US Army Corps of Engineers ®
Pittsburgh District

# Union City Dam

# General Design Memorandum Part 1

# October 1964

# Information for Public Release

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Prepared 21 May 2012

# FRENCH CREEK BASIN, PENNSYLVANIA

## UNION CITY RESERVOIR

## GENERAL DESIGN MEMORANDUM

U. S. Army Engineer District, Pittsburgh
Corps of Engineers
Pittsburgh, Pennsylvania 15219

October 1964

FRENCH CREEK BASIN, PENNSYLVANIA
UNION CITY RESERVOIR

GENERAL DESIGN MEMORANDUM

| Previously Issued Design Memorandum | Submitted | Approved |
|---|---|---|
| None | | |

| Currently Scheduled Design Memoranda | To be submitted |
|---|---|
| Real Estate Detail Design Memorandum, Part I | F.Y. 1965 |
| Highways Detail Design Memorandum, Part II* | F.Y. 1966 |
| Dam and Spillway Detail Design Memorandum | F.Y. 1966 |
| Concrete Aggregate Design Memorandum | F.Y. 1966 |
| Utilities Detail Design Memorandum, Part II and Part III* | F.Y. 1966 |
| Real Estate Detail Design Memorandum, Part II | F.Y. 1966 |
| Cemeteries Design Memorandum | F.Y. 1967 |

* Part I included in General Design Memorandum

Rev. 21 Jan 1965

FRENCH CREEK BASIN, PENNSYLVANIA

UNION CITY RESERVOIR

GENERAL DESIGN MEMORANDUM

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## EXHIBITS


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## BASIS OF DESIGN (APPENDICES)


| Appendix No. | Title |
|---|---|
| I | Hydrology |
| II | Geology, Soils and Embankment Design |
| III | Structural Design |
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FRENCH CREEK BASIN, PENNSYLVANIA

UNION CITY RESERVOIR

GENERAL DESIGN MEMORANDUM

# I. PERTINENT DATA

1. Project Location: French Creek, 1.3 miles above junction of South Branch.

2. Drainage Area: 222 square miles.

3. Features of the Reservoir: *

| | |
|---|---|
| Reservoir full elevation, m.s.l. | 1,278 |
| Reservoir full area, acres | 2,290 |
| Capacity, acre-feet | 47,640 |
| Capacity, inches runoff | 4.0 |

4. Features of the Dam, Spillway and Outlet Works:

a. Dam:

| | |
|---|---|
| Type | Rolled earth embankment |
| Length, feet | 1,430 |
| Elevation at top, m.s.l. | 1,298 |
| Elevation streambed, m.s.l. | 1,210 |
| Height of dam, feet | 88 |

b. Spillway:

| | |
|---|---|
| Location | Right abutment |
| Type | Side-channel, uncontrolled |
| Crest elevation of ogee weir, m.s.l. | 1,278.0 |
| Length ogee weir, feet | 268 |
| Spillway design flood discharge, c.f.s. | 62,700 |
| Reservoir design flood discharge, c.f.s. | 4,500 |
| Elevation of spillway design flood in reservoir, m.s.l. | 1,292.6 |
| Elevation of reservoir design flood, m.s.l. | 1,278.0 |
| Surcharge over crest, spillway design flood, feet | 14.6 |
| Standard project flood discharge, c.f.s. | 20,300 |
| Elevation of standard project flood in reservoir, m.s.l. | 1,284.2 |
| Surcharge over crest, standard project flood, feet | 6.2 |

* No permanent pool will be provided in reservoir.

c. Outlet Works:

| | |
|---|---|
| Location | Valley floor and spillway weir |
| Type | Reinforced concrete conduit, uncontrolled |
| Invert elevations, m.s.l. | |
| Lower intake | 1,210 in valley floor (equipped with trash rack) |
| Upper intake | 1,255 in spillway weir |
| Size of Opening: | |
| Lower | 6.0 feet square with 1.25 ft. fillets in corners |
| Upper | Rectangular section, 10 ft. wide x 16 ft. high |
| Design capacity, c.f.s.: | |
| Elevation 1,278 | 4,500 |
| Elevation 1,210 | 0 |
| Bankfull capacity below dam, | |
| Capacity, c.f.s. | 5,900 |

5. Cost Estimates:

| | |
|---|---|
| a. First cost | $ 10,100,000 |
| b. Average annual charges | $ 376,000 |

6. Estimated Average Annual Benefits: $ 1,050,000

7. Economic Evaluation:

| | |
|---|---|
| a. Ratio, benefits to charges | 2.8 to 1 |

## II. PROJECT AUTHORIZATION

8. Authorizing Act.- The flood protection project for the French Creek Basin in Pennsylvania is authorized by Section 203, Title II - Flood Control, of the Omnibus Rivers and Harbors and Flood Control Act of 1962, House of Representatives 87th Congress, Second Session, Report Number 2557, approved 23 October 1962,which provides as follows:

TITLE II - FLOOD CONTROL

SEC. 203. The following works of improvement for the benefit of navigation and the control of destructive floodwaters and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and the supervision of the Chief of Engineers in accordance with the plans in the respective reports hereinafter designated and subject to the conditions set forth therein: Provided, That the necessary plans, specifications, and preliminary work may be prosecuted on any project authorized in this title with funds from appropriations hereafter made for flood control so as to be ready for rapid inauguration of a construction program: Provided further, That the projects authorized herein shall be initiated as expeditiously and prosecuted as vigorously as may be consistent with budgetary requirements: and, provided further, That penstocks and other similar facilities adapted to possible future use in the development of hydroelectric power shall be installed in any dam authorized in this Act for construction by the Department of the Army when approved by the Secretary of the Army on the recommendation of the Chief of Engineers and the Federal Power Commission.

OHIO RIVER BASIN

The project for French Creek, Pennsylvania, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 95, Eighty-Seventh Congress, at an estimated cost of $23,102,000. The project document further provides for revocation of the authorization for the French Creek (Cambridge Springs) Reservoir.

9. The authorized flood control project for the French Creek Basin provides for a system of three strategically placed reservoirs consisting of the French Creek (Union City) Reservoir, Muddy Creek Reservoir and Woodcock Reservoir. The flood control project would be subject to the requirement that responsible local interests will furnish assurances satisfactory to the Secretary of the Army that they will furnish local cooperation as specified by the Board of Engineers for Rivers and Harbors in a letter to the Chief of Engineers dated 9 August 1961 in which the Board recommended that local interests periodically remind those affected that damages

will still occur from floods of greater severity and lesser frequency than those floods for which protection is completely afforded. This report comprises the General Design Memorandum for the French Creek (Union City) Reservoir, hereafter referred to as the Union City Reservoir.

10. Authority for the Design Memorandum.- This report is submitted in conformity with Advice of Allotment No. C-130, dated 29 October 1962, from the Office of the Chief of Engineers to the District Engineer, U. S. Army Engineer District, Pittsburgh, Appropriation 96X3122, Construction, General, Corps of Engineers, Civil.

## III. INVESTIGATIONS

11. Project document.- Senate Document No. 95, 87th Congress, 2d Session, was the basis for French Creek Basin, Pennsylvania, legislative action and is the project document. The French Creek Basin study recommended a system of three reservoirs to provide a suitable substitute to the then authorized French Creek (Cambridge Springs) Reservoir. The three reservoir system consisted of the Union City Reservoir, Muddy Creek Reservoir, and Woodcock Reservoir.

12. Surveys, studies and planning.- For this report, advantage has been taken of field investigations and office studies made in conjunction with Senate Document 95, 87th Congress. A survey of the flood damage situation in the Basin was made in 1959 to obtain data for the authorizing document. Hydrologic, hydraulic, relocation, real estate, design and cost estimate studies at the Union City and the other two reservoirs were made in 1960 in conjunction with the authorizing document. A public hearing was held by the District Engineer, U. S. Army Engineer District, Pittsburgh, at Meadville, Pennsylvania, on 21 February 1953. The consensus of the hearing was against the location of the then authorized French Creek (Cambridge Springs) Reservoir project with a dam below Cambridge Springs, Pennsylvania. It was the general belief that a feasible solution to the flood problem could be obtained by substitution of smaller flood control reservoirs, local protection works, or both. Interest in low-flow augmentation was expressed by Commonwealth of Pennsylvania and City of Meadville officials. For purposes of preparing this report, topographic surveys of the Union City Reservoir area and the dam site area were made from aerial photographs taken in 1963 at the initiation of this study. The reservoir area topography including the topography in the vicinity of the dam consists of 18 sheets at a scale of 1 inch = 200 feet and a five-foot contour interval. Supplementary topography in the area of the dam site consists of three sheets at a scale of 1 inch = 100 feet and a two-foot contour interval. More detailed hydrologic, hydraulic and design studies were made to determine the features of the reservoir

and dam. Highway and utility relocations have been planned with the cooperation of the operating agencies. A property valuation survey was made of the reservoir and dam site areas. Federal and non-Federal agencies concerned with the proposed Union City Reservoir have been contacted, and the recommendations or comments of these agencies are incorporated in this memorandum. No public hearings have been held in conjunction with this report.

## IV. LOCAL COOPERATION

13. Local cooperation required.- Local cooperation involved under project authorization consists of local interests informing affected interests in the French Creek Basin at least annually, in a manner satisfactory to the District Engineer, that the system of reservoirs of which Union City Reservoir is a part, will not provide protection against maximum floods. Costs of local cooperation are considered to be minor and insignificant for project evaluation purposes. Construction of the dam has been protested by certain potato growers in the proposed reservoir area. The Erie County Planning Commission and other Erie County officials have expressed concern over the omission of a permanent pool and recreational facilities at the project site. Several plans utilizing a permanent pool at the Union City site were thoroughly investigated but could not be economically justified. The Commonwealth of Pennsylvania has requested consideration of low-flow augmentation for French Creek. Since storage in the Union City Reservoir is limited by economic factors to flood control only, low-flow augmentation will be given further consideration in subsequent studies on the Woodcock or the Muddy Creek Reservoirs of the French Creek Reservoir system. The Borough of Northeast officials have complained about the unavailability of storage capacity at Union City to develop a water supply source for the Borough to supplement its present water supply. Opposition to the reservoir obtained through conferences originates chiefly from minority interests residing upstream of the dam. The consensus in the French Creek Basin is favorable toward the Union City Reservoir, especially in the urban areas such as Franklin, Meadville and Cambridge Springs, Pennsylvania. A complete list of communities in the French Creek Basin benefiting from the reservoir follows:

| | |
|---|---|
| Franklin | Meadville |
| Sugar Creek Township | Saegerstown |
| Utica | Venango |
| Cochranton | Cambridge Springs |

These municipalities have maintained active interest and support of the proposed project. The Redevelopment Authority of the City of Meadville has indorsed the project and numerous times has coordinated flood control findings with their recommendations relative to redevelopment of the flood plain in Meadville. The Commonwealth of Pennsylvania, by letter from its Department of Forests and Waters, recognizes the merits of the project. The Pennsylvania Department of Forests and Waters is the agency that will assume the responsibility of local cooperation for the project. Exhibit 1 accompanying this report is the legal document providing the formal assurances of local cooperation for the French Creek project.

