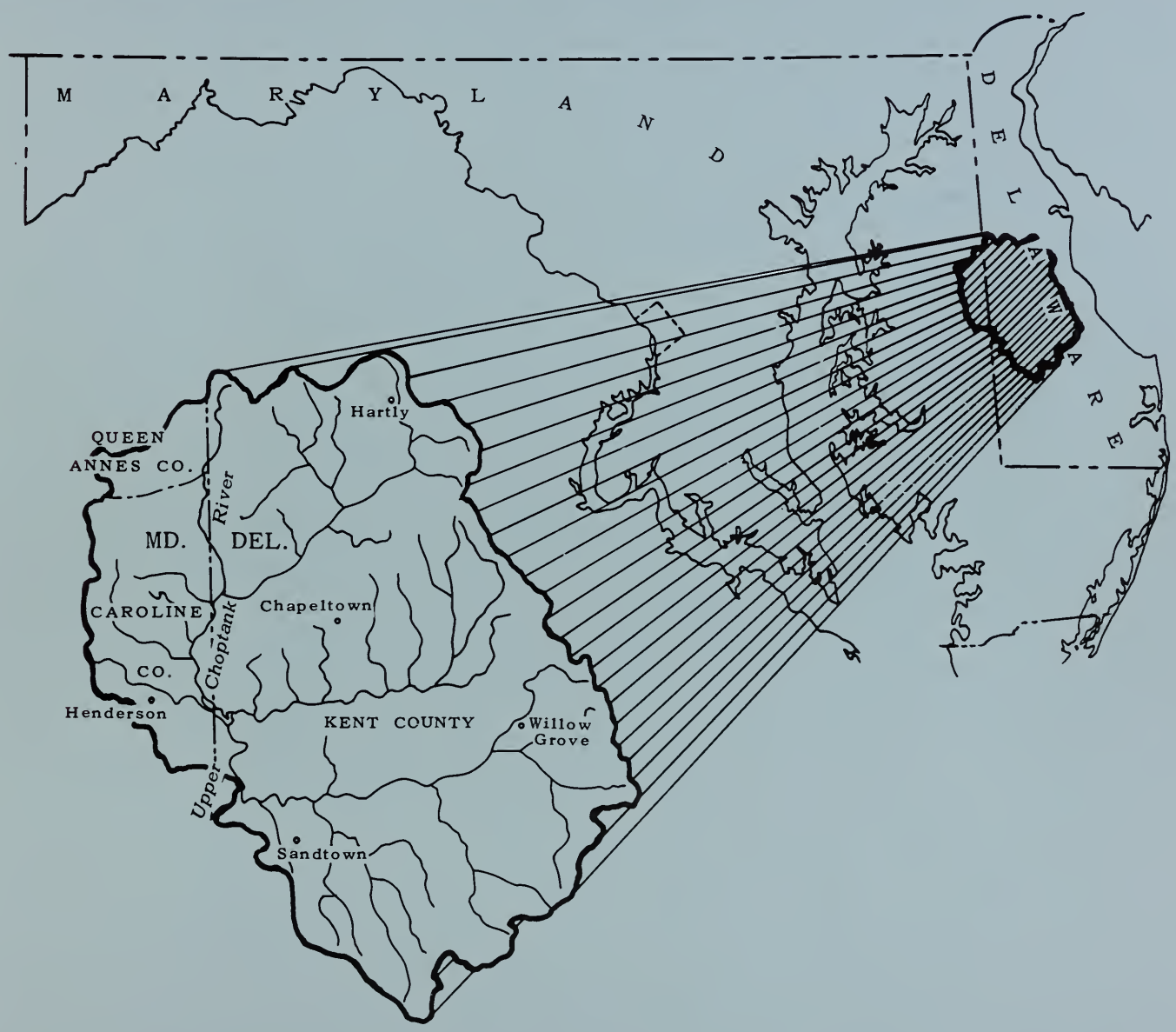
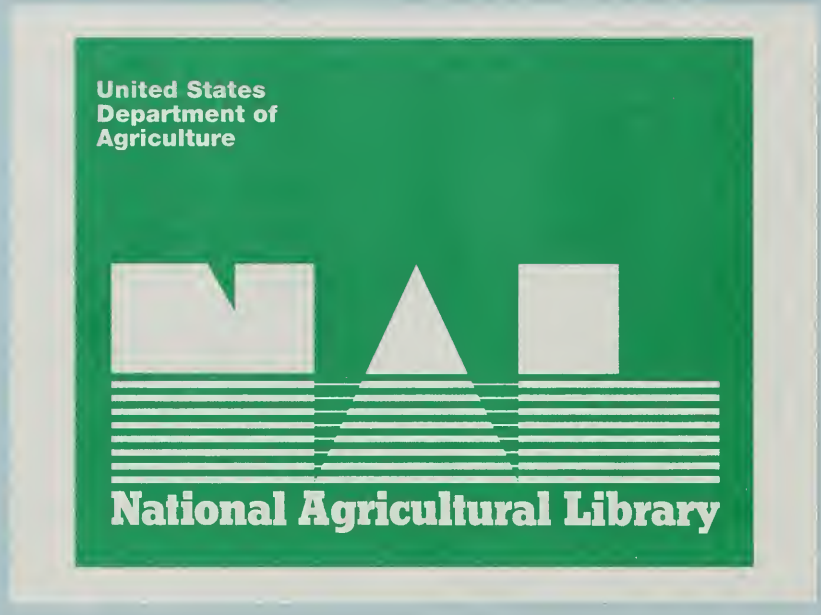
WORK PLAN
for the
UPPER CHOPTANK RIVER WATERSHED



KENT COUNTY, DELAWARE

CAROLINE AND QUEEN ANNE'S COUNTIES, MARYLAND

May, 1965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WORK PLAN FOR

UPPER CHOPTANK RIVER WATERSHED

Kent County, Delaware
and
Caroline and Queen Anne's Counties, Maryland

Prepared under the authority of the Watershed Protection and Flood Prevention Act - (Public Law 566, 83d Congress, 68 Stat. 666) as amended.

Prepared by:

Delaware Soil and Water Conservation Commission
Caroline County Commissioners
Caroline Soil Conservation District
Queen Anne's County Commissioners
Queen Anne's Soil Conservation District

With assistance by:

U. S. Department of Agriculture
Soil Conservation Service
Forest Service
U. S. Department of Interior
Fish and Wildlife Service

May 1965

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WORK PLAN FOR

UPPER CHOPTANK RIVER WATERSHED

Kent County, Delaware and Caroline & Queen Anne's Counties, Maryland

May 1965

SUMMARY OF PLAN

The Upper Choptank Watershed is located primarily in Kent County, Delaware, with a minor portion (18%) in Caroline and Queen Anne's Counties, Maryland. There are approximately 57,000 acres in the watershed.

The local sponsoring organizations are: The Delaware Soil and Water Conservation Commission, Caroline County Commissioners, Caroline Soil Conservation District, Queen Anne's County Commissioners and the Queen Anne's Soil Conservation District.

Approximately 80 percent of the watershed has joint problems of floodwater and drainage damage on the flat Coastal Plain soils. These problems increase progressively in the upstream area and have been a contributing factor in designating Kent County, Delaware, as a "5 b" county under the provisions of the Area Redevelopment Act. Agricultural production is seriously limited in the area by inadequate drainage and periodic flooding.

Delaware is as concerned with the increasing demand for stored water, the need to recharge ground water supplies and the increasing pressure for the enjoyment of impounded fresh water as it is with the need for the disposal of excess water.

The work plan proposes a system of 280 miles of multiple purpose channels in the agricultural areas and land treatment measures on the farms of the watershed to be installed over a ten year period. Also proposed is a fish and wildlife measure impounding 360 surface acres of water.

The total project cost is $4,908,150. The Public Law 566 share of this cost is $3,045,300. Other funds will be used for the remainder of the cost: $1,862,850.

The cost of installation of land treatment measures is estimated to be $589,450. Public Law 566 will provide $129,300 of that cost for accelerated technical assistance by the Soil Conservation Service and the Forest Service.

The structural measures, 280 miles of multiple purpose stream improvements and a fish and wildlife impoundment are estimated to cost $4,318,700. The PL 566 share of that cost is $2,916,000 and the other share is $1,402,700.

Development of the rural area will be enhanced by the planned improvements. Improved economic conditions of the farm families through increased net income will be the primary effect of the project. Increased crop yields will add about $2,500 to the gross income of the 400 farms. Corn and soybeans, the key crops on the Delmarva peninsula, are utilized entirely by local processing plants. The local processing plants also import these grains from other areas. A portion of the corn is used as ensilage on the dairy farms of the watershed. The improvements will not only increase per acre yields of these crops but will also permit diversification to vegetable crop production.

The planned fish and wildlife structure will enhance the fresh water sport fishery resource. The impoundment will help meet the growing demand for this resource by the ever expanding population.

The average annual primary benefits accruing to the channel improvements total $580,241 and are distributed one-half to flood prevention and one-half to agricultural water management. The local secondary benefits total $83,713. Secondary benefits from a national viewpoint were not considered in project evaluations. The estimated annual benefit from the fish and wildlife structure is $70,300.

The ratio of average annual benefits $734,254 to annual cost, $200,708, is 3.7 to 1.0. The annual cost includes $171,840 amortized structure installation cost and $28,868 estimated annual cost of operation and maintenance.

The multiple purpose stream channel improvements will be installed in Delaware by Tax Ditches and in Maryland by Public Drainage Associations. The sponsors will organize such groups when needed under authorities granted by state laws. The sponsors will provide financial and technical assistance to such groups according to established procedures.

The fish and wildlife measures will be installed by the Delaware Soil and Water Conservation Commission.

The cost of the multiple purpose stream channel improvements will be shared by PL 566, $2,236,300 and other, $712,200. The cost of the fish and wildlife improvement will be shared by PL 566, $679,700, and other, $690,500. The installation services cost, $1,143,700, will be provided by PL 566. The costs for land, easements and rights of way and administration of contracts, $465,600, will be borne by the several Tax Ditches, Public Drainage Associations and the Delaware Soil and Water Conservation Commission.

