely,

Thomas C. Hough

Thomas C. Hough
Manager, Hydropower [illegible]
Synergic Resources Corporation

[illegible]

THE PHILADELPHIA URBAN COALITION

MAINSTREAM ENTERPRISES

Business Development Center

1315 Walnut Street - Suite 300 - Philadelphia, Pennsylvania 1910[illegible]

(215) 732-9222

[illegible] R MacKENZIE
Director

February 11, 1980

Mr. John Tunnell
Department of The Army
Phila. District, Corps of Engineers
Custom House - 2nd and Chestnut Streets
Philadelphia, PA 19106

Dear Mr. Tunnell:

I am writing as a business consultant to minority businessmen under a contract with the U.S. Department of Commerce, Minority Business Development Authority. In this function, I have become involved with private developers and municipalities seeking to develop small scale hydroelectric power at existing dams.

I am pleased to hear that the U.S. Army Corps of Engineers will perform additional studies of the Lehigh River Basin aimed at maximizing hydropower development. I am well aware that few people understand the extra long-term benefits which can accrue from careful planning and coordination of storage and flows. To this end, the Corps held a public meeting in Lehighton on January 29, 1980 which aimed at explaining your program and eliciting constructive input.

The price of oil and competitive fuels, rising as they are, enhances the long-term economics and overall feasibility of hydropower projects. As you are aware, there is a critical short-term problem as well. Arab oil supplies could be cut at any time creating an immediate threat to our vital national interests and security. The Army Corps of Engineers must not ignore this important point of national interest. Any new study of the Lehigh River Basin should seek to encourage, or at least not hinder, rapid development wherever possible. This is particularly true in the case of run of the river projects at existing dams where there is the potential to derive short term benefits at a reduced cost to long-term considerations.

Mr. John Tunnell
February 11, 1980
page 2

I am interested in your response and will gladly arrange a meeting of interested parties to encourage coordination of short and long-term planning.

Sincerely,

R. Wick Havens

R. Wick Havens
Mgr. Business Planning Division

RWH:jw

COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA FISH COMMISSION

[illegible]
[illegible]
Robinson Lane
Bellefonte, PA 16823

[illegible]

[illegible]

Re: [illegible] Hydroelectric
Power Study

Dear Mr. [illegible]:

The Pennsylvania Fish Commission, while not at this time opposing either a [illegible] of potential sites or the development of possible sites in the future, wish to express several general concerns which we have regarding such projects.

It is our responsibility to protect our waterways for the boaters and fishermen we represent. We, therefore, would like to present the following for consideration for any hydro project.

1. Any project which will prevent the free upward or downward movement of fish should include the necessary modifications to install a fish ladder. We realize that this may not be essential or even desirable for every possible location, but according to Section 185 of the Pennsylvania Fish Law, such fishways are to be constructed if the Commission deems them necessary. Therefore, such a fishway and its operation must be considered in any economical evaluation of a possible hydroelectric installation.

2. There must be provisions for proper downstream releases. The aquatic life downstream of any hydroelectric installation must not be jeopardized by highly fluctuating releases or water quality changes as a result of such an installation. When the hydro unit is not operating there must be releases to protect the aquatic life in the downstream area.

3. The installation of a hydroelectric unit on any existing dam must not damage the body of water for the recreational uses which existed before installing such a unit. This includes the fishing and boating in the impoundment and also downstream of the dam.

[illegible] River Basin Hydroelectric Power Study
[illegible] 1986
[illegible]

[illegible] appreciate this opportunity to comment on this Lehi[illegible] River Basin [illegible] power study and [illegible] that our comments will be taken into consideration [illegible] study. Please keep us informed as progress is made on [illegible] study, and [illegible] be of help please contact us.

Sincerely,

Jack G. Miller, Chief
Fisheries Environmental Services Section

[illegible]

[illegible] [illegible]
[illegible] Billingsley
[illegible] Kulp
[illegible] Olsen

DELAWARE RIVER BASIN COMMISSION
P. O. BOX 7360
WEST TRENTON, NEW JERSEY 08628
(609) 883 9500

[illegible] M. HANSLER
[illegible] DIRECTOR

HEADQUARTERS LOCATION
25 STATE POLICE DRIVE
WEST TRENTON N. J.

NOTICE OF INTENT

LEHIGH SCENIC RIVER SYSTEM

Environmental Assessment - Negative Declaration

The Delaware River Basin Commission has prepared an environmental assessment based on an environmental report prepared by the Pennsylvania Department of Environmental Resources (PaDER) in relation to a proposal by PaDER to adopt certain portions of the Lehigh River and its tributaries into the Commission's Comprehensive Plan as components of Pennsylvania's Scenic River System.

The analysis indicates that the proposed action will be beneficial to the quality of the human environment in the area involved. There would be few, essentially unavoidable, adverse impacts which would be limited in area and scope. The environmental assessment concludes that an environmental impact statement is not required.

Notice is hereby given that the Executive Director intends to issue a negative declaration, i.e., a finding of no significant adverse [illegible], based upon the environmental assessment, in accordance with [illegible] 2-4.5 of the Commission's Rules of Practice and Procedure, as [illegible]

Objection to the issuance of a negative declaration [illegible] by any interested person or agency in a written statement [illegible] why an environmental impact statement should be prepared. [illegible], such written statement must be submitted to the Executive [illegible] the Commission no later than 5:00 p.m., August 31, 197[illegible].

Copies of the environmental assessment, dated August [illegible], [illegible] available from the Commission upon request. A copy of PaDER [illegible] Report is available for examination in the Commission's Library.

Those interested in receiving a copy of the Commission's [illegible] assessment for this proposed action should advise Mr. J. W. Tha[illegible], Head, Environmental Unit. (609) 883-9500.

W. Brinton Whitall

W. Brinton Whitall, Secretary
August 9, 197[illegible]

23 AUG 1979

Mr. Gerald M. Hansler
Executive Director
Delaware River Basin Commission
P.O. Box 7360
West Trenton, New Jersey 08628

Dear Mr. Hansler:

This is in response to your 9 August 1979 Notice of Intent for the Lehigh Scenic River System.

On 11 May 1977, the Committee on Public Works and Transportation of the U. S. House of Representatives adopted a resolution directing the Corps of Engineers to conduct a feasibility study of the Lehigh River Basin for the development of hydroelectric power. Due to the high priority given to energy development within the Federal government, it is anticipated that the study will be initiated in the near future.

The Lehigh River Basin may have a significant hydroelectric power potential when low head, conventional, and pumped storage systems are considered. As the result of the prohibition imposed on impoundments and the restrictions on other encroachments by the scenic river designation, we are concerned with the impact of the proposed designation on the effective conduct of our study.

Thank you for the opportunity to comment on this notice. It would be appreciated if you would incorporate this letter as a matter of record.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

NAPEN-P

20 FEB 1980

Mr. James Hopson
Regional Engineer, FERC
Federal Plaza, Room 2207
New York, NY 1000

Dear Mr. Hopson

This concerns the Lehigh River Basin Hydroelectric Power Study which was initiated by this office in November 1979. Our study was authorized on 1 May 1977 by the U.S. House of Representatives Committe on Public Works and Transportation.

The purpose of the study is to investigate the potential for developing hydroelectric power in the entire Lehigh Basin. We intend to investigate the feasibility of hydropower additions at all existing dams on the Lehigh River and its tributaries. The major tributaries of this river are Saucon Creek, Monocacy Creek, Little Lehigh Creek, Jordon Creek, Hokendauqua Creek, Aquashicola Creek, Lizard Creek, Pohopoco Creek, Mahoning Creek, Nesquehoning Creek, Black Creek, Mud Run, Bear Creek, Tobyhanna Creek, and Tunkhannock Creek. Based on the inclosed inventory of dams prepared by the Pennsylvania Department of Environmental Resources, this will include approximately 140 existing dams. Construction of new single purpose hydropower dams and multi-purpose projects including hydropower as a major component will also be investigated in our study.

We are aware of the recent issuance of a preliminary permit on the Easton Dam to a private developer, the recent applications for preliminary permits by several parties on our Beltzville and F.E. Walter Dams, and preliminary hydropower addition investigations on several other dams in the Lehigh Basin which may lead to preliminary permit applications. Our study will be a comprehensive investigation of the hydropower resources of the Lehigh Basin. It is intended to result in a more optimal utilization of these resources than single site feasibility studies. In order to avoid development on a site-by site basis which may not be compatible with a comprehensive basin plan, we request that preliminary permit and license applications for sites in the Lehigh Basin be furnished to this office for review. In addition, in view of our study applicants should be informed that they may undertake single site studies at their own risk.

We look forward to close cooperation with your office throughout our study. Should you have any questions concerning the Lehigh study, please contact Mr. John Tunnell, Chief of the Basin Planning Section at (Area Code 215) 597-4714.

Sincerely,

D. J. SHERIDAN
Chief, Planning/Engineering Division

NAPEN-P

14 MAR 1980

Mr. Obra S. Kernodle, III
Regional Representative
U.S. Department of Energy
1421 Cherry Street
Philadelphia, PA 19102

Dear Mr. Kernodle:

This concerns the Lehigh River Basin Hydroelectric Power Study which was initiated by this office in November 1979. Our study was authorized on 10 May 1977 by the U.S. House of Representatives Committee on Public Works and Transportation.

The purpose of the study is to investigate the potential for developing hydroelectric power in the entire Lehigh Basin. We intend to investigate the feasibility of hydropower additions at all existing dams on the Lehigh River and its tributaries. Construction of new single purpose hydropower dams and multi-purpose projects including hydropower as a major component will also be investigated in our study.

We are aware of various recent applications for Department of Energy hydroelectric feasibility study loans to investigate the hydroelectric power potential of various sites. The purpose of this letter is to express our concern that any other studies carried out in the Lehigh Basin with the asssitance of Federal funds could result in a duplication of effort. I hope that this can be avoided through close cooperation between our offices.

Should you have any questions please do not hesitate to contact us.

Sincerely,
Signed by: NICHOLAS J. BARBIERI

N. J. SHERIDAN
Chief, Planning/Engineering [illegible]

DEPARTMENT OF ENERGY
Region III
1421 Cherry Street
Philadelphia, Pa 19102

1980

Mr. [illegible] Sheridan
Chief, Planning/Engineering Division
Department of the Army
Philadelphia District, Corps of Engineers
Custom House-2D & Chestnut Streets
Philadelphia, Pennsylvania 19106

Dear Mr. Sheridan:

In response to your letter of March 14, 1980 concerning the Lehigh River Basin Hydroelectric Power Study, we are pleased to hear that the Study has been initiated.

We thank you for bringing this to our attention due to its relevancy to our Small Scale Hydro Program. We, too, are concerned with the possible duplication of effort; however, close cooperation between our offices should avoid such duplication and contribute to the depth of your Study.

A copy of your letter has been forwarded to our Washington office to apprise them of your Study and your awareness of the need to coordinate our mutual interests. They may make additional comments in regard to any similar Study areas and procedures adopted in such instances.

[illegible] Gray is the Program Manager for Small Scale Hydropower. He may be reached at (215) 597-3607.

Sincerely,

Obra S. Kernodle, III
Regional Representative

cc: Farwell Smith

8 APR 1980

NAPEN P

Mr. James Hebson
Regional Engineer
Federal Energy Regulatory Commission
26 Federal Plaza, Room 2207
New York, New York 10007

Dear Mr. Hebson:

I am writing concerning our Lehigh River Basin Hydroelectric Power Study. As has already been discussed by telephone with Mr. Anton Sidoti of your office, we are currently preparing a Stage 1 Reconnaissance Report on the Lehigh Basin and need your agency's input on existing power development and projected future requirements.

We request that you prepare a brief report similar to the inclosed "Power Development in the Study Area" section of the Raystown Hydropower Plan of Study which was prepared by the Federal Power Commission for Baltimore District, Corps of Engineers. The power market area for the Lehigh Study will be the same as for the Raystown project: the Mid-Atlantic Area Reliability Council (MAAC). The report should include information on past and future requirements of publicly owned electric utilities in the vicinity of the Lehigh River Basin (similar to Tables 11 and 12 in the Raystown Plan of Study). We would also appreciate receiving a copy of any update which may be made of the capacity and energy values currently being used in the National Hydropower Study.

It is requested that your report be submitted to this office by 30 April. Should this schedule present any problems or should you have any questions concerning the Lehigh Study or our request, please contact Mr. John Tunnell, Chief, Basin Planning Section, at (Area Code 215) 597-4714.

Sincerely,

D. J. SHERIDAN
Chief, Planning/Engineering Division

FEDERAL ENERGY REGULATORY COMMISSION
NEW YORK REGIONAL OFFICE
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

[illegible]

[illegible]

Re: NAPEN-P

[illegible]:

This is in reference to your Lehigh River Basin [illegible] Power Study. In answer to the request in your April [illegible] letter to this office, we have prepared an analysis of the existing power development and projected future requirements in the basin. A copy of our report is enclosed.

If we may be of further assistance, please contact us.

Sincerely,

[illegible]

James D. Hebson
Regional Engineer

Enclosure
As Noted

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT CORPS OF ENGINEERS
CUSTOM HOUSE - 2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-P

Mr. Michael Kaiser, Director
Lehigh-Northampton Joint
 Planning Commission
ABE Airport
Lehigh Valley, PA 18103

Dear Mr. Kaiser:

This letter is in reference to the recent hydropower feasibility study loan applications submitted to the Department of Energy by the City of Bethlehem, the Pennsylvania Hydroelectric Development Corporation and the Chain Dam Hydroelectric Corporation concerning three dams in the Lehigh River Basin. These dams are the Penn Forest, Easton, and Chain Dams, respectively.

As a result of a 30 May 1980 coordination meeting between the Department of Energy, the study applicants, and the Corps of Engineers, we have no objection to the studying of these projects by the applicants. This position is based on an agreement with the applicants at the May meeting that there will be an open exchange of technical information by the various parties in order to avoid duplication of effort with our comprehensive Lehigh River Basin Hydroelectric Power Study.

I hope this information is satisfactory for your needs. Should you desire any additional information please do not hesitate to contact us.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

APPENDIX B

U. S. FISH & WILDLIFE SERVICE

PLANNING AID REPORT

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
112 West Foster Avenue
State College, PA 16801

April 16, 1980

Colonel James G. Ton
District Engineer
Philadelphia District, Corps of Engineers
Custom House, 2nd and Chestnut Streets
Philadelphia, PA 19106

Re: Lehigh River Basin Hydropower Study

Dear Colonel Ton:

This planning aid letter about fish and wildlife resources in the study area has been prepared pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). This report is of a reconnaissance nature and does not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Act. It contains information that was available in this office as well as information that we obtained from the Pennsylvania Fish and Game Commissions and Department of Environmental Resources. No special field work for this report was done by the Service or by these cooperating agencies.

The 1360 square mile study area has considerable topographical variation. Narrow, steep-sided valleys dissect the heavily forested Pocono Mountain Plateau in the northern section. In the central section, valleys are more broad and separated by narrow, parallel ridges. Terrain in the southern third of the basin, south of the Blue Mountain ridge, is gently rolling. Elevations in the study area range from about 150' MSL at the mouth of the Lehigh River to about 2300' MSL in the Lackawanna State Forest.

The basin is ecologically diverse. It contains numerous habitats, including forest (oak/hickory, maple/birch/beech, oak/pine, aspen/birch) that covers much of its northern half; pasture and cropland; abandoned fields in various stages of reversion to forest; swamps and marshes; lakes and streams; and urban areas.