## V. LOCATION OF PROJECT AND TRIBUTARY AREA

14. Location of project works.- The proposed reservoir is located in the French Creek Basin and would be contained in French Creek from 3.2 miles northwest of Union City, Pennsylvania, to Wattsburg, Pennsylvania. The selected reservoir dam site would be situated on French Creek in Erie County, Pennsylvania, at a location approximately 1.3 miles above the junction with South Branch, about 71.5 river miles above the mouth of French Creek and at north latitude 41° - 55' - 14" and west longitude 79° - 54' - 03". The location of the proposed reservoir in relation to the Pittsburgh Engineer District and to flood control reservoirs in the District is shown on Plate 1. A general map of the Union City Reservoir area and vicinity is shown on Plate 2.

15. Reservoir area.- The reservoir area lies in Erie County, Pennsylvania, as shown on Plate 1. At the reservoir-full condition at elevation 1278, the surface area would be 2,290 acres. The length of the full flood storage pool would be about 7.8 miles and would average 0.5 mile in width. The proposed Union City Reservoir is in a pre-glacial valley consisting of low-lying flatlands. In some instances, such as at the junction of French Creek with tributaries, the land is flat and swampy, particularly in the vicinity of Baldwin Flats. Generally, the land is utilized for dairy farming and potato growing and there are cases where the fields abut French Creek. The area is adequately serviced by State and Township roads. Pennsylvania State Route 8 traverses the creek and reservoir area. There are utilities in the reservoir area consisting of electric and telephone lines. There are a few rural homesites and several summer cottages in the reservoir area. The present use of the proposed reservoir lands is consistent with the highest and best use of the land.

16. Tributary drainage area.- The drainage area of the watershed for the proposed reservoir would be 222 square miles composed of 145 square miles along French Creek and minor tributaries and about 77 square miles along West Branch French Creek, which is a main tributary to French Creek at Wattsburg, Pennsylvania. The watershed is contained in Erie County in northwestern Pennsylvania and Chautauqua County in southwestern New York. The area is glaciated and is gently rolling except on flanks of stream valleys. There are numerous swamps and marshes in headwater areas upstream of the reservoir site. Land is principally in farms with cultivated land, pastures and wood lots. There is no evidence of serious soil erosion. Wattsburg, population 401 (1960), is the largest community in the Basin above the dam site.

17. Areas protected from floods.- Operation of the Union City Reservoir for flood control would beneficially affect the French Creek valley below the dam, contained in Erie, Crawford, Mercer and Venango Counties. The Meadville, Pennsylvania, metropolitan area, is the principal flood damage center in the valley and is located in Crawford County. The French Creek valley is highly developed for agricultural and recreational purposes, and the communities of the Basin as well as the industrial developments and extensive cottage developments abut and are partly in the flood plains. The valley bottoms are broad and have been subject to severe floods and consequent damages. Based on the 1960 census, the population of the communities in the French Creek valley that would be directly or indirectly affected by recurring floods of record and that would benefit from control of the flood waters of the upper French Creek Basin are as follows:

| Community | Population |
|---|---|
| Meadville | 16,671 |
| Franklin | 9,586 (a) |
| Sugar Creek Twp. | 5,951 |
| Cambridge Springs | 2,031 |
| Cochranton | 1,139 |
| Saegertown | 1,131 |
| Venango | 318 |
| Utica | 274 |

(a) Partly in French Creek Basin.

The above figures do not reflect the inhabitants who reside in the flood plains abutting the reaches of French Creek between the listed communities. Benefits to a lesser degree would accrue in the highly industrialized and heavily populated Allegheny and Ohio River valleys located below the mouth of French Creek at Franklin, Pennsylvania.

## VI. PROJECT PLAN

18. Most feasible plan of improvement.- The most feasible plan for development of the Union City Reservoir of the authorized three - reservoir French Creek system is for a reservoir with a capacity of 47,640 acre-feet to be created by an earth embankment approximately 1,430 feet long and 88 feet high located on French Creek about 1.3 miles above the junction of South Branch and 3.2 miles northwest of Union City, Pennsylvania. No permanent pool would be provided in the reservoir. The outlet works would be uncontrolled and an uncontrolled side channel spillway on the right abutment would be used for emergency purposes.

19. Plates accompanying the memorandum.- The following plates accompany the memorandum:

| Plate | Title |
|---|---|
| | French Creek Basin, Pa. - Union City Reservoir |
| 1 | General Map |
| 2 | Reservoir Area |
| 3 | General Plan |
| 4 | Lower Outlet Works - Plan and Sections |
| 5 | Spillway and Upper Outlet Works - Plan and Profile |
| 6 | Spillway and Upper Outlet Works - Sections |
| 7 | Access Road - Plan, Profile and Sections |
| 8 | Planning and Construction Schedule |

20. Exhibits accompanying the memorandum.- The exhibits resulting from interagency coordination and accompanying the memorandum are as follows:

| Number | |
|---|---|
| 1 | Pennsylvania Department of Forests and Waters |
| 2 | U. S. Department of Interior; Fish and Wildlife Service |
| 3 | U. S. Department of Agriculture; Soil Conservation Service |
| 4 | Federal Power Commission |
| 5 | National Park Service |
| 6 | U. S. Public Health Service |

## VII. DEPARTURES FROM PROJECT DOCUMENT PLAN

21. Departures from project document plan.- The project document is Senate Document Number 95, 87th Congress, 2d Session which describes the features of the project as conceived in the earlier stages of the work. Basically, the general plan for the Union City Reservoir remains unchanged; however, studies for this report indicate the necessity to revise the plans for the structures associated with the reservoir as follows:

a. The provision of a narrow side channel spillway on the right abutment for emergency purposes would be a departure from the project document plan which recommended a shallow sidehill spillway on the left abutment. The side channel spillway would be of the uncontrolled type consisting of an inlet composed of a 268' ogee weir with crest at elevation 1278 m.s.l. emptying into a deep and narrow channel with a 70' bottom width cut into rock on the right abutment. The side channel spillway would replace a sidehill spillway which utilized a 350'-0 wide broad crested weir at elevation 1278 m.s.l. This side channel spillway would be designed to contain about 62,700 c.f.s. which is approximately similar to the capacity of the sidehill spillway proposed in the project document. The new spillway plan would be advantageous from an economic standpoint since the excavated material would be substantially less than under project document plan and could be used as random fill in the embankment, thus eliminating the disposal of 400,000 cubic yards of excavation as contemplated under the project document plan. The side channel spillway will be founded on the right abutment due to geologic conditions and physical characteristics of the terrain in the area. The rock which would form the bed of the spillway channel would resist scour, thus eliminating the need for a concrete lining in the spillway channel.

b. Hydraulic and structural design of the outlet works has been simplified. The uncontrolled outlet works under the project document plan would have consisted of a 10 foot x 13.5 foot reinforced concrete cut and cover conduit under the dam with two openings at the inlet and a stilling basin at the outlet end to handle maximum reservoir discharges. The lower inlet, measuring 2 feet x 10 feet wide, was planned with an invert at elevation 1210 m.s.l. in the streambed. The upper inlet, measuring 10 feet x 10 feet, would have begun to operate at elevation 1255 m.s.l. and was planned to be constructed directly above the lower inlet. The area provided in the conduit was governed by diversion criteria and greatly exceeded the area required for operating purposes. Findings for this report indicate similar hydraulic flow effects could be realized with the advantage of simplifying the hydraulic determinations and structural design of the uncontrolled outlet works. This could be accomplished by constructing a 6.0 foot square, filleted, reinforced concrete cut and cover conduit under the dam with an invert at elevation 1210 m.s.l. and building the

high-level outlet measuring 10 feet wide x 16 feet high into the ogee weir of the side channel spillway on the right abutment. The invert would be at elevation 1255 m.s.l. and the ogee weir would crest at elevation 1278 m.s.l. The opening through the weir would be cut in rock and lined with concrete. The plan recommended in this report would be superior economically because the outlet works would be simpler from a construction standpoint, the stilling basin would be smaller and the diversion tunnel would be eliminated. The latter is possible since findings for this report indicate diversion could be accomplished to handle the maximum flood of record by leaving a section of the dam open until the final construction season when diversion of a 3-year all-season storm will be accomplished through the lower and upper outlet works after the closure section is placed across center section of dam.

c. The steepening of the impervious core of the dam is a departure from the project document plan which recommended a 1 vertical to 1 horizontal slope. The 10 vertical to 1 horizontal impervious core furnished in this report affords a plan which is superior economically to the project document plan and compares favorably from a structural standpoint.

The greater detail of this General Design Memorandum includes relocations which are expanded, in part, to Feature Design Memorandum scope resulting in more finite project quantities and unit prices. The estimated project document costs for the Union City Reservoir, escalated by index from May 1960 cost level, is $9,750,000. The estimated cost for the Union City Reservoir, as recommended in this General Design Memorandum, is $10,100,000, based on May 1964 values.

## VIII. HYDROLOGY

22. Detailed hydrological studies to determine the spillway design flood, flood surcharge storage elevation, spillway width and crest elevation, the maximum reservoir-full elevation and freeboard are contained in Appendix I - "Hydrology". In the derivation of the features for the design, sufficient actual runoff and precipitation data are available in the French Creek Basin for the development of the natural unit hydrographs.