The multiple purpose channels will be operated and maintained by the Tax Ditches and Public Drainage Associations to be organized by the sponsors. The fish and wildlife measures will be operated and maintained by the Delaware Soil and Water Conservation Commission. Specific operations and maintenance agreements will be executed prior to the issuance of invitations to bid on construction contracts. The estimated total annual operations and maintenance cost is $28,868. Land treatment measures will be operated and maintained by the owners and operators of the farms on which the measures are installed.

DESCRIPTION OF THE WATERSHED

Physical Data

The Choptank River rises near Hartly, Delaware, and empties into the Chesapeake Bay near Cambridge, Maryland.

The Upper Choptank Watershed is a small portion of the headwaters of the Choptank River watershed. Approximately 82% of the 57,000 acres in the watershed is in Kent County, Delaware, 17.8% is in Caroline County, Maryland, and the remainder in Queen Anne's County, Maryland.

The project area begins at the Delaware-Maryland boundary approximately two miles NW of Sandtown, Delaware. The Choptank River loses its identity in the vicinity of Marydel where it branches into two major tributaries, the Tappahanna serving Delaware and Harrington-Beaverdam serving Maryland for the most part. Other tributaries include Culbreth Marsh and Cow Marsh in Delaware and Cool Spring and Henderson branches in Maryland.

The watershed is in the Coastal Plain physiographic province. Elevations range from 20 to 80 feet above mean sea level.

The watershed is covered by a mantle of sand and silt with lenses of silt, clay and gravel. The sediments are of Pleistocene and Recent geologic age. The upper reaches of the watershed are flat, lack defined stream channels and are characterized by poorly developed natural drainage patterns.

The soils are sandy and excessively drained on the lower elevations adjacent to the stream. Where natural channels give way to constructed channels, the soils generally are somewhat finer in texture and show evidence of high water table effects in profile development. Most of the flat area is classified as poorly to imperfectly drained although well drained to excessively drained soils are scattered throughout the area. The soils generally are productive when drained, well managed and protected from flooding.

The average annual precipitation is 45 inches with most of this falling as rain. The rainfall is fairly well distributed throughout the year. The heaviest rainfall usually occurs in July, August and September. The precipitation in July and August is usually from high intensity storms of short duration. The normal rainfall in July is 4.8 inches while August and September are 5.2 and 3.8 inches.

The normal growing season for frost tender crops is about 190 days, from mid April to late October. The mean summer temperature is 76° F. The mean winter temperature is 36° F.

The major water uses are for domestic and livestock purposes. The major source for these purposes is shallow wells. Some irrigation is practiced within the watershed. The major users pump directly from the main stream; however, there are a few dugout ponds used for irrigation.

Economic Data

The economy of the watershed is based on agricultural production. The population of the watershed is about 4,000. Half of these people live in the several small communities, the remainder are on the 400 farms and small tracts of land along the principal roads.

The farms in the watershed range in size from less than 40 acre part-time farms to operational units of over 1,000 acres. The average size of the 400 farms is 130 acres with an estimated average value of $26,000. The major farm-enterprise is cash grain production. However, there are a number of dairy farms located within the watershed. The farms are mostly owner operated. The operators of larger farm enterprises rent farms to supplement the acreage owned. Dover Air Force Base (MATS) and a new food processing plant provide supplemental employment for the farmers in the general area. This available off-farm employment is causing more part-time farming operations in the watershed particularly since corn and soybean production does not require full time activity. The median earnings for farmers and farm managers in Kent County during 1960 was $2,190.

The general land use is 30,805 acres of openland and 26,240 acres of forestland. The openland acreage is divided into 25,972 acres of cropland, 4,583 acres of grassland and about 250 acres of homes and other uses. The major crops, corn and

soybeans, are produced on slightly over 16,000 acres. Small grain is produced on about 1,000 acres. There are about 600 acres of truck crops and hay is harvested from about 2,400 acres. About 5,800 acres were kept out of production during 1962. Most of these acres were in one of the cropland control programs administered by ASCS county committees.

State and county roads provide access to US Routes 13 and 301 leading to local and regional markets. Local markets exist for cash grains, truck crops, fluid milk, livestock and poultry. Suppliers of goods and services needed for the production of agricultural products are available near the watershed.

The Delmarva Peninsula produces about 80 percent of the corn processed locally for the current production of 200 million broilers. In 1962, Kent County produced 2.2 million bushels of corn and sold 1.7 million bushels. The total Kent County 1962 cash farm income was $20.9 million. Corn accounted for 10.4%, soybeans 14.5%, broilers 13.0% and fluid milk 15.3%.

Approximately 46 percent, or 26,240 acres, of the watershed is in forest cover. Hardwood stands, occupying 94 percent of the area, consist of the white oak, red oak, bottomland hardwoods and red gum-yellow poplar types. Mixed stands of loblolly pine and hardwoods account for three percent of the forest land, and pure stands of loblolly pine the remaining three percent. Forty percent of the forest area supports saw timber size stands of 1,500 board feet or more per acre, 51 percent is in pole size stands, and the remainder is of seedling and sapling size.

Market conditions are favorable for sale of sawlogs over the entire watershed. Softwood pulpwood and gum-poplar basket stock also have nearby markets. Hardwood pulpwood is not marketable in the area.

The 2,700 acre Petersburg Conservation and Recreation Area is located in the southeast portion of the watershed. The area, administered by the Delaware Game and Fish Commission, was a Land Utilization site until the mid-forties when it was released to the state by SCS. The area is currently under SCD agreement including forestry, cropland and wildlife practices.

Although modern farm machinery is used on most of the farms, animal power and steel mounted tractors are employed in a sizeable area in the eastern portion of the watershed. The

overall economy of the watershed is influenced by these practices.

WATERSHED PROBLEMS

Floodwater Damage

Floodwater damage in the watershed ranges from out of bank flow in a relatively small area near the discharge ends of most of the tributaries, particularly in the area of Marydel, to inundation of large areas of flat land due to direct abnormally high precipitation.

The present drainage systems, the predominantly sandy soils and the usual pattern of rainfall provide for management of normal precipitation particularly during the growing season.

Under flood conditions, occurring on the average of five year intervals, severe crop damage extends to much of the area. During the period 1950-1960, flood producing storms were experienced in August 1955 and August 1958. The 1958 storm was particularly damaging since it climaxed a four month period of unusually high rainfall. Such storms usually occur after the crops are well established and the most expensive crop production practices have been completed, therefore, heavy losses are experienced. Over 21,600 acres of openland and 23,300 acres of forestland are subject to this hazard.

Road and bridge flood damages also occur at points where roads cross channels. Road fill is washed away from culverts and bridges. Damages to road shoulders, and in some cases to the roadbed, occur at flood time.

Problems Related to Agricultural Water Management

For more than a hundred years farmers in the watershed have been concerned with surface drainage. Particular concern centered around the depressions in the fields where water stood after rains during the cropping season and where water tables approached the surface in late winter and early spring. As much as 10% of a field could be affected but the impact was greater than that since the depressions were scattered consequently management of the entire field was affected.

Open ditch drainage has been practiced in the watershed since colonial times. The need for community action to provide

group outlets is evidenced by the charter of the Culbreth Marsh Tax Ditch Company granted by the State Legislature in 1829.

Modern farming methods and the high cost of production require more than disposal of surface run-off from the minor depressions. The soils affected by seasonal high water table require varying degrees of water table control as well as disposal of excess surface water during major storms.

The combination of floodwater and agricultural water management problems causes reduced crop yields, limits diversification, increases crop production costs, limits use of lime and fertilizer and retards the economic growth of the area.

Water Resource Development

Although Delaware is bounded by one of the nation's major rivers and is underlain by enormous quantities of water stored in the deep sand deposits, it is constantly aware of increasing demands for water. The concern for adequate supplies of water on one hand and the need to provide for disposal of water on the other, causes the sponsors to consider water development possibilities in all watersheds. The drought conditions of 1964 emphasize the concern.

The flat topography does not lend itself to flood control by storage methods consequently little opportunity exists for multiple-use impoundments. One good location for a recreational or wildlife improvement is located within the project area. Either of the purposes would fill a need. The watershed is within two hours driving distance of major centers of population and adequate well drained soils surround the area to permit the development of camping or other recreational facilities. Such a lake should also contribute to groundwater recharge. Deep wells are the primary source of water for the towns, irrigation and new industry of the state hence the concern for ground water.

Sediment Damage

Sediment production in the watershed is comparatively low. Most of the sediment comes from shoulders of paved roads, gravel side roads and floodwater damage to channel banks and bottoms. Sediment from roads is particularly damaging since it frequently deposits at or in culverts or bridges.

Erosion Damage

Erosion in the watershed is slight. Most of the more sloping areas are wooded and generally well protected. Where poor woodland management practices are followed, the resulting erosion contributes to the siltation of main channels. Wind erosion occurs seasonally on some of the light soil areas of the watershed. Streambank erosion by entering field ditches, road ditches and concentrations of overland flow contributes most to channel sedimentation. Bank cutting at the discharge end of road culverts also adds to the sediment.

PROJECTS OF OTHER AGENCIES

Two tributaries of the Choptank river empty directly into Mud Mill pond near Choptank Mills. The old mill pond has approximately 64 acres of water surface. It is very shallow and provides a declining fishery resource.

Maintenance of the water level of the pond at its present level will not adversely affect the planned channel improvement measures. The proposed channel improvements will not materially affect the pond.

Investigation of the pond, constructed about 1868, shows that limited capacity for water storage remains. The fish population consists primarily of rough species. It was determined that it was not feasible to consider renovation of the pond. An alternate site with a potential of 360 surface acres is located within the watershed.

BASIS FOR PROJECT FORMULATION

The need for a sound group approach to provide adequate outlets and relief from flooding for the upland agricultural lands of the watershed has been a major problem. The Watershed Protection Act and related state laws provide a new approach to the problem.

The Application and the Preliminary Investigation Report establish that the prime objective of the project is to control the excess surface and sub-surface water on the agricultural lands in the watershed. Channel criteria of the standard that provides "C" curve drainage has proved adequate in similar channel improvement projects to meet both the flood prevention and the agricultural water management needs.

Two controls were established as important in project formulation. Earlier construction in the Harrington-Beaverdam portion of the watershed apparently had increased flows thru the community of Marydel. The impact of further upstream improvements on flows had to be considered in project formulation. The second control was the water level of Mud Mill Pond. Back water effects on channel improvements were of primary concern to the sponsors.