Wetlands are especially important to a wide variety of fish and wildlife. They are extensive in the Lehigh River basin, especially in the Pocono Plateau section. We have listed basin wetlands (Table 1) that were included in a 1975 state-wide inventory by the U.S. Forest Service. Unfortunately, the inventory covered only wetlands of 40 acres or more. Consequently, Table 1 does not include all wetlands that may have existed in the study area during 1975.

Aquatic habitat in the Lehigh River basin includes almost 6900 acres of reservoirs, lakes and ponds (Table 2) and several hundred miles of fishable streams. Water quality varies from excellent to severely degraded. The Pennsylvania Department of Environmental Resources (DER) surveyed water quality and benthic macroinvertebrates in the Lehigh River and 20 tributaries during 1974 (Tables 3 and 4). Conclusions from the DER study are as follows:

1. The upper reaches of the Lehigh River were in excellent biological condition.
2. From Black Creek to Aquashicola Creek, the Lehigh expressed reduced productivity because of the influx of mine drainage and natural sterility of the watershed.
3. High concentrations of zinc entered the river from New Jersey Zinc Company via Aquashicola Creek.
4. Ephemeropterans were absent in the Lehigh River from the confluence of Aquashicola Creek to the mouth at Easton.
5. Alkalinities were increased from Allentown to Easton as the result of limestone tributaries, namely Jordan Creek, Monocacy Creek, Little Lehigh Creek, and Saucon Creek.
6. Benthic fauna were depressed from Allentown to the confluence with the Delaware River. This depression was the result of industrial and municipal waste.
7. The important waste discharges which degraded the lower Lehigh River were Allentown STP, Bethlehem STP, Bethlehem Steel Corporation, New Jersey Zinc Company mine on the Saucon Creek watershed, and storm drains.
8. The lower 7 miles of the Lehigh River were heavily degraded.
9. Tributary streams which were unaffected by serious pollution were Tunkhannock Creek, Tobyhanna Creek, Bear Creek, Sand Spring Run, Mud Run, Mauch Chunk Creek, Mahoning Creek, and Pohopaco Creek.
10. Buckwha and Lizard Creeks were the first tributaries to show increased alkalinities (25-40 mg/l).
11. Aquashicola Creek was severely degraded by heavy metals from the New Jersey Zinc Company plant at Palmerton.
12. Saucon Creek was severely degraded by the New Jersey Zinc Company's Friedensville mine discharge, Bethlehem Steel Corporation, and City of Bethlehem STP.
13. Little Lehigh Creek, while showing signs of organic enrichment, was in good biological condition.
14. The Lehigh River, while naturally infertile, supported a sensitive benthic community. From the confluence with Aquashicola Creek to the mouth at Easton, it was degraded by industrial and municipal wastes. This condition became more severe from Allentown donwstream.

In its most recent annual state-wide assessment (1978 Water Quality Inventory), DER identified major persistent water quality problems in the Lehigh River basin. Inadequately treated sewage was the most widespread problem, adversely affecting Saucon Creek (City of Bethlehem), Hockendauqua Creek (Northampton Borough), Nesquehoning Creek (Nesquehoning Borough), Black Creek (Treskow Village) and the Lehigh River (Allentown and other unnamed municipalities). These five streams and Aquashicola Creek were also adversely affected by industrial waste, acidic drainage from coal refuse piles or both.

The study area's vertebrate fauna, like the habitat that supports it, is diverse. It consists of 51 species of mammals, 220 birds, 23 reptiles, [illegible] amphibians, and [illegible] fishes (Tables 5, 6, 7, 8 and 9, respectively). Detailed information about occurrence of particular species in particular parts of the basin exists only for fishes. Such information results from surveys carried out routinely by the Pennsylvania Fish Commission and is summarized in Table 10.

Endangered species, as defined in the federal Endangered Species Act of 1973, are those in danger of extinction throughout all or a significant portion of their range. Numerous species have been declared endangered by the U.S. Department of Interior, pursuant to the Act. The Lehigh River basin is within the historic ranges of two such species -- bald eagle and peregrine falcon. Both birds are occasionally seen in the basin during autumn, migrating along ridges such as Blue Mountain.

The federal Endangered Species Act makes it unlawful to import, export, harass, harm, capture, and sell or ship in interstate or foreign commerce any endangered species. Furthermore, Section 7 of the Act directs all federal departments to consult with the Department of the Interior (Fish and Wildlife Service) "...to insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered species ... or result in the destruction or modification of habitat ... determined by the Secretary ... to be critical." None of the Lehigh River basin has been formally designated critical habitat for bald eagle or peregrine falcon.

The Pennsylvania Fish Commission has determined that the bog turtle is endangered in the state, i.e., actively threatened with extinction, its continued survival in Pennsylvania dependent on special protective measures. Bog turtles usually occur in relatively small isolated colonies. There have been reliable reports of such colonies at three sites within the study area: near Emmaus and Macungie in Lehigh County and near Cherryville in Northampton County. None of the other reptiles, amphibians and fishes known or likely to occur in the Lehigh River basin has been declared endangered by the Fish Commission.

The Pennsylvania Game Commission is developing an endangered species program for the state's birds and mammals. The Commission recognizes as endangered those species so designated by the federal government (e.g., bald eagle and peregrine falcon). It may include on the state's endangered species list other species that are threatened in a more local or regional sense, as the Fish Commission has done with the bog turtle.

The Lehigh River basin offers widespread opportunity for wildlife-related outdoor recreation. There are more than 113,000 acres of public land open to hikers, bird-watchers, hunters and fishermen, including about 9100 acres of State Forest; 26,700 acres of State Parks; and 77,500 acres of State Game Lands (Table 11, Figures 1 and 2). Almost 88,000 additional acres of private land are enrolled in the Game Commission's Cooperative Farm Game and Safety Zone Programs (Table 11 and Figure 3). These lands also are open to public hunting. There is public access to almost 400 miles of streams and more than 2000 acres of lakes for which the Fish Commission has management responsibilities (Table 12). Several of these waters are navigable by small boats and there are public boat-launching ramps at six lakes (Beltzville Reservoir, Brady's Lake, Francis E. Walters Reservoir, Gouldsboro Lake, Mauch Chunk Lake, and Tobyhanna #2) and seven sites on the Lehigh River (Canal Park and Kimmets Lock at Allentown, Coplay, Northampton, Cementon, Rockdale, Weisport). The Fish Commission's stocking program insures a supply of game fishes throughout the study area. In many streams, stocking of trout sustains a sport fishery that otherwise would not exist.

We appreciate the opportunity to provide this inventory of the Lehigh River basin's fish and wildlife resources. We are prepared to work closely with your agency during the remainder of the hydropower study.