23. In Appendix I basin characteristics are described and used for the unrated tributary areas in the development of the inflow hydrograph for the reservoir. The highest known flood of record on French Creek occurred in April 1947 resulting in a flow of 14,000 c.f.s. at Carters Corners, Pennsylvania, located 3.75 miles upstream of the dam site.

24. Flood frequency studies developed for French Creek at Carters Corners, Pa., indicate a twice yearly flood of 4,200 c.f.s. with an annual peak flow of 5,800 c.f.s. for all year occurrences. The two year flood under these conditions would be 7,500 c.f.s., and the five year flood would equal 9,600 c.f.s. During the crop season only (May through October), the twice yearly flood would be 1,300 c.f.s. with a yearly flood of about 2,200 c.f.s., a two year flood of 3,400 c.f.s. and a five year frequency flood of 5,200 c.f.s.

25. The major storms from which highest flooding resulted in the French Creek Basin occurred in March 1913, April 1947 and January 1959. These storms are discussed in detail in Appendix I.

26. A six-hour natural unit hydrograph was developed from gaging records at Carters Corners. Basin unit hydrographs were also developed for all principal streams and local tributary areas from the headwater junction of West Branch of French Creek and French Creek to Meadville and thence downstream to Utica. Verification of the unit hydrographs was determined by a reconstitution of several floods for which accurate profiles had been obtained from gage records. The six-hour unit hydrographs on unrated tributary streams were combined with the perimeter unit hydrograph to provide the six-hour unit hydrograph of reservoir inflow.

27. The 4-7 April 1947 storm and flood was selected as the pattern for development of the reservoir design flood for the Union City Reservoir. Primarily, it was chosen because it was the highest flood, in a period of more than 50 years, over an area in the French Creek watershed comparable in size to the reservoir basin. Other factors also favored this choice such as highest rainfall intensities ever recorded in the French Creek Basin, total storm runoff augmented by snowmelt to such a degree that runoff exceeded rainfall, and ground water discharges that were unusually high averaging above 2 c.f.s. per square mile. The Union City Reservoir under the assumed conditions of runoff and storage would have had 1.3 inches of impoundment at midnight on 1 April. Total storm rainfall over the basin after this time averaged 4.3 inches with a maximum of 3.6 inches on 5 April. Total runoff was 5.0 inches. If conditions of design should reoccur with the dam in place, the reservoir would rise to elevation 1278 m.s.l. which is spillway crest. Outflow would be 4500 c.f.s. and 47,640 acre-feet would be impounded.

28. The standard project flood is one which would be exceeded in magnitude only on rare occasions. It establishes a standard for design of structures that would provide a high degree of flood protection without regard to economic or other practical limitations. The standard project flood is substantially less than the probable maximum flood and has been adopted as a flood that would be caused by a storm with

rainfall as set forth in Civil Engineer Bulletin No. 52-8, Office of the Chief of Engineers, 26 March 1952, subject, "Standard Project Flood Determinations". The standard project flood was obtained by moving the standard project storm over the center of the French Creek Basin above the Union City Dam. A maximum impoundment of 63,300 acre-feet would occur to elevation 1284.2 with a surcharge of 6.2 feet over the spillway crest which would be discharging 14,700 c.f.s. accompanied by 5,600 c.f.s. through the lower and upper outlet works.

29. Maximum rainfall used for the determination of spillway design floods in this report were obtained by use of charts in Hydrometeorological Report No. 33, "Seasonal Variation of Probable Maximum Precipitation East of the 105th Meridian," prepared by the Hydrometeorological Section of the U. S. Weather Bureau. These estimates represent the limiting precipitation rates for three types of storms which would result in most severe flooding in the Pittsburgh District. The three types of storms are classed as a winter storm accompanied by snowmelt, an extratropical (decadent hurricane) storm occurring in late summer or early fall and a summer convectional storm. The inflow unit hydrograph was applied to these three types of maximum storms and their antecedent rainfall. The hydrograph for the decadent tropical storm resulted in the highest outflow conditions and was selected as the computed spillway flood.

30. The computed spillway flood is sufficiently conservative to be used as a spillway design flood. The magnitude of the inflow peaks are high in comparison to conventional runoff estimates, and the detail of these studies is believed sufficient to insure a high degree of accuracy. A peak flood of 64,000 c.f.s. is realized with a peak reservoir inflow of 87,500 c.f.s. Peak outflow is 62,700 c.f.s. in spillway and 1,300 c.f.s. in lower outlet with a maximum reservoir elevation of 1292.6 m.s.l.

31. A study was made of severe wind conditions in relation to ride-up and wave height for a determination of freeboard for the earth embankment. Wind velocity data was obtained from records at U. S. Weather Bureau stations at Erie and Pittsburgh, Pa. Maximum wind velocities were determined for each of the fetch directions using velocity values from the Pittsburgh graphs. These values were increased 30% to provide for higher velocities which might obtain over the unobstructed surface of Lake Erie. Wave heights were determined by use of the diagram "Wave Heights and Minimum Time Durations for Mean Conditions, Summary Report Projects CW-164 and CW-165."

32. Appendix I "Hydrology" recommends a spillway design flood storage elevation of 1292.6 m.s.l. An uncontrolled side-channel spillway 268 feet in width cresting at elevation 1278 m.s.l. is also recommended.

## IX. GEOLOGY

33. General.- The project site is located in the glaciated section of the Allegheny Plateaus province in a short preglacial divide reach of French Creek between the preglacial valleys of Le Boeuf - French Creek and Lake Pleasant Outlet - Alder Run. Bedrock is exposed in the valley bottom and is present below shallow depths of till in the west side of the valley. On the east side of the valley, a kame deposit covers the adjacent valley wall. The site is underlain with interbedded shales, sandstones, and medium hard grey sandy siltshales of the Devonian formation. The weathering is very shallow ranging from 0 - 10 feet in the valley bottom and abutments except in the area of the upper reaches of the right abutment where the weathering increases in depth to 25 feet. The overburden in the valley bottom is variably gravelly and sandy silt and silty till with various quantities of rock fragments. The kame terrace on the left abutment is quite similar in character to the till on the right bank, except for greater percentage of sand and rounded gravel. The basin is essentially impervious and leakage from the reservoir should not occur. A report on the geology of the reservoir area, dam site and spillway location is contained in Appendix II - Geology, Soils and Embankment Design.

34. Foundation conditions.- The embankment would be founded in bedrock in the valley bottom and on the natural abutments. A five-foot deep cutoff trench would be constructed along the axis of the dam and concrete would be used as a filler. Grout holes 5 feet on centers would be drilled 40 feet into bedrock underneath the trench to form a grout curtain which would preclude any minor leakage which might occur through the relatively tight joints in the rock beneath the dam and on the natural abutments. The underlying rock, consisting of interbedded shales and sandstones, is estimated to have a bearing capacity far greater than would be imposed upon it by construction of the dam; therefore, no settlement problems are anticipated with the construction of the dam. The outlet works would be founded on the approximately 10-foot upper layer of interbedded shales overlying the sandstone bedrock. The bearing capacity of the undisturbed interbedded shales is estimated at 8 tons per square foot which is sufficient to support the outlet works under which the maximum bearing pressures are computed to be 5.5 tons per square foot. As in the dam proper, settlement problems are not anticipated under the outlet works. Embankment drainage would be accomplished by pervious alluvial sands and terrace gravels. The side channel spillway would be located in rock on the right abutment. The bed of the spillway channel would be founded on medium hard grey sandy siltshales which are presently overlain by interbedded sandstones and sandy shales which would form the side walls of the spillway channel.

## X. OTHER PLANS CONSIDERED

35. Alternative sites considered.- Consideration has been given to two reservoirs -- one on West Branch of French Creek upstream of Wattsburg, Pennsylvania, and one on French Creek above Marvin, New York, in lieu of a single reservoir at the project site. Also, a small reservoir system consisting of seven reservoirs, other than West Branch and Marvin, have been considered as a substitute for the Union City Reservoir.

a. West Branch French Creek Reservoir.- West Branch Reservoir would be created by a dam about 4 miles upstream of Wattsburgh in the vicinity of Sears School, and could impound flood inflows up to about elevation 1325 m.s.l. Gross storage in the reservoir would be about 19,200 acre feet corresponding to eight inches of gross runoff from a drainage area of 45 square miles. The reservoir on West Branch would cost more than half as much as the Union City Reservoir, but would control only about one-fifth of the drainage area. In view of the high average cost per square mile of area controlled when compared to Union City, West Branch of French Creek Reservoir was considered an undesirable substitute and was not further investigated.

b. French Creek (Marvin) Reservoir.- The reservoir would be located a short distance above the community of Marvin, New York. The Marvin Reservoir was considered with the West Branch French Creek Reservoir as an alternate to the Union City Reservoir. Flood water would be impounded in a potential reservoir basin to about elevation 1416 m.s.l. Gross storage in the reservoir would be 26,900 acre-feet representing 6.31 inches of gross runoff from a drainage area of 80 square miles. The cost of the reservoir measured in relation to the drainage area controlled compares favorably with the Union City Reservoir; however, this would not justify sacrifice of the additional areal control the latter would afford. Accordingly, French Creek (Marvin) Reservoir alone or in combination with West Branch French Creek Reservoir as an alternate to the Union City Reservoir was not given further consideration.