Other objectives included consideration of improvements to the nearly 100 year old Mud Mill Pond at Choptank Mills for wildlife or other purposes and the feasibility of constructing a new impoundment below the present pond. Detailed hydrologic, hydraulic and engineering investigations were carried out to determine the scope of the plan, to analyze the effects of the works of improvement, to determine the impact on the remaining fishery benefits of Mud Mill Pond and the feasibility of a lake for wildlife purposes on the lower stem of the main channel. Two prospective sites were studied during the preliminary investigation. The sponsors indicated their prime interest was to consider only the larger site. This location was studied and a plan included under works of improvement.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment

The land treatment planned for this watershed is combinations of measures necessary to assure the realization of the benefits used in the justification of the structural measures proposed in this work plan.

The cropland treatment will combine engineering and agronomic measures. The engineering measures such as mains and laterals, tile drains and land smoothing will extend the effects of the group outlets to the individual on-farm problem areas. They are the basis for improved hydrologic conditions of the watershed not only as a result of water table control and disposal of excess surface flood water but also as a requisite for the agronomic measures.

The agronomic measures include conservation cropping systems, cover and green manure crops, pasture renovation and proper pasture use. These or alternate measures in combination with the engineering measures utilize the capacity of the soils to absorb relatively large quantities of water and pass it through

the deepened root zone to the zone of variable water table. The agronomic measures are related primarily to maintaining the soil tilth and preventing surface sealing as well as contributing to the maintenance of soil organic matter and the prevention of erosion. These measures contribute significantly to flood prevention through improved hydrologic conditions of the soil except when flood producing storm follows a period when the soil has been saturated by previous rains.

The forestry practices included in the plan, Tree Planting, Hydrologic Cultural Operations,and Woodland Grazing Control (Fencing), benefit from the improved drainage condition and also contribute to improved hydrologic conditions effective in reducing flood peaks and in recharging ground water during the winter and spring.

Forest trees, through development of deeper root systems, deepen the soil zone available for storage of water. Thus during the summer and fall flood season, evapo-transpiration removes maximum volumes of water from the soil profile and creates optimum opportunity for the immediate storage of storm precipitation.

The forest cover which contributes to lowering of water tables through evapo-transpiration also creates accumulations of litter and humus which increases surface infiltration rates, improves percolation rates and increases soil moisture storage capacity, thus reducing surface runoff contribution to flood flows.

Table IA lists the essential land treatment measures applied to date. Wider use of these measures will be made after installation of the stream channel improvements. Table I shows that 11,000 acres of cropland, 2,350 acres of grassland and 2,570 acres of forest land will receive treatment essential to project purposes during the project period.

Structural Measures

The structural measures consist of seven separate structural units totaling 280 miles of multiple purpose channel improvement for the conveyance, control and disposal of excess drainage and floodwaters of the watershed and a fish and wildlife improvement.

The seven independent construction units or systems of channels

are: Tappahanna, Culbreth Marsh, Cow Marsh, Smith-Leslie, Coolspring, Henderson and the minor Tributaries of the Upper Choptank.

Unit #1 includes the major tributaries of Tappahanna and Harrington-Beaverdam making up the headwaters of the Upper Choptank. They join together near State Highway #8 in Marydel and require works of improvement to protect their common outlet and also provide a measure of flood protection to the rural community of Marydel bordering the main channel.

For the convenience of grouping, minor tributaries bordering the main channel of the Upper Choptank but not dependent on its development for an adequate outlet are included in Unit #7.

Each unit, 1-7 inclusive, contains segments not requiring development of a common outlet and are economically justified in the absence of other works of improvement. The details and location of these segments are described and designated in the supplemental data for this work plan.

An estimate of the proposed channel improvements by construction unit is indicated in the following chart.

Constr Unit	Name	Channel or Tributary Miles Main Channel	Miles Major Trib.	Miles Minor Trib. + Control Inlets & Contingency	Miles Total
1	Tappahanna	3.8	23.2	64.0	91.0
2	Culbreth Marsh	8.8	23.2	27.8	59.8
3	Cow Marsh	3.0	33.5	57.5	94.0
4	Smith Leslie	-	0.8	2.8	3.6
5	Coolspring	-	3.0	11.2	14.2
6	Henderson	-	2.7	7.6	10.3
7	Minor Tribs of Main	-	-	7.1	7.1
		15.6	86.4	178.0	280.0

The main channels and major tributaries of the first six units are shown on the project map and their design details are shown on table 3.

The minor tributaries will provide direct measurable benefits to two or more beneficiaries. They are described and located approximately in the supplemental data for this work plan. The details of the minor tributaries and controlled inlets are not shown on the project map and table 3.

Included in the structural measures, i.e.stream channel improvement, are certain appurtenances needed for the protection of the structure or to protect other structures affected by the channel improvements. These appurtenances include controlled inlets for surface waters at critical points along the channel and underpinnings of bridges where footings are exposed by new construction. In addition to bridge protection, a number of culverts will require enlargement or relocation. These are considered part of the land, easements and rights of way to be furnished at no cost to the Federal Government.

The total estimated cost of the proposed multiple purpose channel measures, including construction costs, installation services, land, easements and rights of way, is $2,948,500. The average annual cost, including the cost of operations and maintenance is $145,349.

A fish and wildlife improvement providing public access is proposed for the Delaware area just below Mud Mill Pond and near the community of Sandtown, Delaware. The area proposed for impoundment is 360 acres averaging approximately 8 feet in depth at the dam. The total estimated cost of the proposed fish and wildlife improvement including construction costs, installation services, land easements and rights of way, is $1,370,200. The average annual cost including cost of operations and maintenance, is $55,359.

Tables 1 and 2 show the breakdown in funds. Table 3 and 3A show structural data for the multiple purpose channels and fish and wildlife improvement.

EXPLANATION OF INSTALLATION COSTS

The costs of applying land treatment were based on combinations of essential conservation measures grouped according to the soil capability and needs. Current expenditures for such measures in the watershed were the basis for cost estimates with custom rates for particular practices used as guides. Soil Conservation Service technical assistance costs

were based on amounts of time and personnel required to provide assistance for planning and application of the essential land treatment.

Costs for the installation of forest land treatment measures are based on current costs of supervision, labor, equipment and materials needed to perform the particular measures. Costs of technical assistance for the installation of forest land treatment measures are based on actual expenditures and accomplishments of the Delaware State Forestry Department and the Maryland Department of Forests and Parks. An analysis of costs against accomplishments was made for each measure to determine unit costs for technical assistance.

The structual measures costs are based on 1963 prices. A 12 percent contingency was added to the cost estimates for the channel improvements and a 15 percent contingency was added to the cost estimates for the fish and wildlife structure. Unit prices were established from bids for contracts recently awarded for projects in Delaware and Maryland. Adjustments were made to fit site conditions. Quantities of particular construction items were determined from design data. The costs of bridge protection is based upon cost for similar work in projects now being installed.

Installation services costs are the costs of providing the engineering and other services needed to install the structural measures. Engineering services for the channel improvements are based on an established per mile cost. Engineering services costs for the fish and wildlife structure are based on percentage factors for particular services. Other services costs are based on percentage factors which have been developed to estimate administration and overhead costs.

The land, easements and rights of way costs for the fish and wildlife structure were based on land values of the area which will be affected by extreme flow through the spillways. Rights of way costs for the channel improvements are based on land values of the entire affected woodland and the crop income loss due to construction in cropland during the cropping season. The costs of relocating highway and road pipes and culverts are based upon the amount of labor and materials required.

Administration of contracts costs represent the value of administration, legal and clerical services to be provided by

the contracting local organization. This cost for the channel contracts is estimated to be four percent of the construction cost based on similar costs in other watershed projects. The cost for the fish and wildlife structures is a job estimate for providing the services.

The second alternative method described in 1132.212 of the Watershed Protection Handbook was used to allocate costs of the multiple purpose channel. The total installation costs are joint costs, therefore, 50 percent of the cost was allocated to flood prevention and 50 percent to drainage. Public Law 566 funds will bear 75 percent of the construction costs of these channels.

The fish and wildlife structure will receive PL 566 financial and technical assistance. PL 566 funds will bear 50 percent of the construction cost and all of the installation services costs. Other funds will bear 50 percent of the construction cost, 100 percent of the land, easements and rights of way costs and 100 percent of the cost of contract administration.

Table 2A shows a summary of the cost allocation and cost sharing.

The following table shows the schedule of fund obligations during the project period:

Project	PL 566		Other	
Period	Land	Structural	Land	Structural
Years	Treatment	Measures	Treatment	Measures
1	$ 8,000	$425,000	$30,700	$138,300
2	8,000	83,000	30,700	79,800
3	8,000	613,400	30,700	180,900
4	8,000	83,000	30,700	80,800
5	8,000	490,000	30,700	143,078
6	17,860	83,000	61,300	9,000
7	17,860	122,300	61,300	201,700
8	17,860	290,000	61,300	25,000
9	17,860	600,000	61,300	534,500
10	17,860	126,300	61,450	9,622

EFFECTS OF THE WORKS OF IMPROVEMENT

Increased net income to the farm families in the watershed will be the primary effect of the installation of the stream channel improvements. Reduction of the floodwater hazards and more favorable soil conditions will bring about this effect. Floodwaters from abnormal high direct precipitation and out-of-bank flow will be removed from the drainage area at a desired rate. Control of the water table during critical planting and harvest seasons will create soil moisture conditions contributive to seed germination, plant growth and the ability to get modern heavy machinery on the fields at desired times.

Crop yields will become more stable with the project installed. This effect will make conditions favorable for changing the agriculture of the watershed from basically cash grain production to livestock, dairy and truck crops. Sporadic crop production, as is presently experienced in the watershed, is a poor basis to establish dairy or beef herds. The reduction of floodwater damages and relief of agricultural water management problems will control the crop hazards which reduce crop production in years when abnormal precipitation occurs.

Reduced crop production costs, improved crop quality and some changes in land use will be some of the other effects of the works of improvement. The improved channels will make it practical to apply improved management and agronomic conservation practices to all of the openland. The effects will extend beyond the benefit area since the problem area is interspersed with soils lacking excess water hazards which are not practical to be treated separately. The total benefit area is 45,020 acres cropland and forestland.