Sincerely yours,

Charles J. Kulp

Charles J. Kulp
Field Supervisor

[illegible] of the Lehigh River Basin

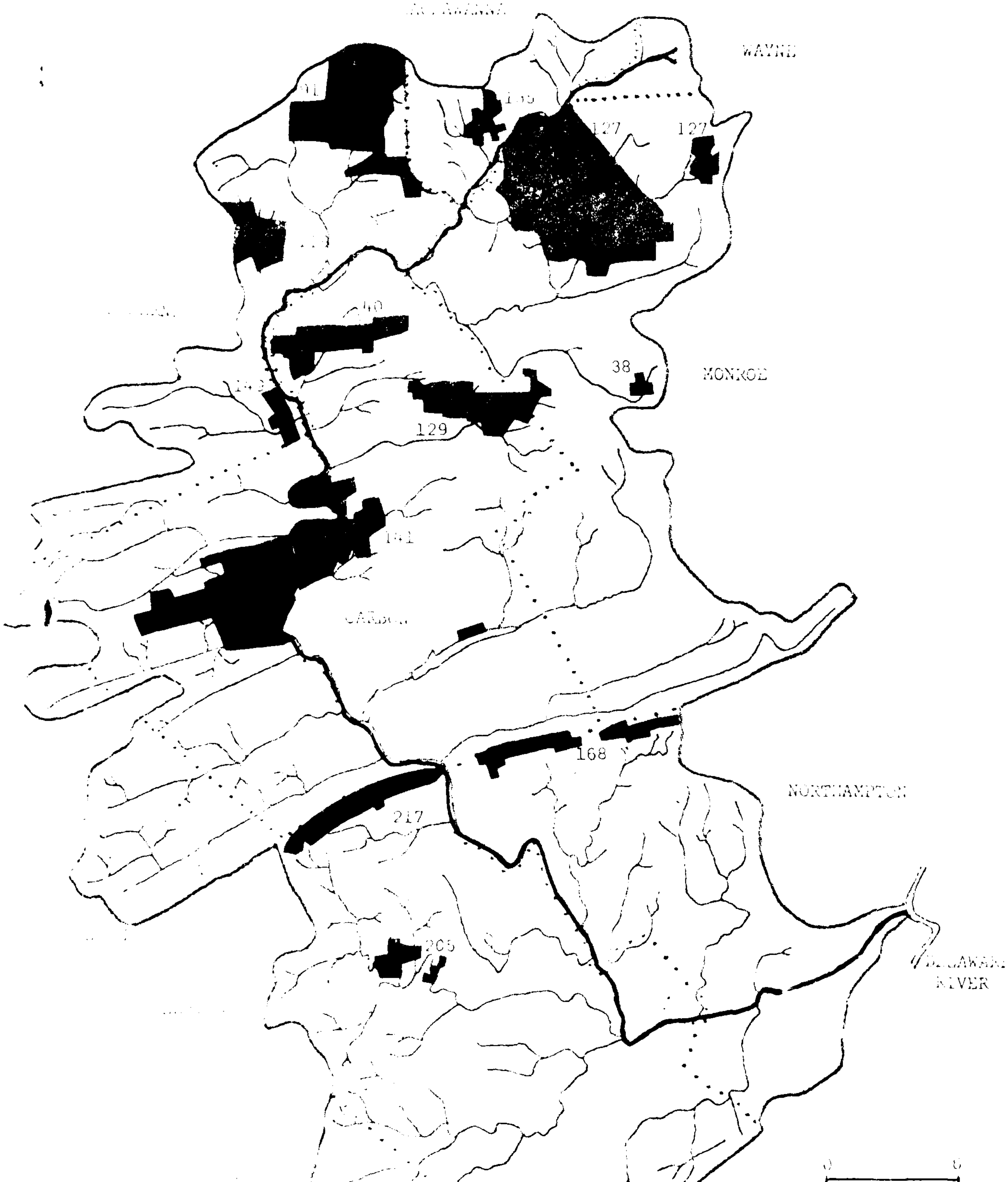


Figure 2. State Forests and State Parks of the Lehigh River Basin

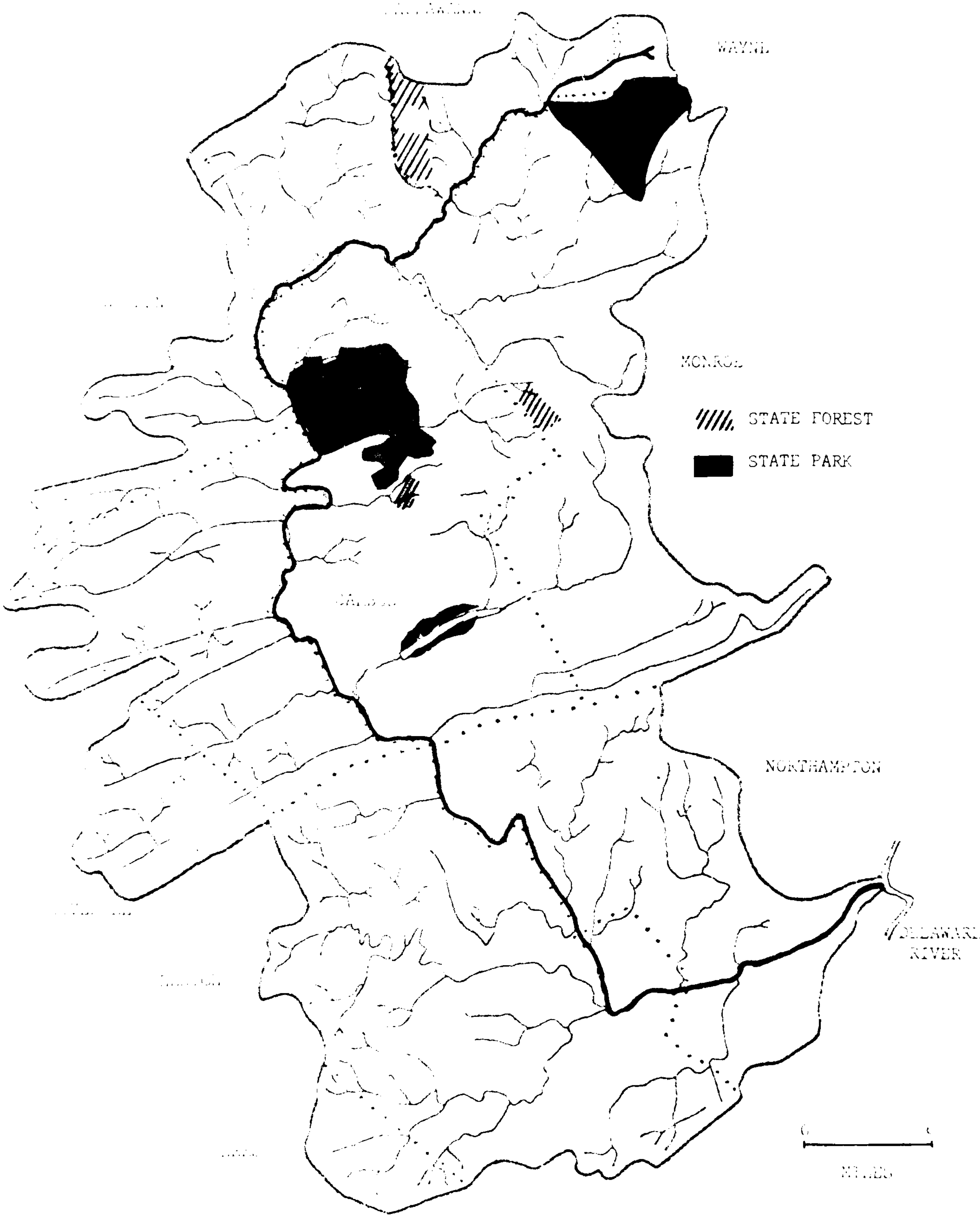


Figure 3. Cooperative farm game projects of the Lehigh River Basin

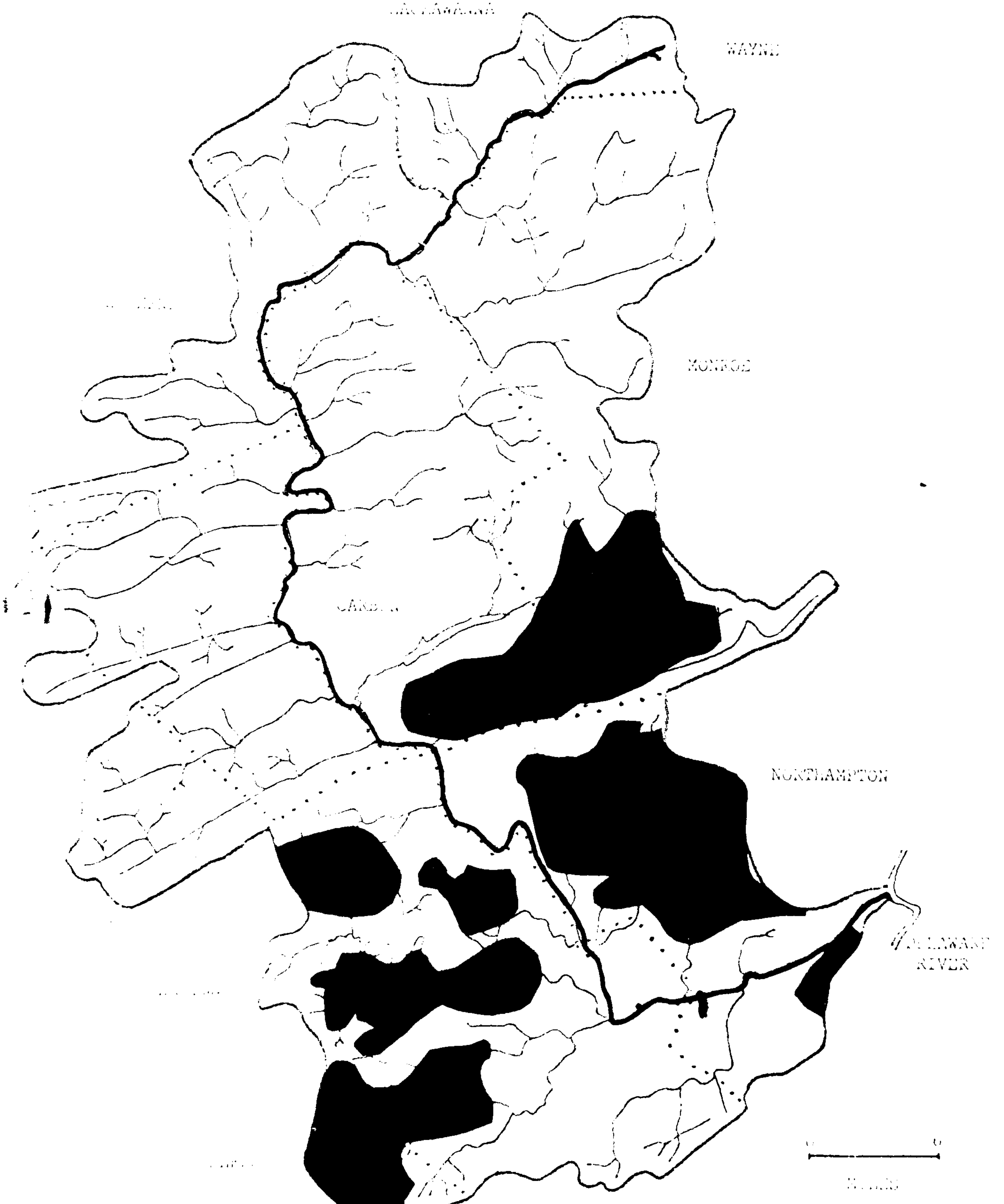


Table 1 Wetlands of the Lehigh River Basin

Name	USGS Map	Latitude	Longitude	Acreage
		CARBON COUNTY		
Yost Swamp	Pohopoco Mt/ Blakeslee	40° 59' 5"	75° 34' 16"	96
--	Tamaqua	40° 50' 52"	75° 53' 40"	50
Hughes Swamp	Weatherly	40° 53' 42"	75° 48' 17"	154
--	Hickory Run	41° 3' 56"	75° 44' 35"	40
--	Christmans	40° 54' 54"	75° 40' 15"	144
Fawn River headwater	Hickory Run	41° 5' 9"	75° 43' 30"	106
Cider River "	" "	41° 6'	75° 42' 25"	66
State Game Land 40	" "	41° 5' 20"	75° 41' 45"	158
Along Black Creek	" "	41° 4' 32"	75° 39' 42"	149
State Game Land 129	Blakeslee	41° 3' 6"	75° 37' 15"	55
		LACKAWANNA COUNTY		
Meadow Bridge headwater	Moscow	41° 16' 5"	75° 31' 3"	53
" " "	"	41° 16' 6"	"	51
--	"	41° 15' 37"	75° 32' 8"	51
Along Marsh Creek	"/ Thornhurst	41° 15'	75° 34' 33"	54
Balsam Swamp	Pleasant View Summit	41° 12' 42"	75° 35' 57"	73
Fenner Mill Run headwater	Thornhurst	41° 14' 8"	75° 35' 6"	40
Wildcat Swamp	Sterling	41° 16' 9"	75° 28' 50"	81
English Swamp	"	41° 16' 17"	75° 28' 9"	40
--	"	41° 16' 20"	75° 26' 47"	48
Johnson Pond Marsh	"	41° 16'	75° 27' 15"	110
		LUZERNE COUNTY		
--	Hickory Run	41° 7' 26"	75° 44' 27"	41
--	Avoca	41° 15' 50"	75° 41' 47"	61
--	"	41° 15' 24"	75° 42' 7"	48
Along Red Run/ Bear Creek	Avoca/Pleasant View Summit	41° 15' 6"	75° 40' 33"	61
--	Avoca	41° 15' 7"	75° 39' 19"	54

Name	USGS Map	Latitude	Longitude	Acreage
	LUZERNE COUNTY (Con't.)			
--	Pleasant View Summit	41° 14'	75° 44' 22"	48
Along Bear Creek	" " "	41° 14' 16"	75° 42' 3"	40
--	" " "/ Avoca	41° 14' 49"	75° 43' 16"	68
--	Pleasant View Summit	41° 14' 33"	75° 39' 58"	58
Mud Pond Marsh	" " "	41° 13' 26"	75° 40' 53"	25
--	" " "	41° 11' 48"	75° 40' 24"	289
Along Kendall Creek	" " "/ Thornhurst	41° 9' 12"	75° 37' 39"	81
--	White Haven	41° 6' 38"	75° 47' 15"	40
Along Mill Creek	" "	41° 4' 21"	75° 47' 48"	62
--	" "	41° 2' 13"	75° 51' 28"	56
--	" "/ Wilkes-Barre East	41° 7' 27"	75° 48' 5"	48
Tenmile Run headwater	Wilkes-Barre East	41° 11' 49"	75° 48' 18"	58
--	" "	41° 10' 42"	75° 46' 42"	45
Along Geneceda Creek	" "	41° 10' 35"	75° 48' 46"	40
Jimmy Kane Swamp	" "	41° 9' 20"	75° 49' 53"	98
Long Swamp	" "	41° 9' 31"	75° 49' 18"	48
Long Swamp	" "	41° 9' 37"	75° 48' 56"	55
--	" "	41° 9' 46"	75° 48' 12"	58
	MONROE COUNTY			
Two Mile Creek headwater	Blakeslee/ Thornhurst	41° 7' 13"	75° 34' 52"	365
Along Two Mile Creek	Blakeslee	41° 5' 34"	75° 35' 58"	53
Along Red Run	"	41° 6' 9"	75° 35'	40
Red Run headwater	"	41° 6' 25"	75° 34' 35"	40
Along Davey Run	"	41° 6' 10"	75° 33' 40"	113
Along Deep Run	"	41° 6' 33"	75° 32' 48"	60
--	"	41° 6' 51"	75° 32' 13"	66
--	"	41° 6' 13"	75° 31' 40"	41
--	"	41° 4' 47"	75° 33' 25"	201
Indian Mt. Lake Marsh	"/Pocono Pines	41° 0' 24"	75° 30'	102

Name	USGS Map	Latitude	Longitude	Acreage
MONROE COUNTY (Con't.)				
--	Blakeslee	41° 4' 12"	75° 32' 3"	40
Weir Creek headwater	Broadheadsville	40° 55' 5"	75° 23' 40"	40
Tamaque Lake Marsh	Pocono Pines	41° 6' 15"	75° 26' 58"	158
--	" "	41° 6' 24"	75° 26' 12"	63
Stillwater Lake Marsh	" "/ Tobyhanna	41° 7' 23"	75° 24' 50"	412
--	Pocono Pines	41° 4' 7"	75° 29' 6"	103
--	" "	41° 4' 5"	75° 27' 55"	83
Along Long Pond, Mud Pond Run and Tunkhannock	" "/ Blakeslee	41° 2' 30"	75° 29'	1171
Buckwa Creek headwater	Saylorsburg	40° 53' 10"	75° 20' 26"	53
--	"	40° 52' 58"	75° 19' 8"	71
Along Cherry Creek	"	40° 53' 32"	75° 17' 52"	42
State Game Land 127	Tobyhanna/ Pocono Pines	41° 7' 44"	75° 26' 10"	193
Yetter Swamp	Tobyhanna	41° 13' 33"	75° 29' 13"	60
--	Thornhurst	41° 11' 45"	75° 32' 11"	141
Along Rauscher Run	"	41° 12' 36"	75° 31' 32"	76
Bradys Lake Marsh	"	41° 10' 44"	75° 31' 32"	106
Longpatch Swamp	"	41° 10' 32"	75° 30' 49"	48
Along Blexley Run	"/ Tobyhanna	41° 11' 32"	75° 30' 8"	53
Underwood Swamp	Thornhurst/ Tobyhanna	41° 10' 27"	75° 30' 13"	78
Selfice Swamp	Thornhurst	41° 8' 51"	75° 30' 38"	148
Along Wagner Run	"	41° 8' 39"	75° 31' 55"	245
--	"	41° 7' 47"	75° 32' 10"	56
--	"	41° 8' 25"	75° 32' 27"	61
--	"	41° 10' 23"	75° 33' 4"	40
Along Trout Creek	"	41° 9' 42"	75° 33' 7"	56
--	"	41° 9' 33"	75° 33' 56"	91
--	"	41° 8' 9"	75° 34' 14"	139
Davey Run headwater	"/ Blakeslee	41° 7' 41"	75° 33' 54"	42
--	Thornhurst	41° 8' 42"	75° 35' 31"	121
Lake Watawga Marsh	Tobyhanna	41° 14' 13"	75° 26' 27"	82

Name	USGS Map	Latitude	Longitude	Acreage
	MONROE COUNTY (Con't.)			
Kistler Swamp	Tobyhanna	41° 13' 28"	75° 28' 32"	54
--	"	41° 14' 5"	75° 29' 40"	40
Along Fritz Run	"	41° 12' 56"	75° 29' 2"	166
Pond Swamp	"	41° 12' 13"	75° 28' 43"	135
Frame Cabin Run headwater	"	41° 12' 24"	75° 27' 30"	259
Big Marsh/Spring Swamp	"/ Thornhurst	41° 12' 18"	75° 29' 30"	194
Oakes Swamp	Tobyhanna	41° 12' 8"	75° 26' 16"	73
Birch Swale	Tobyhanna/ Thornhurst	41° 11' 3"	75° 29' 54"	43
--	Tobyhanna	41° 10' 38"	75° 29' 30"	40
--	"/ Thornhurst	41° 9' 17"	75° 29' 55"	40
Along Tobyhanna Creek	Tobyhanna	41° 8' 21"	75° 28' 45"	40
--	"	41° 9' 42"	75° 27' 47"	123
Still Swamp	"	41° 9' 12"	75° 28' 18"	40
Dark Swamp	"	41° 8' 41"	75° 27' 54"	53
Wagner Swamp	"	41° 8' 50"	75° 27' 20"	143
Beagle Hole Swamp	"	41° 9' 25"	75° 26' 29"	54
Along Pollys Run	"	41° 9' 54"	75° 25' 8"	40
--	"	41° 10' 8"	75° 23' 32"	48
Palen Swamp	"/ Buck Hill Falls	41° 13' 27"	75° 22' 39"	40
Along E. Branch Tobyhanna Creek	"/"	41° 11' 6"	75° 22' 43"	193
Dresser Run headwater	Buck Hill Falls	41° 13' 2"	75° 21' 23"	51
Along Dresser Run	" " "	41° 11' 45"	75° 22' 2"	66

SOURCE: Wetlands Inventory of Pennsylvania, U.S. Forest Service (1977)

Table 2. Reservoirs, lakes and ponds of the Lehigh River Basin

Name	USGS Map	Latitude	Longitude	Acreage
		CARBON COUNTY		
Big Boulder Lake	Blakeslee	41° 3' 31"	75° 35' 30"	185
Lake Harmony	Blakeslee	41° 3' 29"	75° 35' 41"	110
Unnamed dam, Laurel Run	Blakeslee	41° 1' 13"	75° 36' 24"	25
Bear Creek Lake	Christmans	40° 55' 43"	75° 40' 42"	130
No. 1 Storage Reservoir	Christmans	40° 53' 5"	75° 42' 40"	1
No. 3 Storage Reservoir	Christmans	40° 52' 49"	75° 43'	1
Unnamed dam, Drakes Creek	Christmans	40° 59' 7"	75° 40'	23
F. E. Walter Reservoir	Hickory Run	41° 7'	75° 43' 14"	90
Hickory Run Dam	Hickory Run	41° 2' 43"	75° 41'	5
Hickory Run Park Dam	Hickory Run	41° 1' 41"	75° 41' 12"	11
Saylorsville	Hickory Run	41° 2' 24"	75° 42'	1
Bear Creek Dam	Lehighton	40° 51' 36"	75° 40'	53
Mahoning Creek Dam	Lehighton	40° 49' 30"	75° 42' 18"	7
Beltzville Reservoir	Lehighton	40° 50' 53"	75° 38' 18"	947
Constantini Dam	Lehighton	40° 49' 28"	75° 38' 20"	2
No. 1 Storage Reservoir	Lehighton	40° 51' 52"	75° 41'	11
No. 3 Dam	Lehighton	40° 50' 42"	75° 43' 47"	2
Unnamed dam, Pohopoco Creek	Lehighton	40° 49' 6"	75° 40' 35"	13
No. 2 Storage Reservoir	Lehighton	40° 52' 6"	75° 40' 47"	1
Unnamed dam, Sawmill Creek	Lehighton	40° 51' 6"	75° 39'	2
Unnamed dam, Mauch Chunk Creek	Nesquehoning	40° 50' 48"	75° 47' 31"	320
Unnamed dam, Broad Run	Nesquehoning	40° 52' 7"	75° 52'	6
Unnamed dam, Buckwha Creek	Palmerton	40° 49' 55"	75° 31' 29"	1
Christman Dam	Pohopoco Mtn.	40° 56' 19"	75° 36' 37"	2
Unnamed dam, Pine Run	Pohopoco Mtn.	40° 53' 13"	75° 37' 11"	1

Name	USGS Maps	Latitude	Longitude	Acreage
Wild Creek Reservoir	Pohopoco Mtn.	40° 53' 48"	75° 33' 41"	238
Penn Forest Reservoir	Pohopoco Mtn.	40° 56' 13"	75° 34' 5"	461
Lake Hauto	Tamaqua	40° 50' 54"	75° 54' 6"	300
Quakake Dam	Weatherly	40° 54' 58"	75° 51' 36"	9
Indian Run Dam	Weatherly	40° 57' 36"	75° 46' 24"	5
Upper Buck Mtn. Dam	Weatherly	40° 58' 12"	75° 48' 31"	2
Unnamed dam, Hoyle Creek	Weatherly	40° 56' 49"	75° 51' 55"	20
Eurana Park Pool	Weatherly	40° 56' 30"	75° 49' 18"	1
		LACKAWANNA COUNTY		
Bear Lake	Pleasant View Summit	41° 12' 48"	75° 37' 35"	135
Tamarack Dam	Sterling	41° 15' 13"	75° 29' 40"	42
		LEHIGH COUNTY		
Lake Muhlenberg	Allentown West	40° 35' 43"	75° 30' 19"	8
Mill dam, Little Lehigh Creek	Allentown West	40° 30' 53"	75° 30' 19"	1
Mill dam, Cedar Creek	Allentown West	40° 35'	75° 32'	2
Cedar Creek Dam No. 1	Allentown West	40° 34' 41"	75° 32' 11"	5
Kerns Dam	Cementon	40° 38' 7"	75° 36' 6"	3
Wehrs Dam	Cementon	40° 37' 41"	75° 34' 19"	3
Unnamed dam, Spring Creek	Cementon	40° 42'	75° 31' 6"	10
Unnamed dam, E. Branch Swope Creek	East Greenville	40° 29' 25"	75° 35'	1
Unnamed dam, Saucon Creek	Milford Square	40° 29' 24"	75° 24' 6"	1
Unnamed dam, Switzer Creek	Slatedale	40° 38' 48"	75° 44' 25"	3
		LUZERNE COUNTY		
Dam F	Hazleton	40° 57' 12"	75° 54'	64
Dam G	Hazleton	40° 57'	75° 54' 12"	13