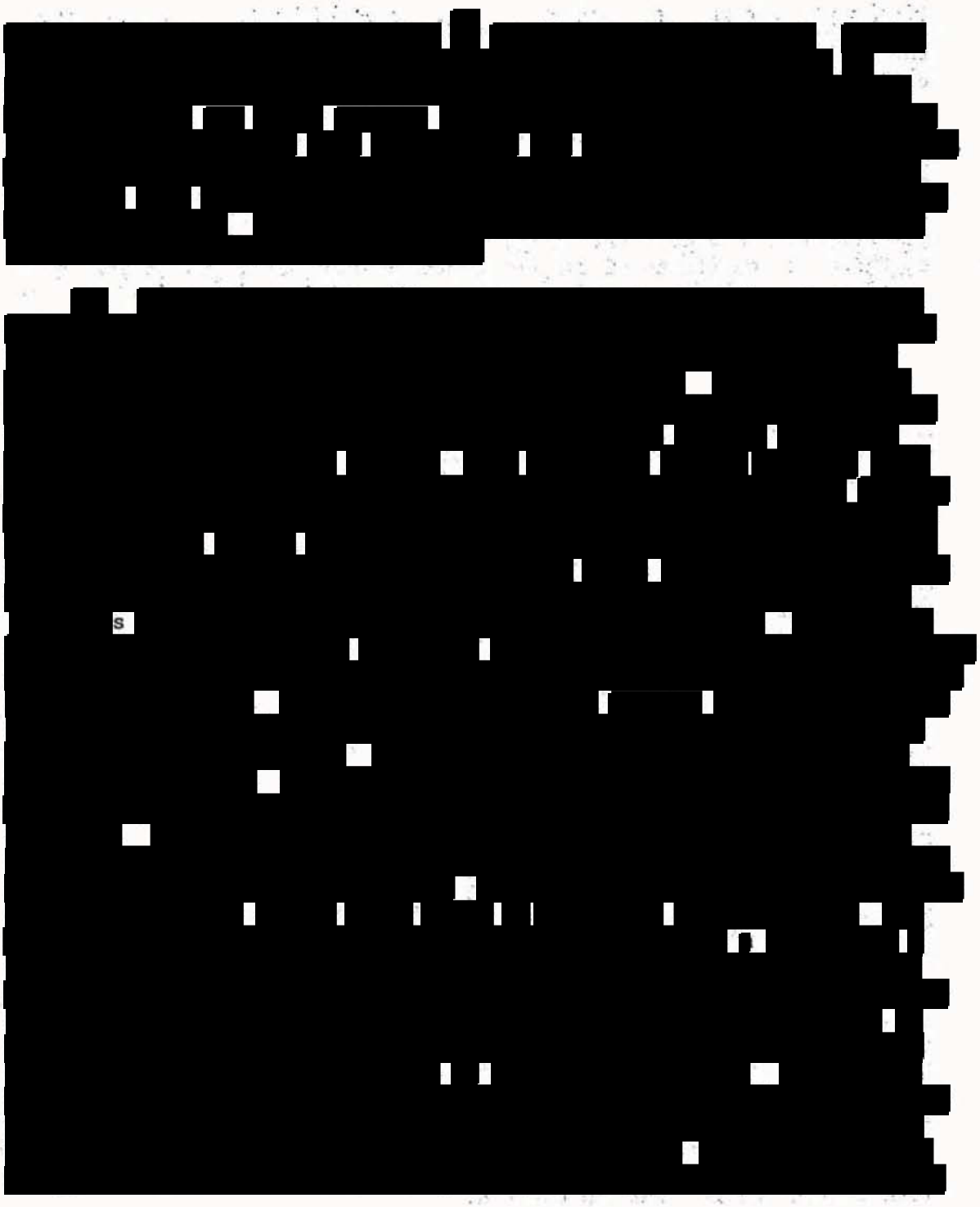
c. Alternate multiple small reservoir system.- In the French Creek Basin area above the Union City Dam site, seven potential sites, other than the West Branch and Marvin sites, were considered. The drainage areas above the potential dam sites ranged from one to 26 square miles and the cumulative controllable drainage area was 52 square miles. The preliminary estimates of cost of these reservoirs indicated that, individually or collectively, the average cost per square mile of area controlled would be far greater than for the Union City Reservoir. In view of this unfavorable comparison, the small reservoirs were not considered as adequate substitutes for the Union City Reservoir. Alternates to

the Union City Reservoir are discussed in greater detail in Senate Document 95, 87th Congress, 2d Session, which is the project document for this study.

36. Alternative plans considered.- The Union City site has been considered frequently as part of systems of reservoirs that were investigated for flood protection in the French Creek Basin. Limitations are imposed on the capacity of a reservoir at Union City by the community of Wattsburg, Pa., at the junction of West Branch of French Creek and French Creek, 10 miles upstream of the dam site. The upper limit of a reservoir without providing protection by dike for Wattsburg is fixed at elevation 1278 m.s.l. Approximately 30% of the buildings in Wattsburg consisting of residential and commercial structures would experience flooding if a reservoir was filled to elevation 1283 m.s.l. More than 80% of the structures in Wattsburg would be flooded at elevation 1287 m.s.l. The following are alternate plans previously considered at the Union City site.

a. A plan was investigated placing full pool level at elevation 1283 m.s.l. resulting in gross storage of about 60,000 acre-feet. The plan, featuring a retention type dam and controlled outlet works, includes 3,900 acre-feet of permanent pool and 56,100 acre-feet representing 4.78 inches of runoff for flood control. The cost of the installation in relation to cost per acre-foot of storage would be high in comparison to the adopted Union City plan. Highway relocations would be expensive. The reservoir alone would not be a suitable solution to the flood problems of the basin, and economic justification is not possible when the reservoir at elevation 1283 m.s.l. is considered collectively as part of a system of reservoirs for the basin. Accordingly, studies for a reservoir at Union City with full pool at elevation 1283 were discontinued.

b. A plan at the Union City site was investigated with a full reservoir level at elevation 1287 m.s.l. accompanied by dikes for protection of Wattsburg. The dikes would be built to elevation 1290 m.s.l. which is considered the maximum practical elevation comparable to the surrounding area in the vicinity of Wattsburg. The plan would feature a retention type reservoir and controlled outlet works. Gross storage of about 74,000 acre-feet would include 3,900 acre-feet of permanent pool and 70,100 acre-feet representing 5.97 inches of runoff for flood control. Average costs per acre-foot of storage would be high when compared to the adopted Union City plan. Highway relocation costs would be exorbitant. The reservoir by itself would not solve the flood problems in the basin, and economic justification is not possible when the reservoir is considered in a system of reservoirs for flood control in the basin and protection of Wattsburg by dikes. Since the plan for a reservoir with full pool at elevation 1287 m.s.l. is not economically justified, the study was abandoned.



## XIII. OUTLET WORKS

46. General.- The uncontrolled outlet works would consist of a cut and cover conduit in the valley flow with invert at elevation 1210 m.s.l. and an outlet constructed in an opening through the rock supporting the ogee weir of the spillway with the invert at elevation 1255 m.s.l. Aprons and training channels would be constructed at the entrance to both outlets. On the lower conduit, a trash rack would be furnished at the inlet, and a stilling basin would be provided at the outlet. Plates 4, 5, and 6 show the layout out the outlet works.

47. Lower outlet works.- The conduit would be founded on rock and constructed of reinforced concrete. The crossection of the conduit would measure 6 feet by 6 feet and would be reinforced by filleted corners. The area provided by the crossection would be about 33 square feet, and the length would be 520 feet. The inlet invert would be elevation 1210 m.s.l. and the outlet invert would be elevation 1207 m.s.l. resulting in a slope of .58 percent. The minimum thickness of concrete provided in the conduit would be 1.5 feet for the top and side walls. The bottom thickness would vary according to the top of rock used as a base. Concrete collars and copper waterstops would be provided at construction joints which would be spaced at 20 foot intervals. Seep fins would be provided where the conduit passes through the impervious core of the dam to increase the seepage path by about 40%. The design capacity of the lower conduit is about 1400 c.f.s. with the reservoir filled to elevation 1278.

48. Upper outlet works.- The outlet would be founded in an opening cut through the rock support of the ogee weir of the side channel spillway. The conduit would be constructed of reinforced concrete and would be incorporated into the ogee weir. The opening would be rectangular measuring 10 feet wide and 16 feet high providing an area of 160 square feet. The invert elevation at the inlet would be 1255 m.s.l. and outlet elevation would be 1240 m.s.l. The length of the outlet would be about 45 feet, and the slope would be about 37 percent. The design capacity of the outlet is 3,100 c.f.s. with the reservoir filled to the spillway crest at elevation 1278.

49. Capacity of outlet works.- The capacity of the combined lower and upper outlets under reservoir full conditions to spillway crest elevation 1278 m.s.l. would be about 4500 c.f.s.

50. Stilling basin.- The stilling basin of reinforced concrete for the lower outlet works would be approximately 90 feet long. It would flare out from the outlet end of the conduit to a width of 26 feet in the first 55 feet. The flared section would slope from elevation 1207 m.s.l. to a rectangular basin at elevation 1202 m.s.l. The rectangular basin, 26 feet in width, would be 30 feet long and would contain a two-step sill to elevation 1206 m.s.l. at the downstream end for dissipating the energy from the outlet works. The concrete floor of the basin would extend 7 feet beyond the sills. The water would flow onto about a 2 foot thick layer of stone protection extending 8 feet beyond the end sill prior to entering the natural stream channel where rock capable of resisting scour would be encountered. The floor of the stilling basin would be 2 feet thick, and would be founded on rock. The floor slab of the stilling basin would contain weep holes and would be designed to withstand hydrostatic uplift. The training walls would be about 11 feet high to confine hydraulic jumps up to the point above which additional

tailwater would be provided by the spillway. Other features would include a wall with a thickness of 2 feet, a vertical water face, and a battered back surface.

## XIV. SPILLWAY

51. General.- The spillway for the dam would be an uncontrolled side-channel type founded in rock on the right abutment. The spillway would consist of an approach channel inlet, weir and a longitudinal outflow channel. The spillway is shown in plan, profile and section on Plates 5 and 6.

52. Inlet.- The inlet would consist of an approach channel normal to the axis of the weir and cut in rock to a width sufficient to accommodate a 268-foot straight weir. The approach channel would slope 1% toward the reservoir from elevation 1268 m.s.l. which is 10 feet lower than the crest of weir. A 16-foot wide training channel leading to the upper outlet works at elevation 1255 m.s.l. would be incorporated on the centerline of the spillway approach channel and would be constructed in rock with side slopes of 4 vertical to 1 horizontal. The side slopes of the spillway approach channel would be as follow:

| Material | Side Slope |
|---|---|
| Rock below elevation 1278 m.s.l. (spillway crest) | 4 vertical to 1 horizontal |
| Rock above elevation 1278 m.s.l. (spillway crest) | 2 vertical to 1 horizontal |
| Overburden | 1 vertical to 2-1/2 horizontal |

The toe of the overburden would be located to allow a 16-foot berm on the top of rock.