The quality of crops grown on soils with water problems is usually sharply increased as a result of water control. This is reflected in reduced disease, less insect damage, better weed control and better curing. The grade of an entire farm's production will frequently be lowered by crops grown in the wet spots. This has been particularly significant in the

soybean markets of the peninsula.

Yields on the problem area are expected to become more stable resulting in higher average yields with the project. This yield increase is based on present day standards and goals. University of Delaware research agronomists have been able to produce more than 200 bushels of corn per acre. Predictions based on this research call for 200 bushel yields of corn being as common in the near future as 100 bushel yields are today. With the improved channel system installed, the watershed will be ready for the use of maximum fertilizer applications and improved seeds to produce the predicted high yields of corn as well as higher yields for other crops. Today it takes 60 bushels of corn per acre to break even. In the near future it may take well over 100 bushels to reach the break even point.

An effect of the works of improvement particularly significant in the Delaware portion of the watershed is the improved crop production. Such improvement is necessary in the western portion of the state to offset the loss of farmland to urban development in the northern and eastern portions. The increased production is necessary for the maintenance of many agriculturally oriented businesses in the area. The 1959 agricultural census shows a loss of land in farms from 1950 to 1959 of about 90,000 acres. Much of this acreage was devoted to small grain and corn. This trend of less land in farms is continuing. The losses of acreage of these crops in the highly productive areas will offset increases in crop production due to higher yields in this and similar projects.

The feed industry imports about 8 million bushels of corn annually to the Delmarva Peninsula. The increased production, expected in this watershed, is only about 5 percent of this deficit. Present production on the poorly drained areas in the watershed barely pays the cost of production in some years. Improved yields of all crops with the project will add some $2,500 to the annual gross income of each of the 400 farms.

Benefits from the works of improvement will not be limited to farm interests. Suppliers of goods and services used in the production and harvest of farm products will enjoy increased sales activities brought about by the improved soils conditions and increased crop production. Similarly the general public will benefit by maintenance of the tax base as a result

of higher land values with the project installed. The project installation will tend to encourage nonagricultural improvements in the watershed since water management problems are not limited to agriculture. The rural communities in the watershed will realize immediate benefits, incidental to the agricultural purposes of the project, by the disposal of excess waters. County and State roads will also enjoy similar incidental effects.

The fish and wildlife structure will provide 360 surface acres of water with an approximate maximum depth of 8 feet. The reservoir will be stocked with warm water sport fish by the Delaware Board of Game and Fish Commissioners. The structure will help relieve the demand for fresh water fishing areas which has developed with the expanding population. Delaware, though on or near vast expanses of tide water, has limited public facilities for fresh water sport fishing. Kent County, Delaware, in 1960 had 14.7 percent of the State's population with 65,651 persons. The County's population increased 73.4 percent between 1950 and 1960. The percent change due to net migration was 44.8 percent and 28.6 percent due to natural increase. This increased population with more leisure time has put great burden on public facilities in the State. This facility will help relieve this growing problem.

PROJECT BENEFITS

The project benefits include primary and local secondary benefits. Secondary benefits from the national viewpoint were not considered pertinent to the economic evaluation. The average annual benefits total $734,254 and are shown in Table 6.

Maintenance of the family farms through improved economic conditions of the farm families is the prime benefit to be realized from the project. The reduction of crop and pasture floodwater damages, more intensive land use and more efficient agricultural water management will increase the net farm incomes and provide an average annual primary benefit of $580,241 including $302,614 from flood prevention and $277,627 from agricultural water management.

Local secondary benefits stemming from the project and induced by the project total $83,713. The benefits stemming from the project $55,525 are based on the primary benefits and include the increased returns from the transportation, marketing and

processing of the increased farm production with the project. The secondary benefits induced by the project, $28,188, are from the net returns from the increased sale of farm production materials and services and the increased consumer expenditures by the farm families.

State and county road and bridge maintenance costs will be reduced by the reduction of floodwater and agricultural water management problems with the project installed. The monetary value of this benefit was not determined.

The monetary value of the benefits from the fish and wildlife structure is estimated to be $70,300 The 360 acre lake will be open to the public for fishing. The lake will provide habitat for warm water species of fish which will be stocked by the State Game Department Water based recreation will be enjoyed at the reservoir where facilities are made available. Such facilities will be compatible with the fish and wildlife purposes of the structure.

COMPARISON OF BENEFITS AND COSTS

The average annual project benefits total $734,254 including $650,541 primary benefits and $83,713 local secondary benefits. The total annual cost of the structural measures is $200,708. The ratio of annual primary benefits to annual costs is 3.2 to 1.0. The ratio of total annual benefits to annual costs is 3.7 to 1.0. The annual benefits and costs are shown in Table 6.

PROJECT INSTALLATION

General

The size, complexity, rate of construction and the dependence of the land treatment measures on the structural measures will require an extended installation period. It is estimated that the project will require ten years for its completion. This will require a continuing information program due to changes in land ownership and changes in the official make-up of the several agencies participating in the formulation and carrying out of the plan.

To assure understanding and continuing interest in the plan and its installation progress, the Extension Service of the

two States, will develop and carry out informational and educational programs. They will be assisted in this work by the other concerned agencies and the sponsors.

Land Treatment

The land treatment measures will be installed by landowners and operators under agreements with the several Soil Conservation Districts serving Kent, Caroline and Queen Anne's Counties.

The Soil Conservation Districts will provide evidence, prior to the installation of each structural measure, that will permit the Soil Conservation Service to determine that a high percentage of landowners and operators to be benefited by the structural measures will agree with the local organization to the development of basic plans.

The Soil Conservation Service will provide technical assistance in the preparation and application of basic farm plans. Such assistance will be provided through the going program of the districts and will be accelerated as needed to meet the project schedule.

The Delaware State Forestry Department and the Maryland Department of Forests and Parks in cooperation with the U. S. Forest Service will provide technical assistance in the preparation and application of forest management plans and the installation of forest land treatment measures. Such assistance on the lands of the watershed will be continued under Federal-State cooperative forestry programs and will be accelerated as needed to meet project schedules.

The County Agricultural Stabilization and Conservation Committees will provide cost-sharing assistance to farmers of the watershed in accordane with the provisions of the program in effect at the time assistance is requested. Consideration will be given to granting high priorities for farms in the watershed in order to accelerate the installation of land treatment measures.

The Farmers Home Administration will make financial assistance available to eligible landowners under the provisions of the Soil and Water Conservation Loan Program.

The Fish and Game Agencies of both States, with encouragement

and assistance from the U. S. Fish and Wildlife Service, will provide technical assistance under going programs for the improvement of wildlife habitat on the farms of the watershed. Special emphasis will be on the use of adapted seeds and plants on spoilbanks and berms of field ditches and treatment of odd areas created by realignment of drainage systems.

Land Rights

All necessary land, easements or rights of way for the multiple purpose channels will be acquired by Tax Ditches in Delaware and by Public Drainage Associations in Maryland. The necessary land, easements and rights of way for the fish and wildlife improvement will be acquired by the Delaware Soil and Water Conservation Commission.

Construction

In Delaware the local contracting organization for stream channel improvements will be the concerned Tax Ditch. The Delaware Soil and Water Conservation Commission may under certain circumstances serve as the local contracting organization. The preparation, award and administration of contracts for stream channel improvements will be under the direction of a contracting officer. The State Drainage Engineer will be assigned this function by the Delaware Soil and Water Commission upon request of the Tax Ditch.

In Maryland the local contracting organization for stream channel improvement will be the concerned Public Drainage Association. The preparation, award and administration of contracts will be under the direction of a contracting officer to be appointed by the Public Drainage Association.

Tax Ditches and Public Drainage Associations are eligible to use the equipment operated by the Soil Conservation Districts in Maryland and Delaware as well as equipment available through commercial channels. When it is economically advantageous to do so, the Tax Ditches or Public Drainage Associations may utilize the SCD equipment. Normally, construction performed using SCD equipment will be by contract although other methods such as equipment rental or force account may be considered if the conditions warrant it. Equipment currently owned and operated by the districts or its replacement equivalent will be used rather than new or additional equipment acquired primarily for this project.

Tax Ditches and Public Drainage Associations will be encouraged to accelerate the construction program through the use of private contractors. The broad authorities of the drainage organization are described in Chapter 41, Title 7 of the Delaware Code (1955) and Article 25 of the Annotated Code of Maryland (1957).

Underpinning of bridges will be done on a case basis. In Delaware, the Delaware Soil and Water Conservation Commission will assume this responsibility. In Maryland, the State Highway Department will become a sponsor, when it is firmly established that such works are required. The concerned agency may work through agreement with other state agencies for the advertisement, awarding and administration of contracts consistent with established precedent set in other projects within the two states.

The local sponsoring organizations have responsibilities under state laws for the formation of tax ditches and public drainage associations. The concerned sponsors in carrying out their obligations will advise the Boards of Viewers in Maryland and the County Boards of Ditch Commissioners in Delaware, that the channel system designated in the supplemental data is the basis for the estimate of PL 566 cost-sharing assistance.

Adequate allowances have been included in the estimates to make the necessary adjustments determined by the final surveys.

The State Drainage Engineers of both States in discharging their duties pertaining to the establishment of such organizations will provide the necessary coordination of channel layout in order to meet project objectives, maintain the basis of economic evaluation and assure establishment of the project essentially as presented in this plan. Assistance for such coordination will be provided by the local Soil Conservation Service Offices and the County Extension Agents as needed.

The Delaware Soil and Water Conservation Commission has authority to construct, operate and maintain the fish and wildlife improvement.

Installation Services

The Soil Conservation Service will provide engineering and other services to assist in the installation of the structural measures. Technicians will be provided to assist in the final surveys, design, supervision of construction, certification of payments and related duties for project installation. Services will also include assistance in the preparation of specifications for use by the local contracting organizations in the letting of contracts.

The local sponsoring organizations will bear all costs associated with the letting and administering of the contracts including the services of a local contracting officer.

FINANCING PROJECT INSTALLATION

Land Treatment Measures

Landowners and operators will bear the cost of installing land treatment measures. Limited financial and other assistance is currently available to eligible landowners and operators under other State and Federal programs. It is expected that these or similar programs will continue. Cost-sharing assistance for most of the measures is offered by the County Agricultural Stabilization and Conservation Committees. Loans are available for soil and water conservation purposes from the Farmers Home Administration. Low cost or free plant materials are furnished by State agencies to cooperating landowners and operators for forestry and wildlife purposes.