Name	USGS Maps	Latitude	Longitude	Acreage
Mtn. Lake Dam	Pleasant View Summit	41° 12' 54"	75° 40' 35"	40
Indian Lake	Pleasant View Summit	41° 11' 36"	75° 40' 11"	31
Meadow Lake	Pleasant View Summit	41° 13' 12"	75° 40' 6"	45
Kiel Lake	Pleasant View Summit	41° 14' 53"	75° 43' 10"	61
Lake Penn	White Haven	41° 5' 24"	75° 46' 48"	56
Santer Springs Dam	White Haven	41° 3' 22"	75° 48' 18"	1
White Haven Dam	White Haven	41° 6' 19"	75° 45' 38"	14
Water Supply Dam	White Haven	41° 3' 6"	75° 48' 37"	5
Bear Creek Dam	Wilkes-Barre East	41° 10' 41"	75° 45' 25"	70
Eikes Pond	Wilkes-Barre East	41° 11' 13"	75° 47' 36"	46
		MONROE COUNTY		
Lake Onocup	Blakeslee	41° 6' 49"	75° 33' 42"	9
Pocono Lake	Blakeslee	41° 5' 49"	75° 32' 23"	750
Trexler Dam	Brodheadsville	40° 57' 12"	75° 29' 30"	1
Unnamed dam, Pohopoco Creek	Brodheadsville	40° 58' 30"	75° 28'	4
Unnamed dam, Princess Run	Brodheadsville	40° 53' 7"	75° 24' 13"	7
Unnamed dam, Middle Creek	Brodheadsville	40° 57' 40"	75° 29' 35"	5
Unnamed Dam, Dresser Run	Buck Hill Falls	41° 11' 36"	75° 22' 12"	57
Chicola Lake	Kunkletown	40° 50' 42"	75° 23'	5
Unnamed dam, Aquashicola Creek	Kunkletown	40° 50' 31"	75° 24' 56"	10
Lake Naomi	Pocono Pines	41° 6' 31"	75° 28' 28"	500
Pocono Summit Lake	Pocono Pines	41° 7' 11"	75° 23' 18"	80
Stillwater Lake	Pocono Pines	41° 7'	75° 25' 31"	348
Lutherland Dam	Pocono Pines	41° 5' 54"	75° 27'	90
Pocono Pines Dam	Pocono Pines	41° 6' 23"	75° 28' 54"	3
Indian Mtn. Lake	Pocono Pines	41° 59' 43"	75° 29' 53"	42
Long Pond	Pocono Pines	41° 3' 55"	75° 30' 19"	59
Blue Mtn. Dam	Saylorsburg	40° 52' 36"	75° 19' 55"	1
Brady Lake	Thornhurst	41° 9' 47"	75° 31' 48"	229

Name	USGS Maps	Latitude	Longitude	Acreage
Arrowhead Lake	Thornhurst	41° 9' 47"	75° 34' 37"	60
Lynchwood Lake	Tobyhanna	41° 8' 49"	75° 23' 24"	44
Gouldsboro Lake	Tobyhanna	41° 14' 7"	75° 27' 11"	250
Tobyhanna No. 2	Tobyhanna	41° 12'	75° 24' 30"	170
		NORTHAMPTON COUNTY		
Unnamed dam, Monocacy Creek	Allentown East	40° 37' 7"	75° 23'	1
Illicks Mill Dam	Catasauqua	40° 38' 30"	75° 22' 55"	5
Lappawingo Dam	Catasauqua	40° 42' 25"	75° 29' 37"	2
Kulp Dam	Hellertown	40° 34' 40"	75° 20' 41"	1
Unnamed dam, Lehigh Canal	Hellertown	40° 37' 24"	75° 20' 7"	12
Indianola Lake	Palmerton	40° 46' 41"	75° 31' 6"	1
		SCHUYLKILL COUNTY		
Greenwood Dam	Tamaqua	40° 50' 12"	75° 56' 20"	111
		WAYNE COUNTY		
Pocono Peak Lake	Sterling	41° 16' 24"	75° 25' 18"	133
Lower Dam	Sterling	41° 15' 13"	75° 26' 57"	44
Lake Watawga	Tobyhanna	41° 14' 18"	75° 26' 43"	135
Westend Pond	Tobyhanna	41° 14' 57"	75° 28'	30
Snag Pond	Tobyhanna	41° 14' 50"	75° 27' 10"	20

SOURCE: Dams, Reservoirs, and Natural Lakes, Water Resources Bulletin No. 5, Pennsylvania Department of Forests and Waters (1970)

Table [illegible]. Water quality and benthic macroinvertebrate sampling stations in the Lehigh River and selected tributaries--July 1974

Sampling Station No. (stream miles)	Sampling Station Location
LEH 000	Lehigh River; at confluence with Delaware River
LEH 003	Lehigh River; at base of Glendon dam, Glendon Borough, Northampton County
LEH 007	Lehigh River; 0.1 mile downstream from confluence with Nancy Run, Lower Saucon Twp., Northampton County
NAN 000	Nancy Run; 400 yards upstream from confluence with Lehigh River, Freemansburg Borough, Northampton County
SAU 000	Saucon Creek; 0.1 mile upstream from confluence with Lehigh River, Northampton County
SAU 004	Saucon Creek; 0.4 miles upstream from confluence with Lehigh River, Northampton County
SAU 009	Saucon Creek; 1,000 feet upstream from New Jersey Zinc Mines, Upper Saucon Twp., Lehigh County
MON 009	Monocacy Creek; 0.5 mile upstream from Route 22 bridge, Northampton County
LEH 012	Lehigh River; at New Street Bridge, City of Bethlehem
LEH 015	Lehigh River; at Civil Defense Training Center, Allentown Borough
LLE 000	Little Lehigh Creek; 0.1 mile upstream from confluence with Jordan Creek, Allentown Borough
LLE 006	Little Lehigh Creek; immediately downstream from Route 29 bridge, Emmaus Borough, Lehigh County
JOR 000	Jordan Creek; 0.2 miles upstream from confluence with Lehigh River, Allentown Borough

Sampling Station No. (stream miles)	Sampling Station Location
LEH 017	Lehigh River; immediately downstream from Hamilton Street Bridge, Allentown Borough
JOR 01[illegible]	Jordan Creek; 100 yards downstream from confluence with Hassen Creek, South Whitehall Twp., Lehigh County
LEH 026	Lehigh River; 0.9 mile downstream from Treichlers, North Whitehall Twp., Lehigh County
LEH 033	Lehigh River; at the Walnutport-Slatington bridge, Northampton County
LEH 036	Lehigh River; directly downstream from confluence with Aquishicola Creek, Carbon County
AQU 000	Aquishicola Creek; 0.1 mile upstream from confluence with Lehigh River, Carbon County
BUC 000	Buckwha Creek; 0.3 mile upstream from confluence with Aquishicola Creek, off L.R. 13035, Carbon County
LIZ 000	Lizard Creek; 100 feet downstream from bridge on T-354, Penn Township, Carbon County
POH 003	Pohopoco Creek; upstream from PA Turnpike bridge, Carbon County
MAH 001	Mahoning Creek; at Route 443 bridge, Lehighton, Carbon County
LEH 047	Lehigh River; 0.2 mile upstream from Jim Thorpe Borough sewage treatment plant, Carbon County
MAU 000	Mauch Chunk Creek; 0.6 mile upstream from confluence with Lehigh River, Jim Thorpe Borough, Carbon County
NES 002	Nesquehoning Creek; at Route 93 bridge, Nesquehoning Borough, Carbon County
LEH 056	Lehigh River; 0.1 mile downstream from confluence with Black Creek, Carbon County

Sampling Station No. (stream miles)	Sampling Station Location
BLA 000	Black Creek; 150 feet upstream from confluence with Lehigh River, Carbon County
BMT 00[illegible]	Buck Mountain Run; at confluence with Lehigh River, Carbon County
LEH 06[illegible]	Lehigh River; upstream from confluence with Buck Mountain Run, Carbon County
MUD 00[illegible]	Mud Run; at PA Turnpike bridge, Carbon County
SSP 001	Sand Spring Run; at confluence with Hickory Run, Carbon County
LEH 067	Lehigh River; downstream from Sandy Run, Luzerne County
SAN [illegible]01	Sandy Run; 1 mile downstream from L.R. 40118, Foster Twp., Luzerne County
LEH 068	Lehigh River; upstream from confluence with Sandy Run, Luzerne County
LEH 073	Lehigh River; 0.1 mile upstream from confluence with Wright Creek, Luzerne County
BEA 003	Bear Cree[illegible]; at bridge on L.R. 40041, Bear Creek Twp., Luzerne County
LEH 083	Lehigh River; at Acahela Boy Scout Camp, Tobyhanna Twp., Monroe County
TOB 004	Tobyhanna Creek; at Route 940 bridge, Tunkhannock Twp., Monroe County
TUN 001	Tunkhannock Creek; at Route 115 bridge, Tunkhannock Twp., Monroe County
LEH 093	Lehigh River; 1.2 miles upstream from Thornhurst School, Coolbaugh Twp., Monroe County

Source: Delaware River Basin Water Quality--1974, Bureau of Water Quality Management, Publication No. 4[illegible], Pennsylvania Department of Environmental Resources (1976)

Table [illegible]. Water quality and benthic macroinvertebrates in the Lehigh River and selected tributaries--July 19[illegible]4

Parameter	LEH 00[illegible]	LEH 003	LEH 007	NAN 000	SAU 000	SAU 004	SAU 009	MON 009	LEH 012	LEH 015	LLE 000	LLE 006	JOR 000	LEH 017	JOR 013	LEH 026	LEH 033
Temperature (°C)	--	--	--	--	--	--	--	--	--	25	17	20	18	25.5	23	25	25.5
pH	--	--	--	--	--	--	--	--	--	7.8	7.9	8.2	7.8	7.6	8.0	6.9	6.8
Dissolved Oxygen (mg/l)	--	--	--	--	--	--	--	--	--	9.6	9.0	10.4	8.4	8.6	8.4	8.9	8.9
Specific Conductance (micromhos/cm)	--	--	--	--	--	--	--	--	--	305	310	300	370	210	170	150	150
Alkalinity (mg/l)	--	--	--	--	--	--	--	--	--	80	150	130	150	45	50	18	12
Iron (mg/l)	--	--	--	--	--	--	--	--	--	0.26	--	--	--	--	--	0.20	0.28
Sulfate (mg/l)	--	--	--	--	--	--	--	--	--	40	18	20	27	--	--	35	35
Nitrate (mg/l)	--	--	--	--	--	--	--	--	--	1.3	3.7	4.4	3.3	0.9	1.2	0.4	0.4
Phosphorus (mg/l)	--	--	--	--	--	--	--	--	--	0.58	0.06	0.06	0.07	0.08	0.05	0.23	0.05
B.O.D.-5 (mg/l)	--	--	--	--	--	--	--	--	--	3.3	0.8	0.6	1.2	1.0	0.8	1.0	0.6
Number of invertebrate taxa taken with hand screen	7	4	8	12	6	6	21	14	9	7	8	12	9	11	10	6	15

AD-A099 372 ARMY ENGINEER DISTRICT PHILADELPHIA PA F/G 13/2
LEHIGH RIVER BASIN, HYDROPOWER STUDY. STAGE 1. RECONNAISSANCE R--ETC(U)
SEP 80
UNCLASSIFIED DAEN/NAP-12202/RR-80/09 NL

4 OF 4
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Sampling Station

Parameter	LEH 036	AQU 000	BUC 000	LIZ 000	POH 003	MAH 001	LEH 047	MAU 000	NES 002	LEH 056	BLA 000	BMT 000	LEH 062	MUD 005	SSP 001	LEH 067
Temperature (°C)	24	24	20	25	18	23	21	19	17	--	21	18	23	19	19	24
pH	6.7	7.2	7.3	7.9	7.4	6.7	6.2	6.6	4.6	--	4.3	6.0	6.2	6.3	6.0	7.4
Dissolved Oxygen (mg/l)	8.0	7.9	9.0	9.4	10.0	9.1	8.8	9.2	9.5	--	9.0	9.2	8.4	8.8	8.8	8.6
Specific Conductance (micromhos/cm)	120	290	70	25	60	70	95	60	115	--	190	140	50	20	30	88
Alkalinity (mg/l)	25	45	25	40	16	16	12	15	5	--	2	18	6	8	10	15
Iron (mg/l)	0.30	0.42	0.22	--	--	--	0.38	1.25	0.46	--	0.36	0.61	0.22	0.22	1.09	0.47
Sulfate (mg/l)	50	80	15	12	10	10	24	10	50	--	75	63	12	6	6	24
Nitrate (mg/l)	0.5	0.8	0.9	0.4	0.7	0.9	0.6	0.5	0.5	--	0.7	0.8	0.5	0.5	0.5	0.5
Phosphorus (mg/l)	0.08	0.17	0.04	0.05	0.01	0.01	--	0.05	0.04	--	--	0.03	0.06	0.05	0.08	0.06
B.O.D.-5 (mg/l)	0.4	0.4	0.4	0.8	1.2	0.6	0.0	2.0	0.8	--	0.4	0.4	0.8	0.4	2.0	1.2
Number of invertebrate taxa taken with hand screen	7	4	21	13	16	10	6	--	11	10	11	2	14	23	18	11

Parameter	Sampling Station							
	SAN 001	LEH 068	LEH 073	BEA 003	LEH 083	TOB 004	TUN 001	LEH 093
Temperature (°C)	19	24	22	19	27	24	23	20
pH	7.0	7.3	7.2	6.9	6.2	6.4	6.4	6.3
Dissolved Oxygen (mg/l)	8.6	8.4	8.6	8.4	8.0	8.0	7.8	8.4
Specific Conductance (micromhos/cm)	150	41	30	20	30	30	19	27
Alkalinity (mg/l)	16	10	12	6	6	5	10	15
Iron (mg/l)	0.85	0.34	0.41	0.32	0.17	0.45	1.63	0.23
Sulfate (mg/l)	90	10	--	--	--	--	--	--
Nitrate (mg/l)	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Phosphorus (mg/l)	0.04	0.04	0.04	0.06	0.02	0.04	0.08	0.06
B.O.D.-5 (mg/l)	1.2	1.0	1.2	0.8	1.6	1.2	2.5	1.6
Number of invertebrate taxa taken with hand screen	0	22	18	13	18	15	18	29