53. Weir.- The uncontrolled weir with its axis almost perpendicular to the axis of the dam would be founded on rock. The weir would be ogee in section, 268 feet long with crest at elevation 1278 m.s.l. The weir and the spillway drop structure would be constructed of reinforced concrete anchored to the rock. The end walls of the weir would be vertical retaining walls of reinforced concrete anchored to rock. The upper outlet works would be incorporated in the 38-foot deep drop below the crest of the weir. The 70-foot wide channel at the base of the drop structure would be paved for the full length of the weir to form the upper end of the longitudinal spillway channel. The paved channel would have a centerline parallel to the

axis of the weir and would be level at elevation 1240 m.s.l. The slab would extend to the end of the weir which is identified as Station 3+10, the beginning of the longitudinal spillway channel. The slab would be founded on rock, would be 2.5 feet thick, and would contain drain holes. The slab would be designed to resist hydrostatic uplift and provide the necessary structural strength to dissipate the energy caused by the 38-foot drop over the weir and the turbulence due to the 90-degree change in direction of flow. The landward and upstream banks of the channel at the base of the weir drop structure would have a slope of 4 vertical to 1 horizontal in rock and 1 vertical to 2-1/2 horizontal in overburden. The change in slope would be separated by a 16-foot berm atop rock. The rock slopes would be concrete lined and keyed into rock at elevation 1295 m.s.l. to complete the concrete basin for protection of the channel at the base of the weir.

54. Longitudinal spillway channel.- The longitudinal channel would extend from Station 3+10 at the downstream end of the weir to French Creek below the dam at Station 16+00. The centerline of the longitudinal channel would be parallel to the axis of the weir from Station 3+10 to Station 6+14.21 which would be the beginning of a horizontal curve on the centerline to carry flows into French Creek. The curve would terminate at Station 13+50.10. The bottom width of the channel would be 70 feet to about Station 12+50 where the channel would be flared to facilitate entry of flows into French Creek. The channel bottom slope would be 4.00% from elevation 1240 m.s.l. at Station 3+10 to elevation 1208 m.s.l. at Station 11+10. The channel bed would terminate with a flatter slope of 1.2% from Station 11+10 to elevation 1202 m.s.l. at Station 16+00 in the natural stream bed. Reduced velocities due to a flatter slope at the lower end would be compensated for by the increased channel width due to the flaring of the channel at the lower end. The channel would be founded on rock capable of resisting scour. The side slopes would be 4 vertical to 1 horizontal in rock and 1 vertical to 2-1/2 horizontal in overburden separated by a 16-foot berm atop rock. The rock in the lower 300 feet of the channel may require some protection in the future due to primary weathering of the newly exposed rock surfaces.

55. Spillway capacity.- The spillway is designed to accommodate the spillway design flood of 62,700 c.f.s. discharge exclusive of outflow in lower outlet with a headwater elevation of 1292.6 m.s.l., or 14.6 feet above the spillway crest.

## XV. OTHER FACILITIES

56. Access road.- Access to the dam would be provided on the left abutment by a road to be constructed from Township Road T674 to Station 19+00 on the dam. The access road would connect with and be similar in design to the roadway on top of the dam. A turnaround and parking area would be furnished on the right abutment between the axis of the dam and downstream end of the weir. These facilities would afford access to the dam and spillway areas for inspection and maintenance purposes. A plan of the turnaround and parking area is shown on Plate 5. A plan of the access road is shown on Plate 7.

57. Trash rack.- A trash rack made of extra strong stainless steel pipe would protect the intake of the lower conduit of the outlet works. The rack would prevent damage and clogging by floating debris and ice. The pipe members of the trash rack would be anchored to the reinforced concrete apron comprising the inlet to the conduit. The trash rack is shown in detail on Plate 4.

58. Maintenance building.- Plate 3 shows location of the building to be used mainly for storage of maintenance equipment. The facility would also contain a small office to be used during inspection visits to the dam and when maintenance work is done. The building would be equipped with water, electricity, and telephone utilities. An electrical heating system and sanitary system would be provided. The treatment of the wastes would be by septic tank and drainage tile field.

59. Water supply.- Domestic use water for the maintenance building would be supplied from a well. It is anticipated that suitable quality and quantity of water will be available from this source.

60. Power distribution lines.- Power lines of the Waterford Electric Company are in the vicinity of the dam site. A power line extension from the existing pole line along Township Road T674 on the left abutment of the dam would be made to a meter pole at the maintenance building.

61. Telephone lines.- Telephone service would be supplied by the General Telephone Company of Pennsylvania and would be installed on power company poles to the meter pole at the maintenance building.

62. Landscaping.- The areas of dam site construction denuded by construction operations would be suitably vegetated and landscaped to control erosion and to present a pleasing appearance.

63. Recording gage and well.- Permanent operating equipment would consist of an electronically controlled recording gage housed in a 10-foot by 10-foot concrete block structure on top of the dam. The gage would be coordinated with water levels at the inlet of the lower conduit by a 1/2 inch pressure tube extending thru a 2-1/2 inch pipe in the face of the dam to a small sump located in the vertical training wall of the apron in front of the conduit. The 2-1/2 inch pipe would parallel the upstream face of the dam at a depth below frost level. Two access points would be provided in the 2-1/2 inch pipe for inspection and replacement of pressure tubing. Electricity would be installed from the meter pole at the maintenance building.

64. Miscellaneous.- A sign identifying the dam and its pertinent features would be erected at a site where it could be observed by all traffic approaching the dam. The sign would acknowledge the agency responsible for the construction of the dam.

## XVI. SOURCES OF CONSTRUCTION MATERIALS

65. Earthfill and borrow materials.- Earthfill for the dam would be obtained from within the immediate dam site area. Suitable materials from required excavation for the dam and spillway would be utilized in the embankment. Additional random fill material would be required, however, and is available from borrow areas located on the right abutment of the dam landward of the spillway as shown on Plate 3. Investigation of the proposed borrow area has shown that approximately 300,000 cubic yards of material is available at the depths selected for maximum excavation. The impervious fill would be obtained from the borrow area on the right abutment. Total material needed for the embankment is estimated at 853,790 cubic yards. Descriptions of borrow materials are given in Appendix II - "Geology, Soils and Embankment Design". Waste materials from the borrow area would consist mainly of stripping and would be disposed of at suitable areas in the vicinity of the dam, as shown on Plate 3.

66. Materials for concrete.-

a. Cement.- Cement is manufactured in the Pittsburgh, Pennsylvania; Erie, Pennsylvania; New Castle, Pennsylvania; and Youngstown, Ohio areas and would be delivered to the dam site by rail or truck.

b. Fine aggregate.- Fine aggregate is available at approved Allegheny River sources at Oil City and Franklin, Pennsylvania as well as in Erie, Pennsylvania.

c. Coarse aggregate.-

(1) The Vanport limestone is available for use in the vicinity of New Castle and Parker, Pennsylvania, with a truck haul of about 75 miles.

(2) Air cooled blast furnace slag is available from sources in Sharon, Pennsylvania, and Youngstown, Ohio. This would be a truck or rail haul of about 80 miles.

(3) Coarse gravel is available from approved sources in the Allegheny River valley up to 2-1/2 inch size. Also, coarse gravel from deposits in the vicinity of Franklinville, Pennsylvania and Machias Junction, New York, which have been approved up to 3-inch size. This is also a truck haul of about 80 miles.

d. Water.- Water from French Creek would be satisfactory for use in concrete. No filtering of impurities in the water is anticipated. Water from French Creek would also be satisfactory for curing concrete.

67. Stone protection.- Rock is available from excavation of the side channel spillway and could also be obtained, if necessary, in the borrow area on the right abutment of the dam.

68. Filter material.- Suitable filter materials are contained in the valley walls. These would be obtained by recovering the pervious alluvial sands and the terrace gravels that are present in the kame deposits in the left or east bank of French Creek and to a lesser degree in the till deposits that occur on the right or west bank.

69. Lumber.- Finished lumber would be obtained from southern and western states. Rough lumber is available locally in Waterford, Wattsburg, Cambridge Springs, Venango and Corry, Pennsylvania.

70. Iron, steel and electrical materials.- The industrial belt running from Pittsburgh, Pennsylvania to Youngstown, Ohio is a center of iron and steel production. The Erie, Pennsylvania and Cleveland, Ohio areas also produce iron and steel products. Steel reinforcement and pipe can be obtained from a number of plants in these areas. Electrical products are manufactured in Pittsburgh and Erie, Pennsylvania, and at several intermediate locations such as Titusville, Pennsylvania.

71. Transportation to the dam site.- The Pennsylvania Railroad may be utilized to transport materials to within about three miles of the dam site. The area around the dam site is served by a network of good roads. Construction by the contractor of short sections of roads on both banks would be necessary to transport materials to the dam site.

## XVII. RESERVOIR MANAGEMENT AND PUBLIC USE

72. General.- French Creek is bordered by agriculture lands. The development of the reservoir would not prevent the use of the reservoir area for its present use; however, any farming in the reservoir area would be undertaken at the risk of inundation from runoff detained by the dam during periods of excessive precipitation. The water in French Creek is of good quality and supports fishlife. The stream is used for swimming at a few locations. There are a few privately-owned vacation cabins and summer homes along the stream banks. Creation of the reservoir would require acquisition and removal of these cabins and summer homes along with any homes or farm buildings in the reservoir area. Public access to the reservoir by means of existing or relocated roads would be available.