The technical assistance to forest landowners will cost $47,800, of which $23,900 will be provided under authority of PL 566, $19,000 will be provided by the Delaware State Forestry Department, and $4,900 will be provided by the Maryland Department of Forests and Parks.

Structural Measures

A substantial part of the costs of the structural measures must be borne by non-Federal sources. These include 25 percent of the contract cost of the multiple purpose channels and appurtenances, 50% of the construction cost of the fish and wildlife measures, 100 percent of the cost of land,easements and rights of way including relocation of facilities,

and 100 percent of the cost of administering contracts.

In Maryland, the County Commissioners or the Public Drainage Associations will provide the local share of the contract costs. Both organizations have adequate taxing authority and a long history of cooperation in similar construction efforts. The Public Drainage Associations will provide all needed land rights and will also arrange for needed contract administration for the multiple purpose channels in Caroline and Queen Anne's Counties.

In Delaware, the Delaware Soil and Water Conservation Commission will bear the local share of construction costs. Funds for such costs will be provided by the sale of bonds by the State of Delaware in accordance with an act of Legislature in 1961, or may be provided through other sources available to the Commission.

In Delaware, the Tax Ditches, to be formed, will provide all needed land, easements and rights of way through their organizational procedure which, in effect, is a condemnation procedure for rights of way as well as a procedure for establishing taxing authority. Tax Ditches may call on the office of the State Drainag e Engineer for such services as are needed for the administration of the affairs of the Tax Ditch including the advertising, awarding and supervision of contracts.

Public Law 566 funds will provide 75 percent of the construction cost of the multiple purpose channels, 50% of the construction cost of the fish and wildlife measure and 100 percent of the installation services cost.

Federal assistance to the local organizations is contingent upon approval of the plan by the States, the Soil Conservation Service and the Congress. This work plan does not constitute a financial document for the obligation of Federal funds. Financial and other assistance to be furnished by the Soil Conservation Service in carrying out the Watershed Work Plan is contingent upon the annual appropriation of funds for the installation of watershed protection and flood prevention projects.

PROVISIONS FOR OPERATIONS AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be operated and maintained by the landowners and operators of the farms on which the measures will be installed. The Soil Conservation Service, in cooperation with the Soil Conservation Districts, will assist the landowners and operators with inspections of the land treatment measures to determine maintenance needs and will provide technical assistance to the landowners for performing the needed maintenance. Technical assistance will be provided by the Delaware State Forestry Department and the Maryland Department of Forests and Parks through the going Cooperative Forest Management Program, in cooperation with the U. S. Forest Service for the maintenance of the forest land treatment measures.

Structural Measures

The multiple purpose channels will be maintained by the Tax Ditches and the Public Drainage Associations to be formed as part of the project. The officers of these organizations are assigned this responsibility by the State Law under which they will be established. Funds for operations and maintenance will be obtained from taxes levied for this purpose. The estimated long-term cost of operations and maintenance of the multiple purpose channels is $28,029.

The cost of such maintenance is estimated to be 2 percent of the construction cost converted to long term prices. The 2 percent factor is an established basis for estimating the operation and maintenance costs for this type of channel.

Technical services and plant materials will be furnished by the game and fish agencies of Delaware and Maryland for the planting of spoil banks, berms and ditch banks. Such plantings, not required as part of the structural measures, will contribute to lowered maintenance costs and improve game habitat.

Specific operations and maintenance agreements will be executed by the responsible sponsor and the Soil Conservation Service prior to the issuance of invitations to bid for structural measures contracts. Such maintenance agreements will include but not be limited to the following:

1. Remove and dispose of debris
2. Repair or replace defective culverts
3. Cut and mow to control vegetative growth on ditch banks and maintenance roads
4. Remove all bars caused by deposition or sloughing
5. Complete other maintenance work as indicated in the annual inspection reports

The fish and wildlife structure will be operated and maintained by the Delaware Soil and Water Conservation Commission. The estimated annual cost of operations and maintenance of the structure is $839. These costs include mowing, debris removal and repairing the structure.

The sponsors or co-sponsors will be responsible for annual inspections of the structural measures to determine maintenance needs. More frequent inspections will be made if unusual conditions occur. A record of all maintenance inspections will be maintained.

The Soil Conservation Service will take part in the annual maintenance inspections. Technical assistance will be provided by the Service to aid in the inspections and furnish technical design information necessary for the maintenance program. Federal inspections of the structures will be made with representatives of the local organizations, if possible, however, separate inspections may be made if necessary.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS

Upper Choptank River Watershed
Delaware and Maryland

Installation Cost Item	Unit	Number Non-Fed Land	Estimated Cost (Dollars) 1/ PL 566 Funds	Other Funds	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acres	11,000		242,550	242,550
Grassland	Acres	2,350		65,800	65,800
Technical Assistance			105,400	82,200	187,600
SCS Subtotal			105,400	390,550	495,950
Forest Service					
Forest Land	Acres	2,570		45,700	45,700
Technical Assistance			23,900	23,900	47,800
FS Subtotal			23,900	69,600	93,500
TOTAL LAND TREATMENT			129,300	460,150	589,450
STRUCTURAL MEASURES					
Soil Conservation Service					
Stream Channel Improvement	Miles	280	1,252,800	417,600	1,670,400
Fish & Wildlife Structure	No	1	519,500	519,500	1,039,000
Subtotal Construction			1,772,300	937,100	2,709,400
Installation Services					
Soil Conservation Service					
Engineering Services			895,200		895,200
Other			248,500		248,500
Subtotal Installation Services			1,143,700		1,143,700
Other Costs					
Land, Easement & Rights of Way				397,900	397,900
Administration of Contracts				67,700	67,700
Subtotal Other				465,600	465,600
TOTAL STRUCTURAL MEASURES			2,916,000	1,402,700	4,318,700
TOTAL PROJECT			3,045,300	1,862,850	4,908,150
SUMMARY					
Subtotal SCS			3,021,400	1,793,250	4,814,650
Subtotal FS			23,900	69,600	93,500
TOTAL PROJECT			3,045,300	1,862,850	4,908,150

1/ Price Base 1963

May, 1965

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(At Time of Work Plan Preparation)

Upper Choptank River Watershed, Delaware & Maryland

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Soil Conservation Service			
Conservation Cropping System	Ac.	8,137	
Cover Crop	Ac.	5,000	35,000
Crop Residue Use	Ac.	3,664	12,824
Land Smoothing	Ac.	2	200
Mains and Laterals	Lin.Ft.	623,874	311,937
Forest Service			
Tree Planting	Ac.	47	1,800
Hydrologic Cultural Operations	Ac.	337	6,600
STRUCTURAL MEASURES			
Stream Channel Improvement	Lin.Ft.	148,951	112,400
Total	xxx	xxx	480,761

1/ Price Base 1963

May, 1965

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Upper Choptank River Watershed, Delaware & Maryland

(Dollars) 1/

Structure Number	Installation Cost - PL-566 Funds				Installation Cost - Other Funds				
		Installation Services				Other			
	Construction	Engineering	Other	Total PL-566	Construction	Administration of Contracts	Land Easements R.O.W. 2/	Total Other	Total Installation Cost
Tappahanna #1	498,525	258,600	77,600	834,725	166,175	26,600	79,800	272,575	1,107,300
Culbreth Marsh #2	242,700	166,500	38,800	448,000	80,900	12,900	40,100	133,900	581,900
Cow Marsh #3	381,825	263,000	61,000	705,825	127,275	20,400	80,800	228,475	934,300
Smith Leslie #4	12,075	10,000	2,000	24,075	4,025	600	2,300	6,925	31,000
Cool Spring #5	53,250	39,200	8,600	101,050	17,750	2,800	10,900	31,450	132,500
Henderson #6	40,050	28,400	6,500	74,950	13,350	2,100	8,500	23,950	98,900
Minor Tribs. of Main #7	24,375	19,300	4,000	47,675	8,125	1,300	5,500	14,925	62,600
Fish & Wildlife Structure	519,500	110,200	50,000	679,700	519,500	1,000	170,000	690,500	1,370,200
GRAND TOTAL	1,772,300	895,200	248,500	2,916,000	937,100	67,700	397,900	1,402,700	4,318,700

1/ Price Base 1963

2/ Includes $25,600 estimated cost of alterations to existing road pipes and culverts.

May. 1965

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Upper Choptank River Watershed, Delaware & Maryland

(Dollars) 1/

Item	Purpose: Flood Prevention	Ag. Water Management	Fish & Wildlife	Total
COST ALLOCATION				
Single Purpose Structure			1,370,200	1,370,200
Multiple Purpose Stream Channel Improv.	1,474,250	1,474,250	-	2,948,500
Total	1,474,250	1,474,250	1,370,200	4,318,700
COST SHARING				
PL 566	1,326,950	909,350	679,700	2,916,000
Other	147,300	564,900	690,500	1,402,700
Total	1,474,250	1,474,250	1,370,200	4,318,700