Table 5. Mammals Known or Likely to Occur in the Lehigh River Basin

Opossum	Didelphis marsupialis
Masked shrew	Sorex cinereus
Water shrew	Sorex palustris
Smoky shrew	Sorex fumeus
Rock shrew	Sorex dispar
Short-tailed shrew	Blarina brevicauda
Least shrew	Cryptotis parva
Hairy-tailed mole	Parascalops breweri
Eastern mole	Scalopus aquaticus
Star-nosed mole	Condylura cristata
Little brown bat	Myotis lucifugus
Keen bat	Myotis keenii
Leib bat	Myotis subulatus
Silver-haired bat	Lasionycteris noctivagans
Pygmy bat	Pipistrellus subflavus
Big brown bat	Eptesicus fuscus
Red bat	Lasiurus borealis
Hoary bat	Lasiurus cinereus
Eastern cottontail	Sylvilagus floridanus
New England cottontail	Sylvilagus transitionalis
Snowshoe hare	Lepus americanus
Woodchuck	Marmota monax
Chipmunk	Tamias striatus
Gray squirrel	Sciurus carolinensis
Red squirrel	Tamiasciurus hudsonicus
Eastern flying squirrel	Glaucomys volans
Beaver	Castor canadensis
Deer mouse	Peromyscus maniculatus
White-footed mouse	Peromyscus leucopus
Eastern wood rat	Neotoma floridana
Red-backed vole	Clethrionomys gapperi
Meadow vole	Microtus pennsylvanicus
Pine vole	Pitymys pinetorum
Muskrat	Ondatra zibethicus
Southern bog lemming	Synaptomys cooperi
Meadow jumping mouse	Zapus hudsonius
Woodland jumping mouse	Napaeozapus insignis
Norway rat	Rattus norvegicus
House mouse	Mus musculus
Porcupine	Erethizon dorsatum
Red fox	Vulpes vulpes
Gray fox	Urocyon cinereoargenteus
Black bear	Ursus americanus
Raccoon	Procyon lotor
Short-tailed weasel	Mustela erminea
Long-tailed weasel	Mustela frenata
Mink	Mustela vison
Striped skunk	Mephitis mephitis
River otter	Lutra canadensis
Bobcat	Lynx rufus
White-tailed deer	Odocoileus virginianus

Table 6. Birds known to occur in the Lehigh River Basin

	Permanent resident	Summer resident	Winter resident	Migrant
Common loon, Gavia immer			X	
Red-necked grebe, Podiceps grisegena				X
Horned grebe, Podiceps auritus			X	
Pied-billed grebe, Podilymbus podiceps			X	
Double-crested cormorant, Phalacrocorax auritus				X
Great blue heron, Ardea herodias	X			
Little blue heron, Florida caerulea		X		
Green heron, Butorides striatus		X		
Cattle egret, Bubulcus ibis				X
Great egret, Casmerodius albus		X		
Black-crowned night heron, Nycticorax nycticorax	X			
American bittern, Botaurus lentiginosus		X		
Whistling swan, Olor columbianus				X
Canada goose, Branta canadensis	X			
Brant, Branta bernicla				X
Snow goose, Chen caerulescens				X
Mallard, Anas platyrhynchos	X			
Black duck, Anas rubripes	X			
Gadwall, Anas strapera				X
Pintail, Anas acuta				X
Green-winged teal, Anas crecca				X
Blue-winged teal, Anas discors		X		
Widgeon, Anas americana				X
Shoveler, Anas clypeata				X
Wood duck, Aix sponsa	X			
Redhead, Aythya americana				X
Ring-necked duck, Aythya collaris				X
Canvasback, Aythya valisineria				X

	Permanent resident	Summer resident	Winter resident	Migrant
Greater scaup, Aythya marila				X
Lesser scaup, Aythya affinis				X
Common goldeneye, Bucephala clangula				X
Bufflehead, Bucephala albeola				X
Oldsquaw, Clangula hyemalis				X
Ruddy duck, Oxyura jamaicensis				X
Hooded merganser, Lophodytes cucullatus				X
Common merganser, Mergus merganser				X
Red-breasted merganser, Mergus serrator				X
Turkey vulture, Cathartes aura		X		
Goshawk, Accipiter gentilis			X	
Sharp-shinned hawk, Accipiter striatus	X			
Cooper's hawk, Accipiter cooperii	X			
Red-tailed hawk, Buteo jamaicensis	X			
Red-shouldered hawk, Buteo lineatus	X			
Broad-winged hawk, Buteo platypterus		X		
Rough-legged hawk, Buteo lagopus			X	
Golden eagle, Aquila chrysaetos				X
Bald eagle, Haliaeetus leucocephalus				X
Marsh hawk, Circus cyaneus	X			
Osprey, Pandion haliaetus	X			
Peregrine falcon, Falco peregrinus				X
Merlin, Falco columbarius				X
American kestrel, Falco sparverius	X			
Ruffed grouse, Bonasa umbellus	X			
Bobwhite, Colinus virginianus	X			
Ring-necked pheasant, Phasianus colchicus	X			
Turkey, Meleagris gallopavo	X			
American coot, Fulica americana			X	
Semipalmated plover, Charadrius semipalmatus				X
Killdeer, Charadrius vociferus	X			
Golden plover, Pluvialis dominica				X
Woodcock, Philohela minor				X
Snipe, Capella gallinago				X

	Permanent resident	Summer resident	Winter resident	Migrant
Spotted sandpiper, Actitis macularia		X		
Solitary sandpiper, Tringa solitaria		X		
Upland plover, Bartramia longicauda		X		
Greater yellowlegs, Tringa melaneoleucus				X
Lesser yellowlegs, Tringa flavipes				X
Pectoral sandpiper, Calidris melanotos				X
Least sandpiper, Calidris minutilla				X
Semipalmated sandpiper, Calidris pusillus		X		
Herring gull, Larus argentatus			X	
Ring-billed gull, Larus delawarensis			X	
Bonaparte's gull, Larus philadelphia				X
Rock dove, Columba livia	X			
Mourning dove, Zenaida macroura	X			
Yellow-billed cuckoo, Coccyzus americanus		X		
Black-billed cuckoo, Coccyzus erythrophthalmus		X		
Barn owl, Tyto alba	X			
Screech owl, Otis asio	X			
Great horned owl, Bubo virginianus	X			
Snowy owl, Nyctea scandiaca			X	
Barred owl, Strix varia	X			
Long-eared owl, Asio otus	X			
Short-eared owl, Asio flammeus			X	
Saw-whet owl, Aegolius acadicus			X	
Whip-poor-will, Caprimulgus vociferus				X
Nighthawk, Chordeiles minor		X		
Chimney swift, Chaetura pelagica		X		
Ruby-throated hummingbird, Archilochus colubris		X		
Belted kingfisher, Megaceryle alcyon	X			
Common flicker, Colaptes auratus	X			
Pileated woodpecker, Dryocopus pileatus	X			
Red-bellied woodpecker, Centurus carolinus	X			
Red-headed woodpecker, Melanerpes erythrocephalus	X			
Yellow-bellied sapsucker, Sphyrapicus varius			X	
Hairy woodpecker, Picoides villosus	X			
Downy woodpecker, Picoides pubescens	X			

	Permanent resident	Summer resident	Winter resident	Migrant
Kingbird, *Tyrannus tyrannus*		X		
Great crested flycatcher, *Myiarchus crinitus*		X		
Eastern phoebe, *Sayornis phoebe*	X			
Yellow-bellied flycatcher, *Empidonax flaviventris*		X		
Arcadian flycatcher, *Empidonax virescens*		X		
Traill's flycatcher, *Empidonax traillii*		X		
Least flycatcher, *Empidonax minimus*		X		
Wood pewee, *Contopus virens*		X		
Olive-sided flycatcher, *Nuttallornis borealis*				X
Horned lark, *Eremophila alpestris*	X			
Tree swallow, *Iridoprocne bicolor*		X		
Bank swallow, *Riparia riparia*		X		
Rough-winged swallow, *Stelgidopteryx ruficollis*		X		
Barn swallow, *Hirundo rustica*		X		
Cliff swallow, *Petrochelidon pyrrhonota*		X		
Purple martin, *Progne subis*		X		
Blue jay, *Cyanocitta cristata*	X			
Raven, *Corvus corax*				X
Crow, *Corvus brachyrhynchos*	X			
Fish crow, *Corvus ossifragus*	X			
Black-capped chickadee, *Parus atricapillus*	X			
Tufted titmouse, *Parus bicolor*	X			
White-breasted nuthatch, *Sitta carolinensis*	X			
Red-breasted nuthatch, *Sitta canadensis*			X	
Brown creeper, *Certhia familiaris*			X	
House wren, *Troglodytes aedon*		X		
Winter wren, *Troglodytes troglodytes*			X	
Carolina wren, *Thryothorus ludovicianus*	X			
Mockingbird, *Mimus polyglottos*	X			
Catbird, *Dumetella carolinensis*		X		
Brown thrasher, *Toxostoma rufum*	X			
Robin, *Turdus migratorius*	X			
Wood thrush, *Hylocichla mustelina*		X		
Hermit thrush, *Catharus guttata*			X	
Swainson's thrush, *Catharus ustulata*				X

	Permanent resident	Summer resident	Winter resident	Migrant
Gray-cheeked thrush, Catharus minima				X
Veery, Hylocichla fuscescens		X		
Bluebird, Sialis sialis	X			
Blue-gray gnatcatcher, Polioptila caerulea		X		
Golden-crowned kinglet, Regulus satrapa			X	
Ruby-crowned kinglet, Regulus calendula			X	
Water pipit, Anthus spinoletta			X	
Cedar waxwing, Bombycilla cedrorum	X			
Northern shrike, Lanius excubitor			X	
Loggerhead shrike, Lanius ludovicianus			X	
Starling, Sturnus vulgaris	X			
White-eyed vireo, Vireo griseus		X		
Yellow-throated vireo, Vireo flavifrons		X		
Solitary vireo, Vireo solitarius				X
Red-eyed vireo, Vireo olivaceus		X		
Philadelphia vireo, Vireo philadelphicus				X
Warbling vireo, Vireo gilvus		X		
Black-and-white warbler, Mniotilta varia		X		
Worm-eating warbler, Helmitheros vermivorus		X		
Blue-winged warbler, Vermivora pinus		X		
Tennessee warbler, Vermivora peregrina				X
Orange-crowned warbler, Vermivora celata				X
Nashville warbler, Vermivora ruficapilla				X
Parula warbler, Parula americana				X
Yellow warbler, Dendroica petechia		X		
Magnolia warbler, Dendroica magnolia				X
Cape May warbler, Dendroica tigrina				X
Black-throated blue warbler, Dendroica caerulescens				X
Yellow-rumped warbler, Dendroica coronata				X
Black-throated green warbler, Dendroica virens				X
Cerulean warbler, Dendroica cerulea		X		
Blackburnian warbler, Dendroica fusca				X
Chestnut-sided warbler, Dendroica pensylvanica		X		
Bay-breasted warbler, Dendroica castanea				X
Blackpoll warbler, Dendroica striata				X

	Permanent resident	Summer resident	Winter resident	Migrant
Pine warbler, *Dendroica pinus*				X
Prairie warbler, *Dendroica discolor*				X
Palm warbler, *Dendroica palmarum*				X
Ovenbird, *Seiurus aurocapillus*		X		
Northern waterthrush, *Seiurus noveboracensis*				X
Louisiana waterthrush, *Seiurus motacilla*		X		
Kentucky warbler, *Oporornis formosus*		X		
Connecticut warbler, *Oporornis agilis*				X
Mourning warbler, *Oporornis philadelphia*				X
Common yellowthroat, *Geothlypis trichas*		X		
Yellow-breasted chat, *Icteria virens*		X		
Hooded warbler, *Wilsonia citrina*		X		
Wilson's warbler, *Wilsonia pusilla*				X
Canada warbler, *Wilsonia canadensis*		X		
American redstart, *Setophaga ruticilla*		X		
House sparrow, *Passer domesticus*	X			
Bobolink, *Dolichonyx oryzivorus*		X		
Meadowlark, *Sternella magna*	X			
Red-winged blackbird, *Agelaius phoeniceus*	X			
Orchard oriole, *Icterus spurius*		X		
Northern oriole, *Icterus galbula*		X		
Rusty blackbird, *Euphagus carolinus*			X	
Common grackle, *Quiscalus quiscula*	X			
Brown-headed cowbird, *Molothrus ater*	X			
Scarlet tanager, *Piranga olivacea*		X		
Cardinal, *Richmondena cardinalis*	X			
Rose-breasted grosbeak, *Pheucticus ludovicianus*		X		
Indigo bunting, *Passerina cyanea*		X		
Evening grosbeak, *Hesperiphona vespertina*			X	
Purple finch, *Carpodacus purpureus*			X	
House finch, *Carpodacus mexicanus*	X			
Pine grosbeak, *Pinicola enucleator*			X	
Common redpoll, *Carduelis flammea*			X	
Pine siskin, *Spinus pinus*			X	
Goldfinch, *Carduelis tristis*	X			
Red crossbill, *Loxia curvirostra*			X	

	Permanent resident	Summer resident	Winter resident	Migrant
White-winged crossbill, Loxia leucoptera			X	
Rufous-sided towhee, Pipilo erythrophthalmus	X			
Savannah sparrow, Passerculus sandwichensis	X			
Grasshopper sparrow, Ammodramus savannarum		X		
Vesper sparrow, Pooecetes gramineus		X		
Dark-eyed junco, Junco hyemalis			X	
Tree sparrow, Spizella arborea			X	
Chipping sparrow, Spizella passerina		X		
Field sparrow, Spizella pusilla	X			
White-crowned sparrow, Zonotrichia leucophrys			X	
White-throated sparrow, Zonotrichia albicollis			X	
Fox sparrow, Passerella iliaca			X	
Lincoln's sparrow, Melospiza lincolnii				X
Swamp sparrow, Melospiza geogiana			X	
Song sparrow, Melospiza melodia	X			
Lapland larkspur, Calcarius lapponicus			X	
Snow bunting, Plectrophenax nivalis			X	

Table 7. Reptiles Known or Likely to Occur in the Lehigh River Basin

Snapping turtle	Chelydra serpintina
Bog turtle	Clemmys muhlenbergi
Wood turtle	Clemmys insculpta
Spotted turtle	Clemmys guttata
Stinkpot	Stenotherus odoratus
Painted turtle	Chrysemys picta
Box turtle	Terrapene carolina
Five-lined skink	Eumeces fasciatus
Water snake	Natrix sipedon
Garter snake	Thamnophis sirtalis
Ribbon snake	Thamnophis sauritus
Smooth earth snake	Virginia valeriae
Red-bellied snake	Storeria occipitomaculata
Brown snake	Storeria dekayi
Hognose snake	Heterodon platyrhinos
Worm snake	Carphophis amoenus
Ringneck snake	Diadophis punctatus
Smooth green snake	Opheodrys vernalis
Black racer	Coluber constrictor
Black rat snake	Elaphe obsoleta
Milk snake	Lampropeltis triangulum
Copperhead	Agkistrodon contortrix
Timber rattlesnake	Crotalus horridus

Table 8. Amphibians Known or Likely to Occur in the Lehigh River Basin

Red-spotted newt	Notophthalmus viridescens
Jefferson salamander	Ambystoma jeffersonianum
Spotted salamander	Ambystoma maculatum
Marbled salamander	Ambystoma opacum
Mountain dusky salamander	Desmognathus ochrophaeus
Northern dusky salamander	Desmognathus fuscus
Spring salamander	Gyrinophilus porphyriticus
Red salamander	Pseudotriton ruber
Slimy salamander	Plethodon glutinosus
Red-backed salamander	Plethodon cinereus
Four-toed salamander	Hemidactylium scutatum
Two-lined salamander	Eurycea bislineata
Long-tailed salamander	Eurycea longicauda
Eastern spadefoot toad	Scaphiopus holbrooki
American toad	Bufo americanus
Fowler's toad	Bufo woodhousei
Spring peeper	Hyla crucifer
Gray treefrog	Hyla versicolor
Upland chorus frog	Pseudacris triseriata
Cricket frog	Acris crepitans
Green frog	Rana clamitans
Bullfrog	Rana catesbeiana
Pickerel frog	Rana palustris
Wood frog	Rana sylvatica