73. Investigations by other agencies.- Exhibits 2 to 6, inclusive, contain reports resulting from interagency coordination for the Union City project. A list of the agencies contacted and a brief resume of their findings follows:

a. U. S. Fish and Wildlife Service.- The report indicates that benefits will accrue to the wildlife resources through more hunting opportunities. The benefits have not been evaluated on a monetary basis.

b. Soil Conservation Service.- Findings of the service respecting the Union City Reservoir indicates no conflict with any small watershed proposals under Public Law 566.

c. Federal Power Commission.- A study of hydropower potential on the Union City project shows that there is no possibility of hydroelectric power development at the dam.

d. National Park Service.- Archeological studies have been initiated by the Carnegie Museum of Pittsburgh, Pennsylvania, under authority and direction of the Smithsonian Institute. The report of the Carnegie Museum will be submitted at a later date.

e. U. S. Public Health Service.- Studies have been made by the Service regarding the necessity of providing low-flow augmentation for pollution abatement in the French Creek Basin. The Service recommends in their report that an increase of minimum flows in French Creek to 75 c.f.s. during the critical season of the year is desirable. Flow regulation to increase the capacity of the stream and assimilate treated wastes is needed primarily to assure water quality consistent with recreational uses in accordance with objectives of the Commonwealth of Pennsylvania. The flood control capacity

established for the Union City Reservoir at 1278 m.s.l. is the practical upper limit of storage. This elevation represents the no-damage limit to the Borough of Wattsburg at the head of the reservoir. Total utilization of storage to elevation 1278 m.s.l. as recommended in this General Design Memorandum is the minimum required for flood control purposes. In view of the above, it is impossible to consider an increase in the capacity of the Union City Reservoir to include storage for low-flow without jeopardizing the flood control project plan for the Union City Reservoir. In order to comply with the request of the U. S. Public Health Service, it is proposed that storage for flow augmentation be considered at either the Woodcock Creek or the Muddy Creek Reservoirs of the French Creek system when pre-construction planning studies are undertaken on these reservoirs. It appears that additional storage capacity required to meet the low-flow requests would be more readily available at the Muddy Creek Reservoir provided, of course, the costs for additional dam appurtenances and higher reservoir features above those required for flood control could be economically justified by low-flow benefits. A copy of the U. S. Public Health Service report is included as Exhibit 6 of this memorandum.

74. Land use possibilities.- The Union City Reservoir area would have land use possibilities as follows:

a. Agriculture.- Lands for reservoir use would be acquired entirely in permanent easement to elevation 1280 m.s.l. The area in general would be reserved for flood water storage by flowage easement and could be used for agriculture. However, land lying at the lower elevations may be inundated too frequently for agricultural use, but no restrictions governing the land use, with exception of building purposes, would be imposed on the reservoir area. A safe lower limit of the reservoir area for agricultural use would be determined by the farmer.

b. Hunting.- There would be opportunity for an increase in hunting in the reservoir area due to the creation of a more suitable atmosphere for wildlife resources in the reservoir area.

## XVIII. REAL ESTATE REQUIREMENTS

75. General.- Authorization for the Union City Reservoir provides that the United States shall acquire title to all lands, improvements, easements and rights-of-way necessary to the project. The Federal Government would acquire fee title to 160 acres in the vicinity of the dam and spillway, fee title to all improvements in the reservoir area, and would acquire flowage easements in the

reservoir area to elevation 1280 m.s.l. The Federal Government is concerned with the right to flood and clear as necessary to the limit of proposed storage at elevation 1278 m.s.l. and, in addition, to avoid damage to abutting properties from wave action, backwater effect, or shore erosion above the established upper reservoir level. A (tentative) guide taking line above reservoir full level is proposed to provide for the effect of the foregoing. A gross appraisal covering areas, types and values of lands and improvements to be acquired is contained in Appendix VI - "Real Estate Requirements".

76. Guide (tentative) taking line.- The guide taking line is usually based on the static reservoir-full elevation plus a variable freeboard height to provide for contingencies. The Union City Reservoir would provide storage such that a reservoir full elevation of 1278 m.s.l. would be anticipated only at rare intervals. Normal annual flood impoundments will fall considerably short of the reservoir-full elevation. Some backwater effect is anticipated at the head of the reservoir, coincident with a reservoir full condition; however, this backwater effect would normally apply on a falling river gradient and will lie below the natural flood gradient of peak inflow into a normally partially-filled reservoir. In consideration of all these factors the elevation 1280 m.s.l. contour, two feet above the static reservoir-full level, has been adopted as a guide (tentative) taking line for easements that will contain all effects of the reservoir operation.

77. Real property taking line.- The real property taking line for the Union City Reservoir for easement acquisition would be such as to include all lands in the reservoir basin below elevation 1280 m.s.l., plus fee acquisition at the dam site and spillway area, plus severance that would be required due to elimination of ingress and egress on lands in the reservoir area. All improvements in the reservoir area will be acquired in fee title. The areas in the subject project are classified as follows:

| | |
|---|---|
| Dam site and construction area | 160 acres (fee) |
| Reservoir area below elevation 1280 m.s.l. | 2,310 acres (easement) |
| Total Area | 2,470 acres |

The total acquisition cost, including improvements, is estimated at $641,000.

## XIX. RELOCATIONS

78. General.- This report covers all highway and utility relocations as required in General Design Memorandum scope. Also, included in this report are certain highway relocations in Feature Design Memorandum scope in order that the first phase of construction can be initiated to expedite completion of the project. The latter includes a Report on Necessity and an Attorney's Report for each highway relocation considered for the initial construction program.

79. Highways.- The proposed relocation of highways is shown on Plate 2 and are discussed in detail in Appendix V. The relocations are proposed to maintain principal existing river crossings and to provide access to the perimeter of the reservoir. The plan of relocation proposed is one of equivalent substitute facilities and would involve state and township roads. The state or the political subdivision involved would probably elect to have detail planning work done by the Corps of Engineers with the State contracting for and supervising the construction work.

80. Utilities.- Utilities in the reservoir area that would be affected by relocation, alteration, abandonment or removal consist of telephone lines and electrical transmission and distribution lines. Descriptions of existing utilities and proposed plans of adjustment are contained in Appendix V. Estimates of cost of proposed changes are shown in Appendix VIII. The work would be done by the owning agencies on a cost-reimbursable basis.

81. Railroads.- There are no railroad lines to be relocated within the limits of the Union City Reservoir.

82. Cemeteries.- There is one small cemetery covering about one-quarter acre near the upper limits of the Union City Reservoir. Estimate of cost for relocation is shown in Appendix VIII.

## XX. COST ESTIMATES

83. Estimate of first cost.- The estimated total first cost of the Union City Reservoir project, as outlined in this report, is $10,100,000, including a contingency allowance of 12 percent. Detailed cost estimates are contained in Appendix VIII, Cost Estimates, and are based on May 1964 values. A summary of the estimated first cost follows:

Estimated First Cost
(May 1964 Cost Level)

| Feature | Amount |
|---|---|
| Lands and Damages | $ 641,000 |
| Relocations | 4,548,000 |
| Reservoir Clearing | 28,000 |
| Dam | 3,354,000 |
| Access Road | 96,000 |
| Buildings, Grounds and Utilities | 20,000 |
| Permanent Operating Equipment | 23,000 |
| Engineering and Design | 660,000 |
| Supervision and Administration | 685,000 |
| Construction Facilities | 15,000 |
| Operation and Maintenance Expenses (during construction) | 10,000 |
| Total, Rounded | $10,100,000 |

84. Estimate of investment cost.- The following table summarizes the estimated investment, as of May 1964 values, based on the first cost presented in the preceding paragraph. The interest charge is based on an interest rate of 3-1/8 percent.

| | |
|---|---|
| a. Estimated project first cost | $10,100,000 |
| Interest during construction (3-1/8% for 1/2 of a 3-year construction period) 10,100,000 x 4.6875% = | 473,437 |
| b. Total Federal gross investment (Rounded) | $10,573,000 |

85. Estimate of average annual charge.- The following table summarizes the average annual charges for the Union City Reservoir according to the cost presented in the preceding paragraph and based on a 3-1/8% interest rate, May 1964 values, and a 100-year project life. Determination of average annual charges is shown in Appendix VIII, Cost Estimates.

| Item | Amount |
|---|---|
| Interest ($10,573,000 x 3.125%) = | $330,406 |
| Amortization ($10,573,000 x 0.151%) = | 15,965 |
| Maintenance | 30,000 |
| Total, (Rounded) | $376,000 |

86. Comparison of current costs with latest approved Federal estimate and project document estimate.- The estimated Federal costs of the Union City Reservoir project, as presented in this memorandum, differ from the latest approved Federal estimate and from the Federal costs, as given in the project document for the following reasons:

a. The change in labor and material costs between May 1960 and May 1964 resulted in an increase in the estimate of $1,100,000.

b. Changes in unit prices as a result of more detailed investigations of construction conditions resulted in an increase in the estimate, particularly, the real estate acquisition cost estimate. This increased the estimate by approximately $350,000.

c. Changes in cross-section of the dam affecting the requirements for impervious and random fill resulted in a decrease in the estimate of about $100,000.

d. Changes in location and design of the emergency spillway resulted in a decrease in the cost estimate of $100,000.

e. Modification in the design of the uncontrolled outlet works resulted in a decrease in the cost estimate of $250,000.

f. Rise in the estimate for engineering, supervision and administration resulting from considering the Union City construction costs separately to determine percentages for the cited estimates. In the project document, total construction costs for the three reservoirs in the French Creek system were considered in determining lower percentages which resulted in lesser engineering, supervision and administration estimates when apportioned to the three reservoirs. This resulted in an increase of about $430,000.

The effects of the foregoing factors are shown in the following comparison:

| | |
|---|---|
| a. Total Federal first cost, project document, May 1960 values | $ 8,650,000 |
| b. Approved total Federal cost, July 1964 values | $ 9,880,000 |
| c. Total Federal first cost, project document, adjusted to May 1964 cost level | $ 9,750,000 |
| d. Total Federal first cost, this memorandum, May 1964 cost level | $10,100,000 |

## XXI. SCHEDULES FOR DESIGN AND CONSTRUCTION

87. General.- Feature design memoranda covering specific phases of project development which are to be prepared follow:

a. Real Estate.

b. Highway Relocations (Second Phase).

c. Sources of Construction Materials.

d. Dam and Spillway.

e. Utility Relocations.

88. Contract plans and specifications.- Contract plans and specifications for highway and utility relocations will be prepared by the Corps of Engineers. Contract plans and specifications for dam construction will be scheduled for completion 10 months after initiation of highway relocation work.

89. Construction schedule.- The proposed schedule for design and construction is shown on Plate 8 of this report.

90. Sequence of Operation.- The sequence of operations shown on the design and construction schedule is based on the following criteria:

a. Funds would be appropriated for planned, orderly, and economic construction.

b. Lands would be acquired and relocations of highways would be well advanced to assure continuous construction of the dam and appurtenant facilities.

c. Outlet works, embankment abutment sections and spillway would be completed first and final diversion would be made between the second and third construction seasons.