1/ Price Base 1963

May, 1965

TABLE 3 - STRUCTURE DATA

Channels

Upper Choptank Watershed, Delaware and Maryland

Unit	Channel Designation	Sta. Numbering For Reach Station	Station	Watershed Area (sq. mi.)	Required Drainage Curve	Required Drainage Capacity (cfs)	Planned Drainage Capacity (cfs)	Average Bottom Width (ft.)	Average Side Slope	Average Depth 1/ (ft)	Average Grade (pct)	Average Velocity (fps)	Volume of Excavation (1000 cy)
1 A	Tappahanna	307+00	340+00		Clearing, Snagging, and Bar Removal								
		340+00	384+00	17.3	C	391	392	26	1:1	5.4	.045	2.3	33.2
		384+00	427+00	16.1	C	371	379	26	1:1	5.5	.040	2.2	33.7
		427+00	440+00	15.4	C	360	361	17	1:1	5.5	.082	2.9	7.4
		440+00	477+00	13.8	C	328	329	17	1:1	5.2	.082	2.8	21.8
		477+00	508+00	13.0	C	315	316	17	1:1	5.1	.082	2.8	18.2
		508+00	526+00	6.0	C	162	161	10	1:1	4.8	.065	2.3	6.6
		526+00	587+00	5.8	C	158	160	10	1:1	4.3	.100	2.6	22.8
		587+00	590+00	4.2	C	124	130	7	1:1	4.5	.100	2.5	0.9
		590+00	598+00	3.2	C	104	104	7	1:1	4.5	.062	2.0	2.4
		598+00	620+00	3.2	C	104	103	7	1:1	5.0	.040	1.7	6.1
		620+00	671+00	2.9	C	63	67	7	1:1	5.0	.018	1.1	14.4
		671+00	686+00	0.8	C	39	61	4	1:1	4.0	.100	1.9	3.1
		686+00	724+00	0.5	C	29	30	4	1:1	2.8	.095	1.6	5.6
1 B	Unnamed	28+00	41+00	0.7	C	35	38	6	1:1	2.4	.152	1.9	1.6
		41+00	44+00	0.7	C	33	35	5	1:1	4.0	.025	1.0	0.7
		44+00	72+00	0.6	C	32	35	4	1:1	2.6	.179	2.0	5.0
		72+00	87+00	0.2	C	16		4	1:1	2.0	.103	1.3	1.4
1 C	Harrington Beaverdam	0+00	13+00	8.7	C	223	220	20	1:1	5.2	.027	1.7	7.4
		13+00	33+00	8.7	C	223	231	14	1:1	5.0	.065	2.4	9.1
		33+00	42+00	8.1	C	211	214	13	1:1	5.0	.065	2.4	3.6
		42+00	65+00	8.0	C	207	214	13	1:1	5.0	.065	2.4	13.1
		65+00	86+10	7.6	C	205	201	10	1:1	5.0	.089	2.7	9.3
		86+10	102+50	4.9	C	155	157	9	1:1	5.0	.065	2.2	6.0
		102+50	144+68	2.6	C	83	91	4	1:1	4.5	.136	2.4	11.0
		144+68	160+73	1.9	C	66	68	4	1:1	4.0	.126	2.1	3.6
		160+73	170+73	1.9	C	66	97	4	1:1	3.8	.320	3.3	1.7
		170+73	212+73	1.4	C	51	51	4	1:1	3.8	.086	1.7	7.0
		212+73	233+73	0.4	C	23	23	4	1:1	2.6	.076	1.3	2.6
	Tributary 3	0+00	20+00	0.9	C	41	56	4	1:1	2.9	.312	2.8	4.1
		20+00	55+00	0.9	C	40	42	4	1:1	2.8	.199	2.2	6.2
	Tributary 5	0+00	33+00	1.3	C	50	82	6	1:1	3.5	.170	2.5	9.0
		33+00	60+00	1.0	C	50	48	6	1:1	3.6	.050	1.4	7.2
		60+00	92+00	0.8	C	50	50	6	1:1	3.7	.050	1.4	8.5
		92+00	96+00	0.2	C	11	11	4	1:1	2.0	.050	1.0	0.7

1/ Depths shown are minimum design depths and do not reflect construction depth - Minimum construction depth is 3.0 feet.

TABLE 3 - STRUCTURE DATA

Channels

Upper Choptank Watershed, Delaware and Maryland

Unit	Channel Designation	Sta. Numbering For Reach Station	Station	Watershed Area (sq mi)	Required Drainage Curve	Required Drainage Capacity (cfs)	Planned Drainage Capacity (cfs)	Average Bottom Width (ft)	Average Side Slope	Average Depth 1/ (ft)	Average Grade (pct)	Average Velocity (fps)	Volume of Excavation (1000 cy)
1	Tappahanna (cont)	0+00	9+00	5.5	C	159	167	11	1:1	5.1	.050	2.0	3.7
		9+00	25+00	5.5	C	159	161	7	1:1	5.0	.099	2.7	5.0
	Tributary 6	25+00	58+00	4.0	C	116	115	6	1:1	4.8	.073	2.2	9.0
		58+00	80+00	2.1	C	86	87	4	1:1	4.8	.096	2.0	4.8
		80+00	102+00	1.1	C	44	44	4	1:1	3.4	.102	1.8	3.8
		102+00	125+00	0.9	C	40	44	4	1:1	3.2	.128	1.9	3.2
	Subtributary 1	0+00	20+00	1.5	C	54	71	7	1:1	4.2	.050	1.5	6.5
		20+00	82+00	1.4	C	51	53	7	1:1	3.2	.076	1.6	19.7
	Subtributary 2	0+00	65+00	1.3	C	49	49	8	1:1	3.2	.050	1.4	16.6
	Subtributary 3	0+00	70+00	1.0	C	42	43	5	1:1	3.7	.050	1.3	15.0
	Tributary 7	0+00	30+00	1.0	C	47	46	17	1:1	2.7	.019	0.9	11.6
		30+00	55+00	0.3	C	20	21	8	1:1	2.7	.017	0.7	4.0
	Tributary 8	0+00	75+00	1.0	C	44	43	16	1:1	3.0	.013	0.8	29.2
2	Culbreth Marsh	0+00	29+03	18.3	C	414	425	32	1:1	6.6	.035	1.7	17.9
		29+03	77+67	18.1	C	392	393	23	1:1	5.7	.035	2.4	25.6
		77+67	108+24	16.5	C	357	357	23	1:1	5.4	.035	2.3	11.3
		108+24	134+30	15.4	C	321	325	17	1:1	5.2	.079	2.8	16.5
		134+30	161+66	13.2	C	303	309	16	1:1	5.2	.079	2.8	8.2
		161+66	181+35	12.5	C	295	309	16	1:1	5.2	.079	2.8	4.8
		181+35	203+72	12.1	C	244	255	13	1:1	5.2	.079	2.7	2.5
		203+72	224+82	9.7	C	207	220	12	1:1	5.0	.079	2.6	5.2
		224+82	234+90	7.4	C	200	204	12	1:1	5.1	.062	2.3	3.1
		234+90	272+35	6.8	C	138	145	11	1:1	4.4	.062	2.1	9.0
		272+35	315+26	4.2	C	55	70	6	1:1	4.2	.062	1.6	7.3
		315+26	368+20	1.5	C	40	41	6	1:1	4.1	.024	1.0	5.8
		368+20	398+57	0.9	C	33	33	6	1:1	3.6	.024	1.0	6.2
		398+57	413+46	0.6	C	20	23	6	1:1	3.0	.024	0.9	3.4
		413+46	458+96	0.3	C	20	26	4	1:1	3.0	.057	1.2	7.5
	Grey Prong	0+00	42+07	0.7	C	36	36	9	1:1	1.6	.025	2.1	13.3
		42+07	54+31	0.4	C	26	26	9	1:1	1.6	.130	1.5	3.4
		54+31	82+00	0.2	C	12	12	4	1:1	1.6	.130	1.4	5.1

1/ Depths shown are minimum design depths and do not reflect construction depth - Minimum construction depth is 3.0 feet.

TABLE 3 - STRUCTURE DATA

Channels

Upper Choptank Watershed, Delaware and Maryland

Unit	Channel Designation	Sta. Numbering For Reach Station	Station	Watershed Area (sq mi)	Required Drainage Curve	Required Drainage Capacity (cfs)	Planned Drainage Capacity (cfs)	Average Bottom Width (ft)	Average Side Slope	Average Depth 1/ (ft)	Average Grade (pct)	Average Velocity (fps)	Volume of Excavation (1000 cy)
2	Culbreth Marsh (Cont)												
	Melton Prong	0+00	36+00	0.7	C	36	48	4	1:1	2.6	.339	2.8	12.2
		36+00	42+37	0.4	C	25	23	4	1:1	2.6	.080	1.4	0.9
		42+37	48+41	0.4	C	25	23	4	1:1	2.6	.074	1.3	0.9
		48+41	77+85	0.4	C	23	24	4	1:1	2.7	.075	1.3	5.3
		77+85	85+65	0.1	C	9	28	4	1:1	2.9	.076	1.4	1.0
		0+00	10+25	1.8	C	63	85	7	1:1	2.9	.271	3.0	3.1
		10+25	17+62	1.8	C	63	67	7	1:1	2.9	.170	2.3	1.4
		17+62	50+00	1.6	C	13	19	4	1:1	1.9	.170	1.7	4.7
		50+00	104+00	0.2	C	13	14	4	1:1	1.9	.090	1.3	7.7
	Golden Prong	0+00	27+42	1.9	C	70	169	7	1:1	4.6	.200	3.2	8.9
		27+42	50+00	1.8	C	70	70	7	1:1	4.7	.032	1.3	6.5
		50+00	68+81	1.5	C	70	73	7	1:1	3.7	.083	1.8	5.3
		68+81	107+00	1.4	C	27	31	4	1:1	3.0	.083	1.5	8.2
		107+00	130+00	0.4	C	23	24	4	1:1	3.0	.048	1.2	3.0
		130+00	149+49	0.1	C	8	28	4	1:1	2.4	.150	1.8	2.2
	Luther-Marvel Prong	0+00	48+33	1.7	C	69	107	8	1:1	3.9	.120	2.3	16.4
		48+33	59+83	1.3	C	69	71	8	1:1	3.7	.062	1.6	3.2
		59+83	122+61	1.3	C	39	38	6	1:1	3.0	.062	1.4	14.0
		122+61	148+21	0.1	C	10	20	4	1:1	3.0	.033	1.0	4.3
	Beachy-Neidig Prong	0+00	12+50	2.4	C	76	111	7	1:1	4.2	.120	2.4	4.1
		12+50	71+00	2.4	C	65	65	7	1:1	4.1	.045	1.4	18.7
		71+00	80+81	1.5	C	44	65	7	1:1	4.1	.045	1.4	2.8
		80+81	119+54	1.0	C	38	63	7	1:1	4.0	.045	1.4	11.3
		119+54	135+80	0.8	C	35	35	7	1:1	4.0	.014	0.8	4.2
		135+80	174+82	0.7	C	29	29	7	1:1	3.6	.014	0.8	9.7
		174+82	210+94	0.4	C	16	21	4	1:1	3.0	.035	1.0	7.0
	Ditch Road Ditch	0+00	44+78	2.4	C	80	92	11	1:1	3.9	.050	1.6	17.5
		44+78	70+50	2.1	C	80	80	11	1:1	3.6	.050	1.5	9.0
		70+50	88+83	1.7	C	37	38	7	1:1	3.0	.050	1.3	6.5
		88+83	160+34	0.7	C	37	37	4	1:1	3.0	.060	1.3	12.8

1/ Depths shown are minimum design depths and do not reflect construction depth - Minimum construction depth is 3.0 feet.