Table 9. Fishes known to occur in the Lehigh River Basin

1.	American eel	Anguilla rostrada
2.	Rainbow trout	Salmo gairdneri
3.	Brown trout	Salmo trutta
4.	Brook trout	Salvelinus fontinalis
5.	Chain pickerel	Esox niger
6.	Redfin pickerel	Esox americanus
7.	Tiger muskellunge (hybrid)	Esox lucius x Esox masquinongy
8.	Goldfish	Carassius auratus
9.	Carp	Cyprinus carpio
10.	Cutlips minnow	Exoglossum maxillingua
11.	River chub	Nocomis micropogon
12.	Golden shiner	Notemigonus crysoleucas
13.	Comely shiner	Notropis amoenus
14.	Satinfin shiner	Notropis analostanus
15.	Common shiner	Notropis cornutus
16.	Spottail shiner	Notropis hudsonius
17.	Swallowtail shiner	Notropis procne
18.	Rosyface shiner	Notropis rubellus
19.	Spotfin shiner	Notropis spilopterus
20.	Bluntnose minnow	Pimephales notatus
21.	Blacknose dace	Rhinichthys atratulus
22.	Longnose dace	Rhinichthys cataractae
23.	Creek chub	Semotilus atromaculatus
24.	Fallfish	Semotilus corporalis
25.	Pearl dace	Semotilus margarita
26.	White sucker	Catostomus commersoni
27.	Creek chubsucker	Erimyzon oblongus
28.	Yellow bullhead	Ictalurus natalis
29.	Brown bullhead	Ictalurus nebulosus
30.	Channel catfish	Ictalurus punctatus
31.	Margined madtom	Noturus insignis
32.	Banded killifish	Fundulus diaphanus
33.	Four-spine stickleback	Apeltes quadracus
34.	Rock bass	Ambloplites rupestris
35.	Bluespotted sunfish	Enneacanthus gloriosus
36.	Redbreast sunfish	Lepomis auritus
37.	Green sunfish	Lepomis cyanellus
38.	Pumpkinseed	Lepomis gibbosus
39.	Bluegill	Lepomis macrochirus
40.	Smallmouth bass	Micropterus dolomieui
41.	Largemouth bass	Micropterus salmoides
42.	White crappie	Pomoxis annularis
43.	Black crappie	Pomoxis nigromaculatus
44.	Tessellated darter	Etheostoma olmstedi
45.	Yellow perch	Perca flavescens
46.	Shield darter	Percina peltata
47.	Walleye	Stizostedion vitreum
48.	Slimy sculpin	Cottus cognatus

Table 10. Fish surveys of selected waters in the Lehigh River Basin

Stream/Lake	Tributary of	Survey Date	Fishes Collected*
		CARBON COUNTY	
Black Creek	Lehigh River	8/10/78	1,2,3,4,10,12,21,22,26
Fourth Run	Black Creek	10/19/76	3,4,21,22
Hunter Creek	Buckwha Creek	7/21/78	1,2,3,10,15,21,22,23,24,26,44
Hickory Run	Lehigh River	10/18/76	1,3,4,12,21
Lehigh River Mahoning Cr. to Palmerton	Delaware River	9/18/72	1,5,10,15,17,24,26,29,38
Lesley Run	Lehigh River	7/25/78	1,3,4,21,22,23,26,38,41,43
Mud Run	Lehigh River	8/ 7/73	3,4,21,26,48
Sand Spring Run	Hickory Run	10/19/76	3,4,21
Aquashicola Creek	Lehigh River	5/18/76	1,2,3,4,5,6,10,12,15,21,23,24,26,27, 31,36,38,41,44
Big Bear Creek	Lehigh River	10/15/76	3,4,21,22,23,38,45
Beltzville Reservoir	Pohopoco Creek	7/ 8/75	7,12,28,29,34,38,39,40,41,43,45,47
Drakes Creek	Lehigh River	10/13/76	3,4
Hell Creek	Penn Forest Reservoir	8/ 5/70	3,4
Jeans Run	Nesquehoning Creek	7/24/78	4
Lizzard Creek	Lehigh River	8/10/78	1,3,5,10,14,15,16,21,22,24,26,27,29, 31,34,36,37,38,40,41,44
Mahoning Creek	Lehigh River	8/10/78	1,3,6,10,12,14,15,21,22,23,24,26,31, 36,38,40,44
Mauch Chunk Creek	Lehigh River	10/13/76	1,3,22,26,44
Mauch Chunk Lake	Mauch Chunk Creek	9/28/76	5,7,26,29,30,38,39,43,45,47
Pohopoco Creek	Lehigh River	8/25/77	1,2,3,4,6,10,12,21,22,23,24,26,31,34, 38,41,44,45,48
Quakake Creek	Black Creek	8/29/77	3,4,10,21,22,23,26,44
Stony Creek	Lehigh River	7/25/78	3,4,29

Stream	Tributary of	Survey Date	Fishes Collected*
		LACKAWANNA COUNTY	
Ash Creek	Lehigh River	8/10/76	3,4,12,21,22,24
		LEHIGH COUNTY	
Little Lehigh Creek	Lehigh River	8/22/78	1,3,6,10,14,15,16,21,22,23,26,27,29, 31,36,38,39,41,44
Big Trout Run	Lehigh River	7/ 1/69	1,3,6,21,24,26,44
Catasauqua Creek	Lehigh River	5/25/77	1,2,3,16,20,21,22,23,26,32,34,36,38,44
Cedar Creek	Little Lehigh Creek	6/15/77	1,3,4,8,21,26,33,38,44
Coplay Creek	Lehigh River	5/12/76	1,2,3,4,9,21,23,26,37,38,44
Jordan Creek	Lehigh River	7/ 6/78	1,2,3,6,8,9,10,12,14,15,16,21,22,24,26, 27,29,31,32,34,36,38,39,40,44,48
		5/ 8/74	1,2,13,14,15,16,17,19,20,21,22,23,24,26, 29,31,32,36,38,39,40
Little Lehigh Creek	Lehigh River	9/ 7/77	1,2,3,4,6,9,10,12,13,14,15,17,21,22,23, 24,26,32,34,36,37,38,39,41,44,48
Lehigh Canal at Allentown	Lehigh River	9/ 3/69	1,15,16,17,18,19,22,26,31,32,34,38,41
Lehigh River at Cementon	Delaware River	9/19/72	10,15,16,17,19,20,21,24,26,36,37,38,39
Lehigh River at Allentown	Delaware River	9/19/72	1,10,15,16,17,19,21,22,26,27,29,34,36, 38,39,41,44
Monocacy Creek	Lehigh River	10/ 4/76	1,3,4,5,8,10,12,14,15,21,22,23,24,26,27, 33,34,36,38,39,41,44
Saucon Creek, S. Br.	Saucon Creek	9/ 8/76	3,15,16,20,21,22,23,26,31,36,37,38,39, 41,44,48
Swabia Creek	Little Lehigh Creek	6/16/77	2,3,4,10,15,16,21,23,26,32,44
Trout Creek	Lehigh River	8/31/76	1,3,5,8,10,12,14,15,20,21,22,23,24,26, 34,38,41,44

Stream/Lake	Tributary of	Survey Date	Fish Collected*
		LUZERNE COUNTY	
F. E. Walters Reservoir	Lehigh River	7/10/75	9,12,24,26,28,29,32,38,39,40,41,43,45
Lehigh River upstream from Walter Res.	Delaware River	6/27/77	2,3,4,5,6,8,10,12,15,17,21,22,24,26, 27,29,31,35,38,41,44,45
Lehigh River Walter Res. tailwater to Sandy Run	Delaware River	9/15/77	1,3,10,12,15,21,22,24,26,29,31,36,38, 40,43,44,45
Wrights Creek	Lehigh River	6/ 7/76	1,3,4,16,21,22,26,29
		MONROE COUNTY	
Brady's Lake	Trout Creek	7/16/68	5,12,28,29,30,35,38,39,41,43,45
Cross Keys Run	Tobyhanna Creek	7/17/75	3,4,21
Frame Cabin Run	Tobyhanna Creek	7/17/75	4,6,15,21,29
Gouldsboro Lake	----	8/14/69	5,7,12,28,29,32,37,38,39,41,45,47
Kistler Run	Tobyhanna Creek	6/24/69	4,5
Mill Pond No. 1	Tobyhanna Creek	10/10/72	3,5,6,10,15,22,24,26,31,35,44
Tobyhanna Creek	Lehigh River	8/19/77	3,4,5,6,9,10,12,15,21,22,23,24,26,27, 29,31,35,38,41,44,45,46
Tobyhanna Lake No. 2	Tobyhanna Creek	8/24/76	5,12,28,29,38,41,43,45
Tunkhannock Creek	Tobyhanna Creek	6/17/77	6,12,21,24,26,27,29,38,44,46
Buckwha Creek	Aquashicola Creek	8/30/76	1,2,3,4,8,10,12,14,15,16,21,22,23,24, 26,31,38,39,41,44
Dotter's Creek	Middle Creek	8/16/76	3,4,48
Middle Creek	Pohopoco Creek	8/11/76	1,2,3,4,10,21,22,26,38,39,44,45,48
Princess Run	Buckwha Creek	8/18/76	3,4,6,10,12,14,15.21,22,23,24,26,38, 39,41,44

Stream/Lake	Tributary of	Survey Date	Fish Collected*
		NORTHAMPTON COUNTY	
Bertsch Creek	Lehigh River	10/12/76	1,3,21,24,26,44
Hokendauqua Creek	Lehigh River	8/21/78	1,2,3,6,10,11,14,[illegible],16,21,22,23,24, 26,31,34,[illegible],38,[illegible],40,41,44
Indian Creek	Hokendauqua Creek	8/ 6/78	1,2,[illegible],10,15,21,[illegible],[illegible],24,26,31,41,44
Lehigh Canal near Walnutport	Lehigh River	10/11/72	1,5,9,12,26,27,37,[illegible],[illegible],41,43
Lehigh River at Treichers	Delaware River	9/19/72	5,10,15,19,21,23,24,26,27,29,38,44
Lehigh River at Freemansburg	Delaware River	9/19/72	1,10,26,36,38,39
Lehigh River at Glendon	Delaware River	9/19/72	1,15,16,19,21,26,32,36,37
Nancy Run	Lehigh River	7/ 5/78	1,2,3,4,21,26,38,48
Saucon Creek	Lehigh River	9/ 9/76	3,4,6,12,15,21,22,[illegible],26,29,36,37,38, 39,44,48

*Numerals refer to species listed in Table 9

Source: Stream survey reports of Pennsylvania Fish Commission

Table 11. Lands Open to Public Hunting in the Lehigh River Basin

STATE GAME LANDS

County	Identification Number	Acreage
Carbon	40	5,743
"	141	17,048
"/Lehigh	217	3,969
"/Monroe	129	3,518
Lackawanna	135	3,039
"/Luzerne	91	9,035 approx.
Lehigh	205	1,303
Luzerne	149	1,334
"	119	3,974 approx.
Monroe	127	25,079
"	38	789 approx.
Northampton	168	2,635 approx.

STATE FORESTS

County	Name	Acreage
Carbon	--	997
Lackawanna	Thornhurst	6,052
Monroe	Delaware-Lehigh	2,054

STATE PARKS

County	Name	Acreage
Carbon	Beltzville*	2,972 (including 947-acre lake)*
"	Hickory Run	15,500 (" 17 acres of lakes)
Monroe	Gouldsboro	2,800 (" 250-acre lake)
"	Tobyhanna	5,439 (" 170-acre lake)

COOPERATIVE FARM GAME PROJECTS

County	Identification Number	Acreage
Berks/Lehigh	53	3,775
Carbon/Monroe	179	13,337
Lehigh	127	724 approx.
"	9	3,905 approx.
"	93	4,095
Northampton	44	1,713 approx.
"	64	4,219
"	54	11,379 approx.

SAFETY ZONE PROJECTS

County	Acreage (approximate)
Berks	254
Carbon	29,145
Lackawanna	762
Lehigh	2,764
Luzerne	4,154
Monroe	1,565
Northampton	4,176
Schuylkill	1,882

*An additional 422 acres at the Beltzville Reservoir Project is leased to the Pennsylvania Game Commission for wildlife management.

Table 1?. Fishery management areas in the Lehigh River Basin

Streams	Managed length (km)	Managed for: Warmwater species	Stocked trout	Wild trout
		CARBON COUNTY		
Black Creek	4.8		X	
Dilldown Creek	6.5			X
Fourth Run	7.3		X(5.7)	X(1.6)
Hawk Run	2.5			X
Hickory Run	9.3		X	
Leslie Run	8.1		X	
Mud Run	9.7		X(4.2)	X(5.5)
Aquashicola Creek	26.9		X(24.9)	X(2.0)
Bear Creek	6.7		X	
Little Bear Creek	3.3			X
Black Creek	7.0	X		
Buck Mtn. Run	6.8	X		
Buckwha Creek	13.8		X	
Drakes Creek	3.2		X	
Hell Creek	4.1			X
Hunter Creek	4.8		X	
Jeans Run	4.8		X	
Lehigh Canal	6.4	X		
Lehigh River				
Palmerton to Rockport	43.0	X		
Lizzard Creek	21.5		X	
Mahoning Creek	16.3		X	
Mauch Chunk Creek	2.9		X	
Nesquehoning Creek	12.3	X		
Pine Run	3.7			X
Pohopoco Creek	22.6		X	
Stony Creek	8.6		X(4.2)	X(4.4)
Wild Creek	1.0			X

Streams	Managed length (km)	Managed for: Warmwater species	Stocked trout	Wild trout
LACKAWANNA COUNTY				
Ash Creek	3.0		X	
Lehigh River (see Luzerne County)				
LEHIGH COUNTY				
Catasauqua Creek	6.1		X	
Cedar Creek	3.8		X	
Coplay Creek	9.4		X	
Jordan Creek	20.1		X	
Little Lehigh Creek	32.5		X(31.0)	X(1.5)
Lehigh River (see Northampton County)				
Saucon Creek	8.8		X	
Saucon Creek, S. Br.	3.8		X	
Spring Creek	4.6	X		
Swabia Creek	5.5		X	
Trout Creek (Lehigh R. trib.)	10.6		X	
Trout Creek (Little Lehigh Cr. trib.)	2.6			X
LUZERNE COUNTY				
Bear Creek	5.3	X		
Lehigh River Upstream from Rockport	55.3	X(8.8)	X(46.5)	
Sandy Creek	2.9	X		
Shades Creek	3.8			X
Wright Creek	10.0		X	

Streams	Managed length (km)	Managed for: Warmwater species	Stocked trout	Wild trout
		MONROE COUNTY		
Cross Keys Run	7.2			X
Frame Cabin Run	8.9			X
Kistler Run	4.8			X
Tobyhanna Creek	12.7	X(2.2)	X(10.5)	
Dotter Creek	6.0		X	
Middle Creek	7.9		X	
Princess Run	8.7		X	
		NORTHAMPTON COUNTY		
Bertsch Creek	3.3		X	
Hokendauqua Creek	25.4	X(3.0)	X(22.4)	
Indian Creek	8.5		X	
Lehigh Canal	19.7	X		
Lehigh River				
Mouth to Palmerton	57.2	X		
Monocacy Creek	22.0	X(4.8)	X(14.2)	X(3.0)
Monocacy Creek, E. Br.	2.6	X		
Nancy Run	2.6		X	
Saucon Creek	8.2	X(3.0)	X(5.2)	

Lakes	Surface acreage	Managed for Warmwater species	Managed for Stocked trout
Hickory Run Dam, Carbon Co.	5	X	X
Beltzville Reservoir, Carbon Co.	947	X	
Mauch Chunk Lake, Carbon Co.	330	X	
Treschow Dam, Carbon Co.	1		X
F.E. Walter Reservoir, Luzerne Co.	90	X	X
Tobyhanna Lake #2, Monroe Co.	170	X	
Gouldsboro Lake, Monroe Co.	250	X	
Brady's Lake, Monroe Co.	229	X	

APPENDIX C

GLOSSARY

APPENDIX C

GLOSSARY

Abbreviations

alternating current	ac	gravitational constant	g
barrel (42 gallons)	bbl	head in feet	H
benefit to cost ratio	B/C	horsepower	hp
cents	¢	kilovolt	kV
cubic feet	ft^3	kilowatt	kW
cubic feet per second	cfs	kilowatt-hours	kWh
cubic yard	cy yd	megawatt	MW
direct current	dc	megawatt-hours	MWh
dollars	$	percent	%
efficiency in percent	E	pound	lb
feet	ft	pounds per square inch	psi
flow in cfs	Q	square yards	sq yd
gigawatt	GW		

Definitions

ALTERNATING CURRENT (ac) - an electric current that reverses its direction of flow periodically as contrasted to direct current.