91. Relocations of highway and utilities would require approximately three construction seasons.

92. Construction of the dam would be completed during the third construction season.

93. Construction of the parking area, maintenance buildings and gage well and appurtenances would be completed during the third construction season.

94. Fund requirements.- Federal funds previously expended and additional funds required for planning and construction are shown in the table that follows:

| | |
|---|---|
| Previous | $300,000 |
| First fiscal year | 500,000 |
| Second fiscal year | 2,080,000 |
| Third fiscal year | 4,200,000 |
| Fourth fiscal year | 3,000,000 |
| Total (rounded) | $10,100,000 * |

* Does not include preauthorization costs of $56,000.

## XXII. OPERATION AND MAINTENANCE

95. There will be no operating personnel permanently assigned to the Union City Reservoir as operation of the reservoir would require only periodic checks to observe conditions. Other periodic work required would be minor maintenance such as mowing grass, maintenance of the growth on the downstream slope of the dam and servicing the gage atop the dam. The work would be done on a part-time basis by personnel assigned to the Woodcock Reservoir. During the interim between construction of the Union City Reservoir and the Woodcock Reservoir, the maintenance work at the Union City Reservoir will be under the direction of the damtender of an existing Federal reservoir project (Allegheny Reservoir) under jurisdiction of the Pittsburgh District and located within a reasonable distance of the proposed Union City Reservoir. The cost for maintenance, including wages and depreciation and upkeep of equipment is estimated at $30,000 per year.

96. Initial clearing of the reservoir area would leave it free of major floatable materials to the limit of flowage easement. Thereafter, normal Federal maintenance of the reservoir area would consist of gathering and burning drift resulting from intermittent flooding. The work would be performed by hired labor under the direction of the damtender assigned to aforementioned Woodcock Reservoir.

97. The proposed structures associated with the project are so planned as to have convenient access. The structures consist of a building to store the maintenance equipment and a gage house at the top of the dam to house the recording gage.

## XXIII. RESERVOIR REGULATION

98. The Union City Reservoir will be an uncontrolled type with discharges limited by the sizes of the outlet works. Maximum discharges through the upper and lower outlet works will be 4,500 c.f.s. under reservoir design flood conditions. Bankfull capacities downstream of the dam are estimated at 5,900 c.f.s. The reservoir design flood would have a peak inflow of 16,000 c.f.s. resulting in a

full pool elevation of 1278 m.s.l. which was used as a guide for establishing vertical limits for relocations of highways and utilities and as a basis for establishing a guide taking line for acquisition of permanent easements on reservoir lands. Detail information and illustrations regarding reservoir discharges are included in Appendix I - Hydrology and Appendix IV - Hydraulics, accompanying this report.

## XXIV. BENEFITS

99. General.- The estimated average annual benefit which would result from the Union City Reservoir consists of the following:

a. Benefit from the elimination or reduction of primary damages resulting from a decrease in flood flows in the French Creek Basin and along the Allegheny River between Franklin and Pittsburgh, Pennsylvania.

b. Benefit from the elimination or reduction of primary damages which would apply to normal future development in the flood zones, even if flood protection were not provided.

Flood control benefits were evaluated on a basis of an incremental addition to the existing elements of the Ohio River Basin system using stage-damage and stage-frequency curves up to a 1000-year frequency.

100. Evaluation of primary flood control benefits.- There are no existing flood control projects in the French Creek Basin. Therefore, the average annual primary flood control benefit in each damage district would have a monetary value equal to the difference between the average annual natural damages and the average annual residual damages remaining with the Union City Reservoir in operation. Average annual primary flood control benefits downstream from French Creek which would accrue to the Union City Reservoir have been conservatively evaluated for use in this report. Benefits have been estimated only as those resulting from stage reductions after full credit has been applied to the existing reservoir system plus all active authorized reservoirs, for reduction of natural flood stages. The total estimated average annual primary benefit based on May 1964 values and May 1960 degree of development for the affected districts in the French Creek Basin and along the Allegheny River from Franklin to Pittsburgh are allocated among districts as follows:

| Damage District | Average Annual Primary Benefit |
|---|---|
| French Creek Basin: | |
| Union City Reservoir dam site to Cambridge Springs | $ 16,140 |
| Cambridge Springs | 71,520 |
| Cambridge Springs to Venango | 2,358 |
| Venango | 848 |
| Venango to Saegerstown | 11,888 |
| Saegerstown | 10,635 |
| Saegerstown to Meadville | 1,926 |
| Meadville to Kerrtown | 530,220 |
| Kerrtown to Cochranton | 851 |
| Cochranton | 51,588 |
| Cochranton to Franklin (a) | 5,575 |
| Franklin | 26,535 |
| Subtotal, Rounded | $ 730,000 |
| Allegheny River to Pittsburgh: | |
| Franklin )<br>Parkers Landing)<br>Kittanning )<br>New Kensington ) | $ 5,880 |
| Pittsburgh | 36,800 |
| Total, Rounded | $773,000 |

(a) Utica, Carlton and Sugar Creek districts combined.

101. Evaluation of normal future development benefits for the French Creek valley.- The average annual benefit which would result from elimination of primary damage applicable to normal future development in the Meadville flood zones has been computed for the Union City Reservoir on the basis of a normal future growth projection developed for the Meadville area flood zone in conjunction with the project document. This trend, averaging 1.70% growth annually, was based on a 15-year history (1944 to 1960) of building permit and assessment valuations in the Meadville area flood zone. For purposes of this report the trend line has been projected for the life of the Union City Reservoir project (2064) assuming the same rate of growth.

This rate of growth compares with a 1.30% flood zone growth rate at Franklin, 1.31% at Cochranton, and 0.84% at Cambridge Springs, which were also computed for the project document. Since the project document was published, there has been no significant increase or decrease in construction activity in the Meadville area flood zone that would materially affect the trend line average of 1.70%. According to projection of the trend line, the Meadville area flood zone building valuation in 1964 is estimated at $26,600,000. The flood zone development throughout the remainder of the French Creek valley is considered insignificant in the evaluation of future development benefits. The method for computing the future development benefits on a monetary basis for the Meadville flood zone due to construction of the Union City Reservoir follows. The ratio of total primary damages in the Meadville flood zone to the total projected 1964 flood zone building valuation for the Meadville area is used to establish a ratio of 1.99%:

$$\frac{530,220 \text{ (Total primary benefits - Meadville)}}{26,600,000 \text{ (Flood zone building valuation - Meadville)}} = 1.99\%$$

This percentage is assumed to apply to the normal future development in the flood zone as developed by projection, and is considered to represent the portion of the total future development benefits in the Meadville flood zone that can be credited to the Union City Reservoir. The projection shows a trend line value of $71,800,000 in 2064 or a total gain in the flood zone value of $45,200,000 for a 100-year period. Therefore, the annual benefit attributable to future development would amount to 1.99% x $45,200,000 = $900,000. This amount is discounted by .28168 which is the average annual equivalent compound interest factor for a 100-year growth period and an interest rate of 3-1/8%. The resultant discounted figure of $254,000 is the amount of average annual future development benefits in the City of Meadville apportioned to the Union City Reservoir.

102. Evaluation of normal future development benefits for the downriver area.- The average annual benefit which would result from elimination of primary damages applicable to normal future development in the Allegheny River reach downstream of French Creek has been computed for the Union City Reservoir on the basis of population growth of four principal counties over a 60-year period. This method was used in conjunction with the project document. The population of Allegheny, Armstrong, Beaver, and Westmoreland Counties combined, increased from 1,044,216 in 1900 to 2,267,730 in 1960, representing an average annual gain of 1.95% as reported in the project document. This is a conservative rate of growth when compared to the average yearly increase of 5.51% for total industrial production for the Pittsburgh district over a 20-year period and a similar growth rate of 5.43% for general business activity for the same area and period of time. The conservative growth rate of 1.95% is used for the downriver area and projected for 100 years, gives a total growth of 195%. This percentage, applied to the existing primary benefits of approximately 42,000

would show an increase of about $83,000 in average annual primary benefits in 100 years. This figure is discounted by .28168 giving $23,000 as the average annual downriver future development benefits attributed to the Union City Reservoir.

103. Summary of flood protection benefits.- Average annual flood control benefits which would result from construction of the Union City Reservoir based on May 1964 values and May 1960 degree of development are as follow:

| | Benefits | | |
|---|---|---|---|
| | Primary | Future Development | Total |
| French Creek Valley | $730,000 | $254,000 | $ 984,000 |
| Downriver | 43,000 | 23,000 | 66,000 |
| Total | $773,000 | $277,000 | $1,050,000 |

104. Area Redevelopment Administration benefits.- It is acknowledged that labor, materials and services for construction, and later for operation and maintenance of the project, would be required in Erie County, Pennsylvania. However, for purposes of this memorandum, no ARA benefits have been applied to the project.

105. Annual charges.- Total estimated average annual charges are $376,000, as determined earlier in this report.

106. Benefit-to-cost ratio.- A comparison of average annual monetary benefits to average annual charges results in a ratio of 2.8 to 1.

107. Comparison with economic ratio in the project document.- Based on the Union City Reservoir being first in the order of construction of the French Creek Reservoir system, comparison of the current economic ratio with the economic ratio developed in the project document is as follows:

| | Current (May 1964) | Project Document (May 1960) |
|---|---|---|
| Estimated average annual benefits | $ 1,050,000 | $ 821,300 |
| Estimated average annual charges | $ 376,000 | $ 336,400 |
| Economic ratio, benefits to charges | 2.8 to 1 | 2.4 to 1 |

The differences resulting from a comparison of the above figures can be attributed to the following:

a. Average annual benefits are higher due to increased dollar value of property since preparation of the project document and the consideration of a 100-year project life instead of a 50-year project life, as used in the project document.

b. Average annual charges are higher due to the increased dollar cost of construction, the increase in the Federal interest rate to 3-1/8 percent as compared to 2-5/8 percent used in the project document, and a higher estimated maintenance cost.

c. Changes in design based on more complete topographic and subsurface information which resulted in an embankment and spillway design which was economically superior to that proposed in the project document.