TABLE 3 - STRUCTURE DATA

Channels

Upper Choptank Watershed, Delaware and Maryland

Unit	Channel Designation	Sta. Numbering For Reach Station	Sta. Numbering For Reach Station	Watershed Area (sq mi)	Required Drainage Curve	Required Drainage Capacity (cfs)	Planned Drainage Capacity (cfs)	Average Bottom Width (ft)	Average Side Slope	Average Depth 1/ (ft)	Average Grade (pct)	Average Velocity (fps)	Volume of Excavation (1000 cy)
2	Culbreth Marsh (Cont)												
	Powell Prong	0+00	34-79	0.9	C	41	50	8	1:1	3.0	.070	1.5	8.9
		34+79	107+10	0.7	C	37	38	8	1:1	3.0	.040	1.2	14.7
3	Cow Marsh	163+00	168+00	20.2	C	449	456	30	1:1	5.1	.074	2.5	3.3
		168+00	176+00	20.2	C	449	448	30	1:1	5.2	.037	2.4	4.0
		176+00	200+00	19.4	C	435	443	30	1:1	5.2	.037	2.4	15.6
		200+00	214+00	18.7	C	435	442	26	1:1	5.6	.037	2.5	6.8
		214+00	242+00	18.2	C	435	438	22	1:1	5.2	.089	3.1	12.7
		242+00	258+00	11.7	C	285	285	18	1:1	4.8	.078	2.7	7.6
		258+00	263+00	10.9	C	268	267	18	1:1	4.8	.068	2.6	2.5
		263+00	283+00	10.9	C	268	280	18	1:1	4.8	.070	2.6	10.7
		283+00	302+00	10.0	C	258	273	18	1:1	4.9	.062	2.4	10.1
		302+00	324+00	9.6	C	258	265	18	1:1	4.8	.062	2.4	11.3
		324+00	329+00	5.5	C	153	160	15	1:1	4.5	.040	1.8	2.1
		329+00	352+00	5.5	C	152	158	15	1:1	4.4	.043	1.8	10.3
		352+00	368+00	4.6	C	131	128	12	1:1	4.4	.042	1.8	7.3
		368+00	394+00	3.4	C	110	108	12	1:1	4.0	.042	1.7	12.1
		394+00	430+00	1.8	C	61	64	8	1:1	3.9	.042	1.4	11.2
		430+00	447+00	1.3	C	50	48	6	1:1	3.8	.042	1.3	3.9
		447+00	462+00	1.0	C	45	48	6	1:1	3.8	.042	1.3	3.1
		462+00	470+00	1.0	C	45	44	6	1:1	3.6	.043	1.3	1.5
		470+00	507+00	0.6	C	33	32	4	1:1	3.6	.043	1.2	5.0
		507+00	544+00	0.3	C	22	26	4	1:1	3.2	.043	1.1	4.9
	Sandtown Ditch	36+00	41+00	0.8	C	39	39	5	1:1	2.0	.410	2.8	0.4
		41+00	47+00	0.7	C	35	40	4	1:1	3.5	.075	1.5	0.9
		47+00	76+00	0.6	C	32	33	4	1:1	2.4	.210	2.1	4.8
	Tributary 2	5+00	10+00	0.7	C	36	38	4	1:1	3.0	.124	1.8	0.6
		10+00	23+00	0.3	C	18	24	4	1:1	1.5	.627	2.9	1.9
	Meredith Branch	70+00	92+00	5.2	C	146	149	11	1:1	4.0	.122	2.5	6.5
		92+00	116+00	3.7	C	121	131	10	1:1	3.9	.122	2.4	6.7
		116+00	126+00	2.2	C	70	72	10	1:1	3.2	.075	1.7	2.6
		126+00	156+00	2.1	C	68	68	10	1:1	3.1	.075	1.7	7.1
		156+00	171+00	1.6	C	59	59	9	1:1	3.0	.075	1.6	2.9
		171+00	187+00	1.5	C	59	59	9	1:1	3.0	.075	1.6	3.3
		187+00	226+00	1.0	C	49	51	7	1:1	3.0	.088	1.7	6.8
		226+00	273-00	0.3	C	20	28	4	1:1	2.8	.088	1.5	5.9

1/ Depths shown are minimum design depths and do not reflect construction depth - Minimum construction depth is 3.0 feet.

TABLE 3 - STRUCTURE DATA

Channels

Upper Choptank Watershed, Delaware and Maryland

Unit	Channel	Sta. Numbering For Reach		Watershed Area	Required Drainage Curve	Required Drainage Capacity (cfs)	Planned Draingge Capacity (cfs)	Average Bottom Width (ft)	Average Side Slope	Average Depth 1/ (ft)	Average Grade (pct)	Average Velocity (fps)	Volume of Excavation (1000 cy)
3	Cow Marsh (Cont)												
	Meredith Branch (Cont)												
	Tributary 1	0+00	23+00	1.4	C	52	63	4	1:1	3.9	.120	2.0	3.9
		23+00	39+00	1.3	C	49	49	4	1:1	3.6	.100	1.8	2.7
	Wildcat Branch	40+00	48+00	1.6	C	76	78	6	1:1	3.4	.168	2.4	1.0
		48+00	64+00	1.6	C	76	79	6	1:1	3.2	.213	2.7	1.8
		64+00	71+00	1.6	C	76	76	6	1:1	3.0	.250	2.8	1.2
		71+00	114+00	0.7	C	35	35	5	1:1	3.0	.072	1.4	6.1
		114+00	158+00	0.4	C	24	27	4	1:1	2.8	.080	1.4	5.2
	Tributary 1	0+00	7+00	0.9	C	41	42	9	1:1	2.8	.050	1.3	1.3
		7+00	27+00	0.8	C	39	38	6	1:1	2.5	.125	1.8	2.8
	Horse Pen Ditch	0+00	19+00	1.3	C	49	52	9	1:1	2.3	.150	2.0	4.5
		19+00	36+00	1.0	C	43	52	9	1:1	2.3	.150	2.0	4.2
		36+00	62+00	0.9	C	41	41	8	1:1	2.9	.050	1.3	7.0
		62+00	119+00	0.7	C	36	37	7	1:1	2.9	.050	1.3	12.0
	Iron Mine	0+00	17+00	6.0	C	164	172	8	1:1	4.7	.118	2.9	4.7
		17+00	22+00	5.7	C	158	160	8	1:1	4.7	.102	2.7	1.5
		22+00	42+00	5.7	C	157	160	8	1:1	4.7	.102	2.7	6.2
		42+00	52+00	5.4	C	150	153	8	1:1	4.6	.102	2.6	3.1
		52+00	65+00	5.2	C	144	147	8	1:1	4.5	.102	2.6	3.8
		65+00	81+00	4.7	C	134	133	7	1:1	4.5	.102	2.6	4.4
		81+00	82+00	3.6	C	107	107	7	1:1	4.5	.066	2.1	0.3
		82+00	97+50	3.6	C	107	107	7	1:1	4.5	.066	2.1	4.0
		97+50	109+00	3.1	C	100	103	7	1:1	4.4	.066	2.0	2.9
		109+00	142+00	2.1	C	71	75	7	1:1	4.0	.066	1.7	7.9
		142+00	158+00	1.5	C	71	72	7	1:1	3.9	.066	1.7	3.8
		158+00	171+50	0.7	C	35	42	4	1:1	3.8	.059	1.4	2.2
		171+50	185+00	0.5	C	29	32	4	1:1	3.3	.059	1.3	1.9
		185+00	198+50	0.3	C	22	23	4	1:1	2.8	.059	1.2	1.6
		198+50	212+00	0.2	C	12	15	4	1:1	2.2	.059	1.1	1.3

1/ Depths shown are minimum design depths and do not reflect construction depth - Minimum construction depth is 3.0 feet.

TABLE 3 - STRUCTURE DATA

Channels

Upper Choptank Watershed, Delaware and Maryland

Unit	Channel Designation	Sta. Numbering For Reach Station	Sta. Numbering For Reach Station	Watershed Area (sq mi)	Required Drainage Curve	Required Drainage Capacity (cfs)	Planned Drainage Capacity (cfs)	Average Bottom Width (ft)	Average Side Slope	Average Depth 1/ (ft)	Average Grade (pct)	Average Velocity (fps)	Volume of Excavation (1000 cy)
3	Cow Marsh (Cont)												
	Iron Mine (Cont)												
	Tributary 1	0+00	56+00	0.9	C	40	41	4	1:1	3.7	.062	1.4	10.5
		56+00	79+00	0.5	C	28	28	4	1:1	3.0	.062	1.3	3.1
	Willow Grove	0+00	9+00	3.6	C	106	113	10	1:1	4.2	.069	1.9	2.9
		9+00	34+00	3.1	C	94	99	10	1:1	3.9	.069	1.8	7.9
		34+00	37+00	3.0	C	91	95	10	1:1	3.8	.069	1.8	1.0
		37+00	45+00	3.0	C	91	95	10	1:1	3.8	.069	1.8	2.3
		45+00	59+50	2.3	C	73	70	10	1:1	3.8	.037	1.3	3.8
		59+50	63+00	2.1	C	73	70	10	1:1	3.8	.037	1.3	0.9
		63+00	100+00	1.6	C	59	64	9	1:1	3.8	.037	1.3	9.1
		100+00	123+00	0.8	C	39	41	6	1:1	3.6	.037	1.2	4.4
		123+00	141+00	0.7	C	37	36	6	1:1	3.0	.056	1.3	3.2
		141+00	162+00	0.5	C	29	30	6	1:1	3.0	.038	1.1	3.1
		162+00	188+00	0.2	C	11	11	4	1:1	2.2	.030	0.8	2.5
	Tributary 4	0+00	34+00	1.1	C	44	46	4	1:1	3.8	.070	1.6	7.5
		34+00	66+00	0.8	C	39	41	4	1:1	3.8	.055	1.4	6.2
		66+00	100+00	0.4	C	24	24	4	1:1	3.0	.050	1.2	5.6
	Heron Drain	0+00	20+00	1.3	C	49	51	8	1:1	3.2	.055	1.4	6.1
		20+00	87+00	1.1	C	46	48	7	1:1	3.3	.055	1.4	14.1
4	Smith Leslie	25+00	27+00		Clearing, Snagging and Bar Removal								
		27+00	37+50	0.3	C	18	20	4	1:1	1.7	.275	2.1	0.9
		37+50	51+00	0.2	C	15	21	4	1:1	2.0	.173	1.8	1.2
		51+00	67+00	0.2	C	14	25	4	1:1	2.0	.250	2.1	1.4
5	Cool Spring	20+00	57+00		Clearing, Snagging and Bar Removal								
		57+00	73+50	1.8	C	61	61	6	1:1	2.9	.185	2.4	2.5
		73+50	85+00	1.6	C	58	67	5	1:1	3.0	.265	2.8	2.3
		85+00	103+00	1.4	C	51	51	5	1:1	4.0	.050	1.4	4.1
		103+00	120+00	1.0	C	44	45	5	1:1	3.2	.094	1.7	2.8
6	Henderson	36+00	93+00		Clearing, Snagging and Bar Removal								
		93+00	140+00	0.9	C	41	41	10	1:1	1.8	.180	1.9	15.6

1/ Depths shown are minimum design depths and do not reflect construction depth - Minimum construction depth is 3.0 feet.