AVERAGE LOAD - the hypothetical constant load over a specified time period that would produce the same energy as the actual load would produce for the same period.

BENEFIT-COST RATIO (B/C) - the ratio of the present value of the benefit stream to the present value of the project cost stream computed for comparable price level assumptions.

BENEFITS (ECONOMIC) - the increase in economic value produced by the hydropower project, typically represented as a time stream of value produced by the generation of hydroelectric power. In small hydro projects this is often limited for analysis purposes to the stream of costs that would be representative of the least costly alternative source of equivalent power.

CAPACITY - the maximum power output or load for which a turbine-generator, station, or system is rated.

CAPACITY VALUE - that part of the market value of electric power which is assigned to dependable capacity.

CAPITAL RECOVERY FACTOR - a mathematics of finance value used to convert a lump sum amount to an equivalent uniform annual stream of values.

CONVENTIONAL HYDRO PLANT - a plant using only water naturally occurring at a site to produce power, as contrasted to a pumped storage plant.

COSTS (ECONOMIC) - the stream of value required to produce the hydroelectric power. In small hydro projects this is often limited to the management and construction cost required to develop the power plant, and the administration, operations, maintenance and replacement costs required to continue the power plant in service.

COST OF SERVICE - cost of producing electric energy at the point of ownership transfer.

CRITICAL STREAMFLOW - the amount of streamflow available for hydroelectric power generation during the most adverse streamflow period.

CRITICAL DRAWDOWN PERIOD - the time period between maximum pool drawdown and the previous occurrence of full pool.

DEMAND - see LOAD

DEPENDABLE CAPACITY - the load carrying ability of a hydropower plant under adverse hydrological conditions for the time interval and period specified of a particular system load.

DIRECT CURRENT (dc) - electricity that flows continuously in one direction as contrasted with alternating current.

ENERGY - the capacity for performing work. The electrical energy term generally used is kilowatt-hours and represents power (kilowatts) operating for some time period (hours).

ENERGY VALUE - that part of the market value of electric power which is assigned to energy generated.

ELECTRIC RATE SCHEDULE - a statement of the terms and conditions governing the sale of electric service to a particular class of customers.

FEASIBILITY STUDY - an investigation performed to formulate a hydropower project and definitely assess its desirability for implementation.

FEDERAL ENERGY REGULATORY COMMISSION (FERC) - an ageny in the Department of Energy which licenses non-Federal hydropower projects and regulates interstate transfer of electric energy. Formerly the Federal Power Commission (FPC).

FIRM ENERGY - the energy generation ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified of a particular system load.

FORCE OUTAGE - the shutting down of a generating unit for emergency reasons.

FORCED OUTAGE RATE - the percent of scheduled generating time a unit is unable to generate because of forced outages due to mechanical, electrical or other failure.

FOSSIL FUELS - refers to coal, oil, and natural gas.

GENERATOR - a machine which converts mechanical energy into electric energy.

GIGAWATT (GW) - one million kilowatts.

HEAD, GROSS (H) - the difference in elevation between the headwater surface above and the tailwater surface below a hydroelectric power plant, under specified conditions.

HYDROELECTRIC PLANT or HYDROPOWER PLANT - an electric power plant in which the turbine/generators are driven by falling water.

INSTALLED CAPACITY - the total of the capacities shown on the nameplates of the generating units in a hydropower plant.

INTERCONNECTION - a transmission line joining two or more power systems through which power produced by one can be used by the other.

KILOVOLT (kV) - one thousand volts.

KILOWATT (kW) - one thousand watts.

KILOWATT-HOUR (kWh) - the amount of electrical energy involved with a one-kilowatt demand over a period of one hour. It is equivalent to 3,413 BTU of heat energy.

LOAD - the amount of power needed to be delivered at a given point on an electric system.

LOAD CURVE - a curve showing power (kilowatts) supplied, plotted against time of occurence, and illustrating the varying magnitude of the load during the period covered.

LOAD FACTOR - the ratio of the average load during a designated period to the peak or maximum load occurring in that period.

LOW HEAD HYDROPOWER - hydropower that operates with a head of 20 meters (66 feet) or less.

(AT) MARKET VALUE - the value of power at the load center as measured by the cost of producing and delivering equivalent alternative power to the market.

MEGAWATT (MW) - one thousand kilowatts.

MEGAWATT-HOURS (MWh) - one thousand kilowatt-hours.

MULTI-PURPOSE RIVER BASIN PROGRAM - programs for the development of rivers with dams and related structures which serve more than one purpose, such as - hydroelectric power, irrigation, water supply, water quality control, and fish and wildlife enhancement.

NUCLEAR ENERGY - energy produced largely in the form of heat during nuclear reactions, which with conventional generating equipment can be transformed into electric energy.

NUCLEAR POWER - power released from the heat of nuclear reactions, which is converted to electric power by a turbine/generator unit.

OUTAGE - the period in which a generating unit, transmission line, or other facility, is out of service.

PEAKING CAPACITY - that part of a system's capacity which is operated during the hours of highest power demand.

PEAK LOAD - the maximum load in a stated period of time.

PLANT FACTOR - ratio of the average load to the plants installed capacity, expressed as an annual percentage.

PONDAGE - the amount of water stored behind a hydroelectric dam of relatively small storage capacity used for daily or weekly regulation of the flow of a river.

POWER (ELECTRIC) - the rate of generation or use of electric energy, usually measured in kilowatts.

POWER POOL - two or more electric systems which are interconnected and coordinated to a greater or lesser degree to supply, in the most economical manner, electric power for their combined loads.

PREFERENCE CUSTOMERS - publicly-owned systems and nonprofit cooperatives which by law have preference over investor-owned systems for the purchase of power from Federal projects.

PUMPED STORAGE - an arrangement whereby electric power is generated during peak load periods by using water previously pumped into a storage reservoir during off-peak periods.

RECONNAISSANCE STUDY - a preliminary feasibility study designed to ascertain whether a feasibility study is warranted.

RUN OF RIVER HYDRO PLANT - a conventional hydro plant having little or no storage available for regulating releases of water for power generation.

SECONDARY ENERGY - all hydroelectric energy other than FIRM ENERGY.

SERVICE OUTAGE - the shut-down of a generating unit, transmission line or other facility for inspection, maintenance, or repair.

SMALL HYDROPOWER - hydropower installations that are 15,000 KW (15 MW) or less in capacity.

SPINNING RESERVE - generating units operating at no load or a partial load with excess capacity readily available to support additional load.

STEAM-ELECTRIC PLANT - a plant in which the prime movers (turbines) connected to the generators are driven by steam.

STORAGE HYDRO PLANT - a hydro plant which stores water during periods of low electrical demand and generates power during high demand periods.

SURPLUS POWER - generating capacity which is not needed on the system at the time it is available.

SYSTEM, ELECTRIC - the physically connected generation, transmission, distribution, and other facilities operated as an integral unit under one control, management or operating supervision.

THERMAL PLANT - a generating plant which uses heat to produce electricity. Such plants may burn coal, gas, oil, or use nuclear energy to produce thermal energy.

THERMAL POLLUTION - rise in temperature of water such as that resulting from heat released by a thermal plant to the cooling water when the effects on other uses of the water are detrimental.

TRANSFORMER - an electromagnetic device for changing the voltage of alternating current electricity.

TRANSMISSION - the act or process of transporting electric energy in bulk.

TURBINE - the part of a generating unit which is spun by the force of water or steam to drive an electric generator. The turbine usually consists of a series of curved vanes or blades on a central spindle.

TURBINE/GENERATOR - a rotary-type unit consisting of a turbine and an electric generator. (See TURBINE & GENERATOR)

VOLTAGE OF A CIRCUIT - the electric potential difference between conductors or conductors to the ground, usually expressed in volts or kilovolts.

WATT - the rate of energy transfer equivalent to one ampere under a pressure of one volt at unity power factor.

WHEELING - transportation of electricity by a utility over its lines for another utility; also includes the receipt from and delivery to another system of like amounts but not necessarily the same energy.

APPENDIX D

STUDY TASKS AND COSTS

RCS:

STUDY COST ESTIMATE (PB-6) ($000) For use of this form, see ER 11-2-220	APPROPRIATION TITLE: General Investigations	NAME OF STUDY
	CATEGORY: Surveys	Lehigh River Basin (Hydroelectric Power)
	CLASS: Flood Control	SUBCLASS: None

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT FEDERAL COST ESTIMATE ACCOUNT STAGE 1	STAGE 2	STAGE 3	TOTAL	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED (Mar. 77)	REMARKS
	a	b	c	d	e	f	g	h
1	.01	Public Involvement	9.0	38.0	18.0	65.0	55.0	
2	.02	Institutional Studies	2.0	4.0	2.0	8.0	30.0	
3	.03	Social Studies	2.0	5.0	5.0	12.0	5.0	
4	.04	Cultural Resources Studies	-	10.0	68.0	78.0	-	
5	.05	Environmental Studies	2.0	53.0	105.0	160.0	30.0	
6	.06	Fish and Wildlife Studies	6.6	20.0	30.0	56.6	25.0	
7	.07	Economic Studies	2.0	23.0	19.0	44.0	20.0	
8	.08	Surveying and Mapping	-	11.0	30.0	41.0	20.0	
9	.09	Hydrology & Hydraulics	5.0	236.0	45.0	286.0	50.0	
10	.10	Foundations & Materials Invest.	0.5	43.0	120.0	163.5	25.0	
11	.11	Design & Cost Estimates	2.0	133.0	120.0	255.0	20.0	
12	.12	Real Estate Studies	-	5.0	20.0	25.0	10.0	
13	.13	Study Management	3.0	153.0	139.0	295.0	-	
14	.14	Plan Formulation & Evaluation	6.5	30.0	19.0	55.5	-	

DATE PREPARED	DIVISION / DISTRICT	REGION / BASIN	
Sept 1980	DIVISION North Atlantic; DISTRICT Philadelphia	REGION North Atlantic; BASIN Delaware River	Page 1 of 2

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RCS

STUDY COST ESTIMATE (PB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations

CATEGORY: Surveys

CLASS: Flood Control

NAME OF STUDY: Lehigh River basin (Hydroelectric Power)

SUBCLASS: None

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT FEDERAL COST ESTIMATE ACCOUNT STAGE 1	STAGE 2	STAGE 3	TOTAL	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED ( )	REMARKS
	a	b	c	d	e	f	g	h
1	.15	Report Preparation	6.4	24.0	102.0	132.4	35.0	
2	.20	Marketability Studies	-	7.0	4.0	11.0	-	
3	.31	Supervision & Administration	3.0	53.0	52.0	108.0	25.0	
4								
5		NOTE: Cost increase the result of increase in study scope (number of sites to review) as the result of the current favorable economics associated with small scale hydropower and the impact of revised Principles and Standards on economic and marketability analyses.						
6								
7								
8								
9								
10								
11								
12								
13								
14		TOTAL	50.0	848.0	898.0	1796.0	350.0	

DATE PREPARED: Sept 1980

DIVISION: North Atlantic

DISTRICT: Philadelphia

REGION: North Atlantic

BASIN: Delaware River

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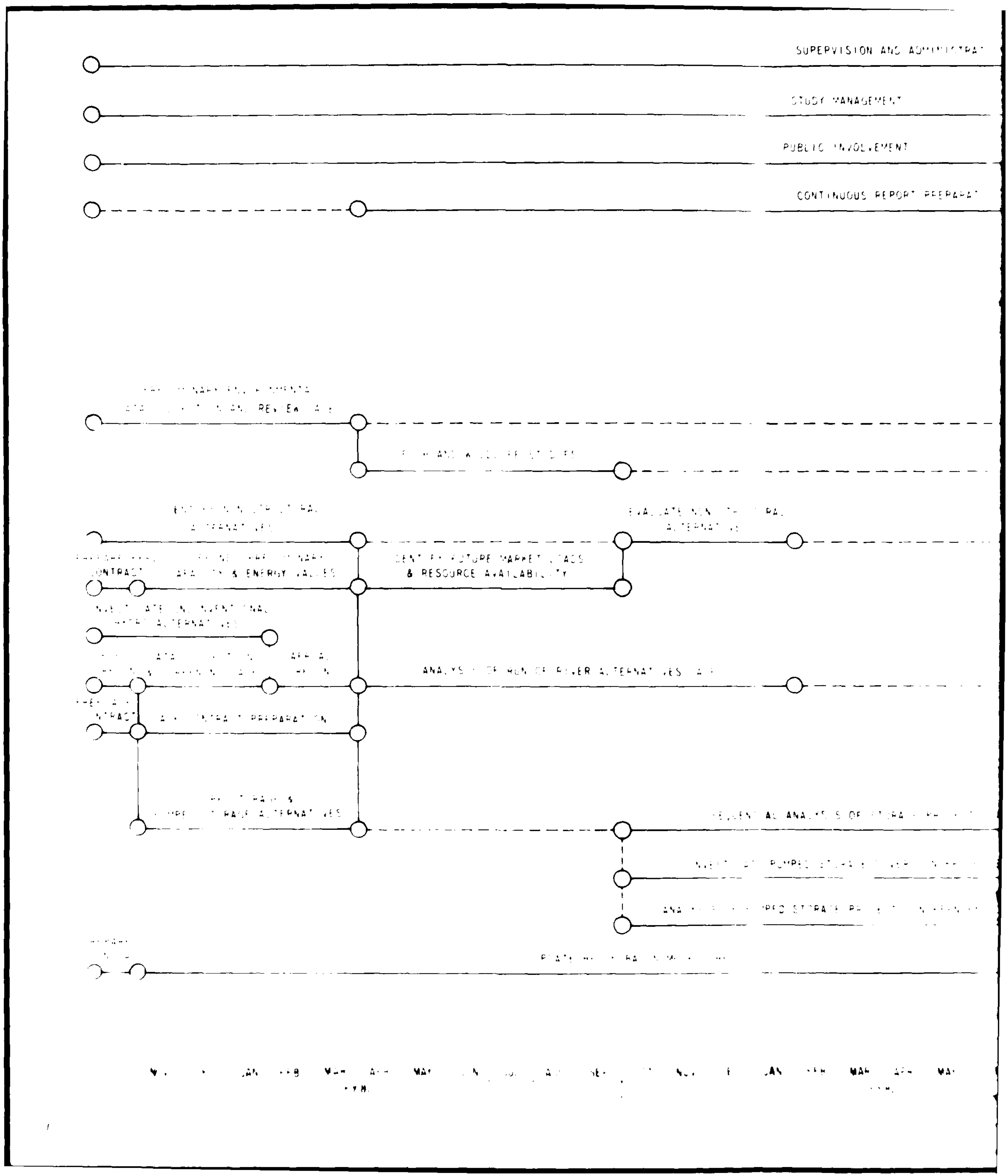
TABLE D-1
LEHIGH RIVER BASIN HYDROELECTRIC POWER STUDY
MAJOR STUDY TASKS AND STUDY COST ESTIMATE