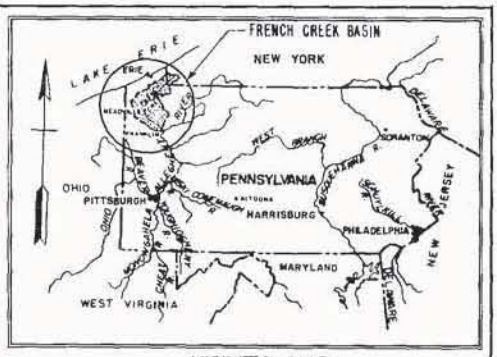
## XXV. RECOMMENDATION

108. It is recommended that the Union City Reservoir of the authorized French Creek Reservoir system be constructed in accordance with the General Plan as outlined in this General Design Memorandum at a total first cost of $10,100,000, provided that, prior to initiation of construction, local interests give assurances satisfactory to the Secretary of the Secretary of the Army that affected interests in the French Creek Basin will be informed at least annually that the system of reservoirs, of which Union City Reservoir is a part, will not provide protection against maximum floods.

Accompanying the report:
Plates 1 to 8, incl.
Exhibits 1 to 6, incl.
Appendices 1 to VIII, incl.

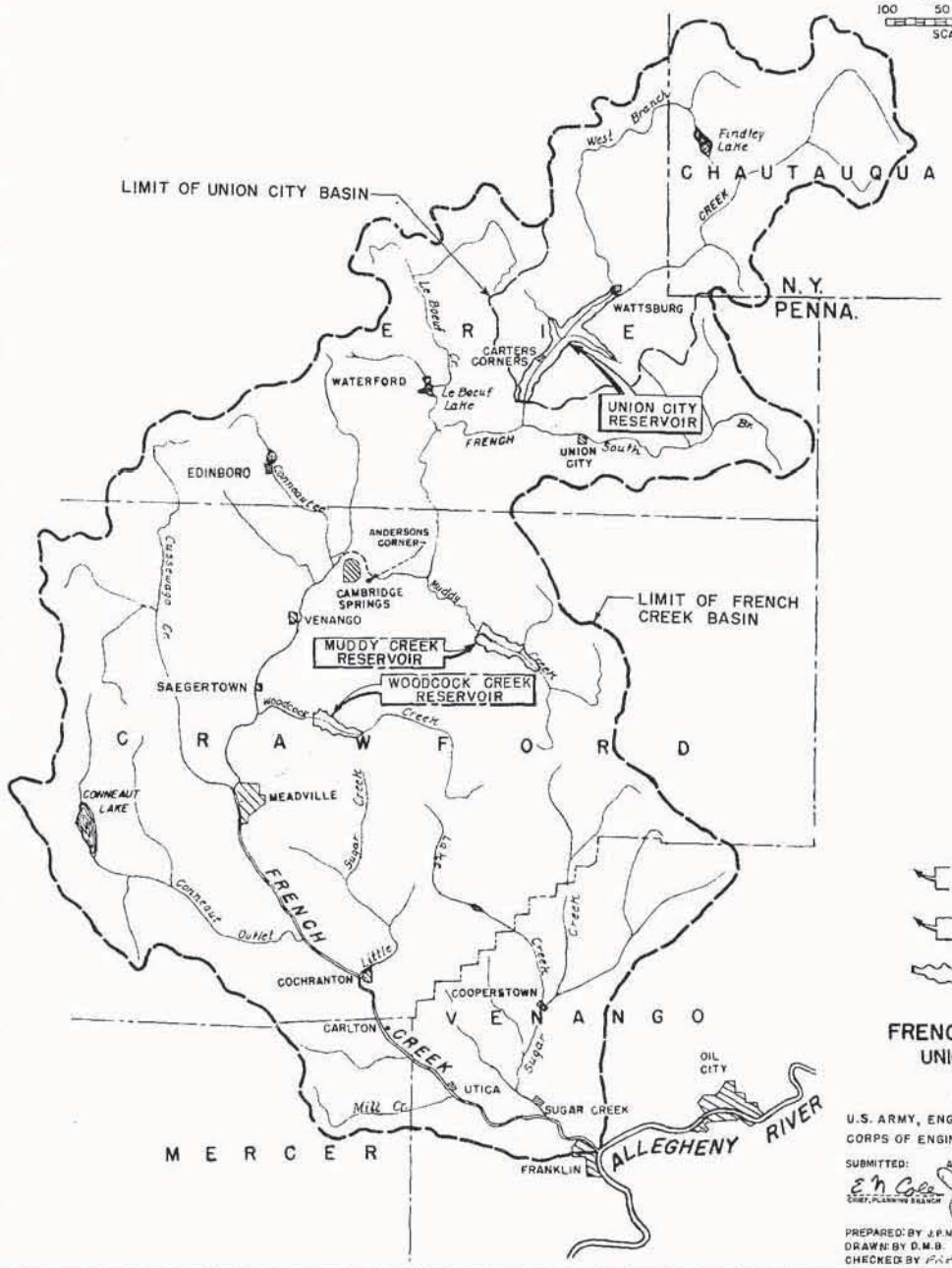
J. E. HAMMER
Colonel, Corps of Engineers
District Engineer

CORPS OF ENGINEERS U.S. ARMY




VICINITY MAP

100 50 0 100
SCALE IN MILES




LEGEND

- AUTHORIZED
- RECOMMENDED FOR CONSTRUCTION
- LIMIT OF FULL POOL

PLATE 1

FRENCH CREEK BASIN, PA.
UNION CITY RESERVOIR
GENERAL MAP

4 2 0 4 MILES

U.S. ARMY, ENGINEER DISTRICT, PITTSBURGH
CORPS OF ENGINEERS, PITTSBURGH, PA. 24 AUGUST 1964

SUBMITTED: APPROVAL RECOMMENDED: APPROVED:

E. N. Cole — CHIEF, PLANNING BRANCH
CHIEF, ENGINEERING DIVISION
COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

PREPARED BY J.P.N.
DRAWN BY D.M.B.
CHECKED BY

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CORPS OF ENGINEERS

U. S. ARMY

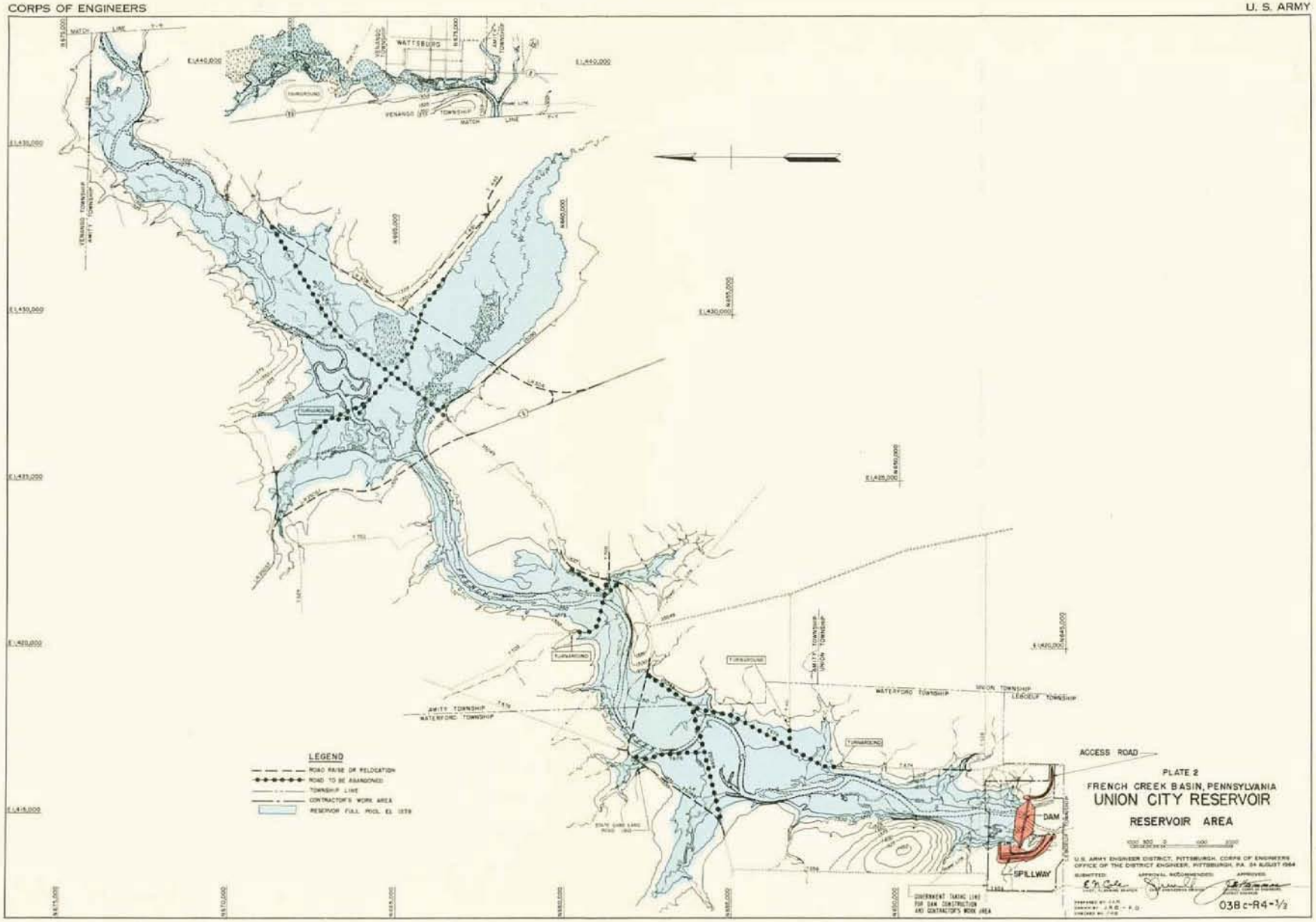


PLATE 2

FRENCH CREEK BASIN, PENNSYLVANIA

# UNION CITY RESERVOIR

## RESERVOIR AREA

U.S. ARMY ENGINEER DISTRICT, PITTSBURGH, CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER, PITTSBURGH, PA. 24 AUGUST 1964

SUBMITTED: APPROVAL RECOMMENDED: APPROVED:

038 c-R4-½