STUDY TASK	STUDY COST ESTIMATE (thousands of dollars)							
	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	TOTALS
Public Involvement	9.0	10.0	10.0	18.0	5.0	5.0	8.0	65.0
Institutional Studies	2.0	-	-	4.0	2.0	-	-	8.0
Social Studies	2.0	-	-	5.0	5.0	-	-	12.0
Cultural Resources Studies	-	-	-	10.0	34.0	34.0	-	78.0
Environmental Studies	2.0	26.0	4.0	23.0	55.0	50.0	-	160.0
Fish & Wildlife Studies	6.6	10.0	-	10.0	-	30.0	-	56.6
Economic Studies	2.0	4.0	13.0	6.0	8.0	11.0	-	44.0
Surveying & Mapping	-	11.0	-	5.0	25.0	-	-	41.0
Hydrology & Hydraulics	5.0	71.0	123.0	42.0	24.0	21.0	-	286.0
Foundations & Materials Invest.	0.5	31.0	11.0	1.0	120.0	-	-	163.5
Design & Cost Estimates	2.0	55.0	60.0	18.0	64.0	56.0	-	255.0
Real Estate Studies	-	1.0	4.0	-	-	20.0	-	25.0
Study Management	3.0	44.0	50.0	59.0	59.0	63.0	17.0	295.0
Plan Formulation & Evaluation	6.5	12.0	6.0	12.0	6.0	13.0	-	55.5
Report Preparation	6.4	4.0	5.0	15.0	5.0	47.0	50.0	132.4
Marketability Studies	-	7.0	-	-	4.0	-	-	11.0
Supervision & Administration	3.0	19.0	14.0	20.0	24.0	20.0	8.0	108.0
TOTALS	50.0	305.0	300.0	248.0	440.0	370.0	83.0	1796.0



SUPERVISION AND ADMINISTRAT
STUDY MANAGEMENT
PUBLIC INVOLVEMENT
CONTINUOUS REPORT PREPARAT
& RESOURCE AVAILABILITY
JAN
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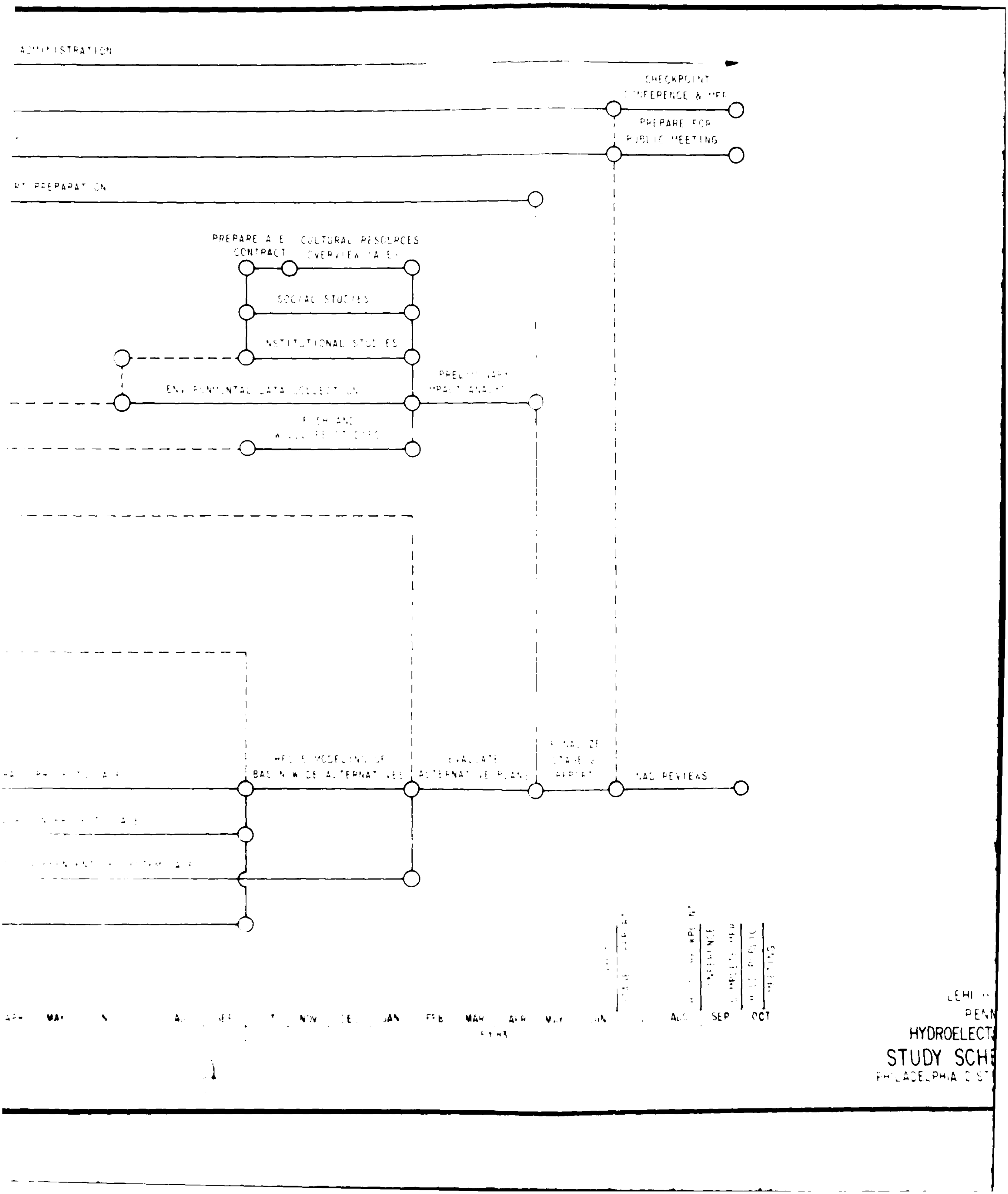
MAR
MAY
JAN
MAR
MAY

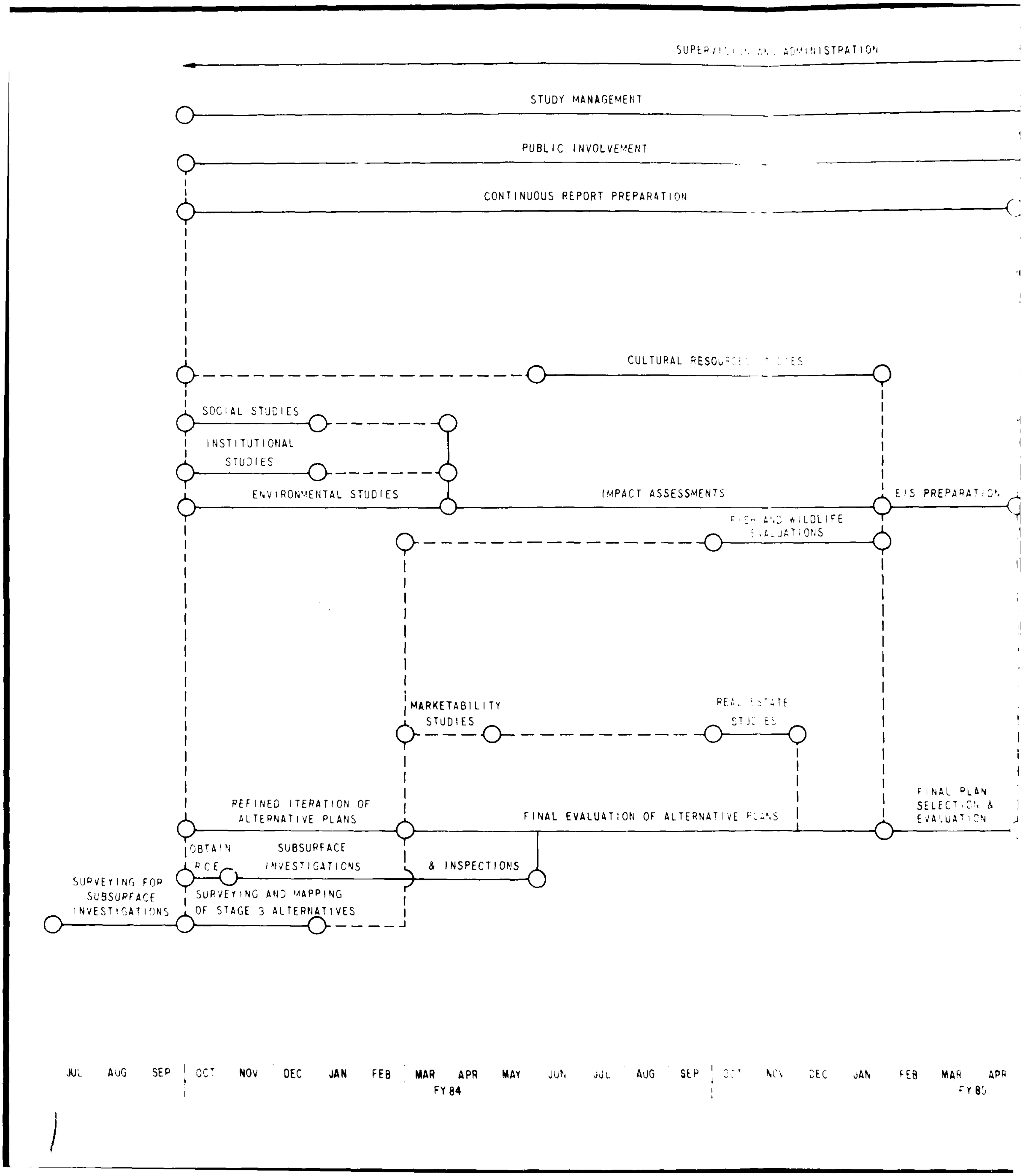


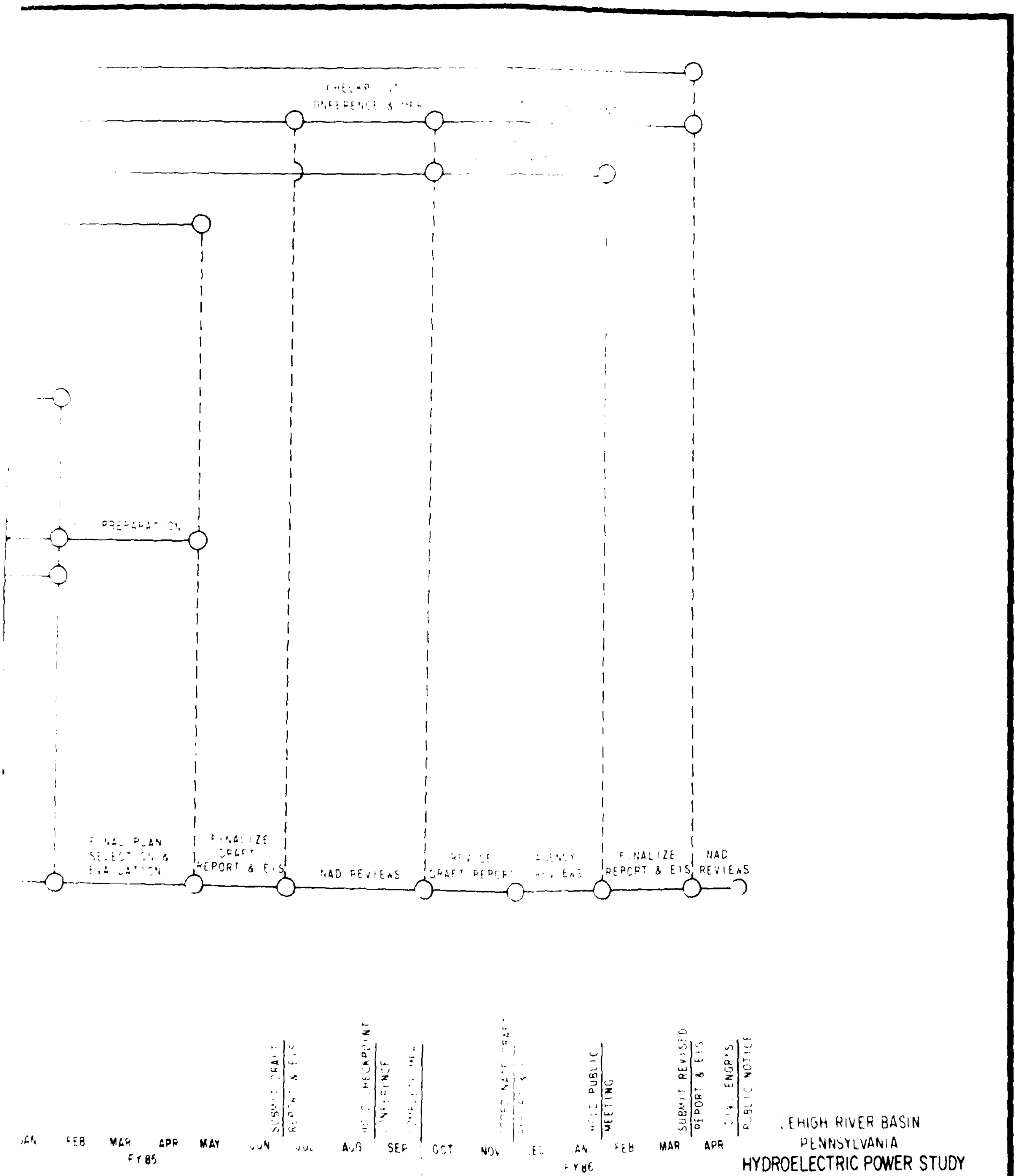
CHECKPOINT
PREPARE FOR
PREPARE A/E
CONTRACT
CULTURAL RESOURCES
SOCIAL STUDIES
EVALUATE
NAD REVIEWS
MAY
NOV
JAN
FEB
MAR
APR
AUG
SEP
OCT
HYDROELECT
STUDY SCH

LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY

STUDY SCHEDULE STAGE-2

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS


STUDY MANAGEMENT
PUBLIC INVOLVEMENT
CONTINUOUS REPORT PREPARATION
SOCIAL STUDIES
INSTITUTIONAL STUDIES
ENVIRONMENTAL STUDIES
IMPACT ASSESSMENTS
EIS PREPARATION
MARKETABILITY STUDIES
REFINED ITERATION OF ALTERNATIVE PLANS
FINAL EVALUATION OF ALTERNATIVE PLANS
FINAL PLAN SELECTION & EVALUATION
OBTAIN ROE
SUBSURFACE INVESTIGATIONS
& INSPECTIONS
SURVEYING FOR SUBSURFACE INVESTIGATIONS
SURVEYING AND MAPPING OF STAGE 3 ALTERNATIVES
JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
FY 84
DEC JAN FEB MAR APR



LEHIGH RIVER BASIN
PENNSYLVANIA
HYDROELECTRIC POWER STUDY
STUDY SCHEDULE STAGE-3
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE D-2

END

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