USDA-SCS-HYATTSVILLE, MD. 1966

TABLE 3A - STRUCTURAL MEASURES DATA

Fish and Wildlife Improvement

Upper Choptank Watershed, Delaware

Item	Unit	Site
Drainage Area	Sq. Mi.	87.93
Storage Capacity		
Sediment	Ac. Ft.	217
Fish and Wildlife (1)	Ac. Ft.	4,781
Total	Ac. Ft.	4,998
Surface Area		
Fish and Wildlife (5)	Acre	360
Volume of Fill	Cu. Yd.	136,000
Elevation of Top of Dam	Ft.-MSL	45.4
Maximum Height of Dam	Ft.	25.4
Principal Spillway		
Crest Elevation	Ft.-MSL	30.0
Width	Ft.	300
Type		Drop
Emergency Spillway		
Crest Elevation	Ft.-MSL	38.0
Bottom Width	Ft.	300
Type		Grass
Percent of Chance of Use		Less than 1%
Average Curve No. Cond. II		78
Design Hydrograph (2)		
Storm Rainfall	Inches	11.32
Storm Runoff	Inches	8.54
Discharge Rate (3)	cfs	30,200
Velocity of Flow	fps	5.2
Maximum W. S. Elev.	Ft.-MSL	41.7
Freeboard Hydrograph (2)		
Storm Rainfall	Inches	19.50
Storm Runoff	Inches	16.49
Discharge Rate (3)	cfs	58,300
Velocity of Flow	fps	7.1
Maximum W. S. Elev.	Ft.-MSL	45.4
Principal Spillway Capacity (4)	cfs	26,000
Emergency Spillway Capacity (4)	cfs	4,200
Capacity Equivalents		
Sediment Volume	Inches	0.04
Fish and Wildlife (1)	Inches	1.01
Class of Structure		A

(1) Includes 3,630 Ac. Ft. or 0.77 inches of temporary storage.

(2) Applies to both principal and emergency spillways.

(3) Combined Flow, also peak flow.

(4) Design storm.

(5) Permanent pool level.

May, 1965

TABLE 4 - ANNUAL COST

Upper Choptank River Watershed, Delaware & Maryland

(Dollars)

Evaluation Unit	Amortization of 1/ Installation Cost 2/	Operations and Maintenance Cost 3/	Total
Stream Channel Improvement	117,320	28,029	145,349
Fish and Wildlife Structure	54,520	839	55,359
TOTAL	171,840	28,868	200,708

1/ Price Base 1963
2/ Amortized at 3 1/8% for 50 years
3/ Price Base Long Term (ARS)

May, 1965

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE BENEFITS

Upper Choptank River Watershed, Delaware and Maryland

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	403,030	153,165	249,865
Indirect	40,303	15,317	24,986
TOTAL	443,333	168,482	274,851

1/ Price Base Long Term (ARS)

May, 1965

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Upper Choptank River Watershed, Delaware and Maryland

(Dollars) 1/

Evaluation Unit	Average Annual Benefits						Average Annual Cost	Benefit Cost Ratio
	Flood Prevention Damage Reduction	Flood Prevention More Intensive Land Use	Av.Water Mgt. Improved Efficiency 2/	Non-Ag.Water Mgt. Fish & Wildlife	Local Secondary 3/	TOTAL		
Stream Channel Improv.	274,851	27,763	277,627		83,713	663,954	145,349	4.6 to 1.0
Fish & Wildlife Str.				70,300		70,300	55,359	1.3 to 1.0
TOTAL	274,851	27,763	277,627	70,300	83,713	734,254	200,708	3.7 to 1.0

1/ Price Base: Benefits Long Term (ARS); Costs 1963
2/ Represents reduced production costs, improved quality plus increases in production.
3/ Secondary benefits from national viewpoint were not considered in economic evaluation.

May, 1965

TABLE 7 - CONSTRUCTION UNITS

Upper Choptank River Watershed

(Dollars)

Measures in Construction Unit	Annual Benefits	Annual Cost
#1	179,622	55,214
#2	135,935	28,584
#3	224,801	45,719
#4	3,394	1,504
#5	28,679	6,463
#6	27,997	4,831
#7	15,027	3,036

May, 1965

INVESTIGATIONS AND ANALYSIS

Hydrology

Stream channel hydraulics for natural channels was computed by the method given in part 4.1 of the U. S. Soil Conservation Service National Engineering Handbook Section 4A. These back water curves provided a basis for points of beginning of the multiple purpose channels and tail water information for the proposed fish and wildlife lake.

Hydrographs were computed for the 100 year and 5 year events. These were routed through the various reaches by Wilson's method. Times of concentration were computed by sub watershed areas of Cow Marsh by stream channel hydraulics. From these computations a correlation was found between slope and velocity. This relationship was used to determine time of concentration for the remaining sub areas.

As a part of the feasibility study for the proposed fish and wildlife pond, design and overtopping hydrographs were computed.

Engineering (Multiple Purpose Channels)

A bench level net of third order accuracy was established throughout the watershed. Valley sections were surveyed starting at a stream gage at Greensboro and extending upstream to points on the Choptank and its tributaries where the valley was no longer defined. Channel sections of the remaining tributaries were surveyed. Field elevations and watershed boundary elevations were surveyed to establish grade requirements for ditch design. These surveys established the major hydraulic features of the watershed.

A semi-controlled mosaic, provided by the SCS Cartographic Division was used for horizontal control. Survey data, ditch locations and watershed boundaries were located in the field and plotted on this mosaic.

The Northeast Humid Area Chart and the 20-40 rule,published in

the National Engineering Handbook Section 16, were used to determine design discharges. Hydraulic gradients were established on profiles showing existing channel conditions and required control elevations.

Ditch designs were computed using Manning's formula. Values of Manning's "N" varied from .030 to .040 depending upon the hydraulic radius. Head losses through bridges and culverts were determined by standard procedure.

No attempt was made during planning to establish final alignment of the works of improvement. Therefore, conservative estimates were made of volume of excavation based on full excavation of the design section. Area of woodland clearing was computed from channel length measurements and clearing width computed by a formula, 2.3 times the top width of channel plus 33 feet. Clearing width in cropland areas varied from 15 to 30 feet. Spoil spreading was computed for cropland only. Spoil disposal in woodland will be in accordance with SCS specifications.

The point of intercept between the flow line of existing channels and the flow line required to provide project benefits plus adjustments to relieve any troublesome conditions at a point of beginning, provided the logical point of beginning of structural measures.

Work plan designs were prepared for the six main channels and their major tributaries. Minor tributaries (generally the small ditches of minimum cross section) were located in the field plotted and measured on the mosaic. An additional 10 percent was added to the total measured length of ditches to make allowance for controlled inlets and necessary adjustments when construction plans are prepared.

It is not practical to show all of the ditches proposed in this plan on the project map. Therefore, the minor tributaries and some of the less important major tributaries were necessarily deleted from this map. Table 3 provides data for only those ditches shown on the project map. The minor tributaries not shown on the project map are shown on the Work Plan mosaic which is on file with the supporting data.

Engineering (Fish and Wildlife Structure)

A closed traverse was surveyed around the proposed lake site and a level bench net established. Topography of the lake site was surveyed by plane table procedures.

Preliminary geologic investigations indicated a high permeability rate. It was deduced that the water holding capacity was dependent upon the location of the water table. The pond would literally be held up by a wall of water. The numerous mill ponds in the area that successfully hold water substantiate this. The water table was located by well observations, dug out pond elevations and seismic investigations. Depth to a surface having a sound velocity of about 5,000 feet per second was assumed to be the surface of the water table. This was checked by hand auger at one point and proved to be accurate.

A flow net was plotted. Seepage losses were computed for the area of the dam between the ground water surfaces of each abutment. A water budget analysis for the year 1930 indicates that the lake will maintain adequate levels.

Examination of topography and the purpose to be served dictated the proportions of the permanent pool of approximately 8 feet deep at the dam and a surface area of about 360 acres. Flow conditions of the valley dictated that the spillway will be a weir type of structure. During extreme storm events,the entire valley is filled thus leaving little available storage. Because of this condition, a closed conduit spillway is not feasible.

A 300 foot long concrete drop spillway was designed. Investigations indicated that additional length of spillway would add greatly to the cost and would not proportionately reduce the top elevation of the dam. Tail water conditions automatically govern the minimum possible top of the dam.

The spillway is type "C" as defined in Section II of the National Engineering Handbook. The hydraulic proportions of the structure were computed by the use of the six pages of standard drawing ES 111, which takes into consideration high tail water effects.

A 300 foot emergency sod spillway is planned. During the

operations phase, this emergency spillway will be designed consistent with allowable velocities.

The limited foundation investigations indicate that there is a piping potential. This will be handled by an extensive drainage system. There is included in the work plan cost estimate an item for such a drainage system. Seepage underneath the principal spillway was investigated by flow net analysis.

Although this is a Class "A" structure, Class "B" criteria was used in the hydraulic design.

The main body of the dam is designed as earth fill with 3 to 1 side slopes upstream and down. Rapid drawdown problems occur on both faces.

An estimate of the volume of sediment that will be trapped by the structure was computed for a fifty year period. This estimate proved to be quite low, 217 acre feet, which is less than 16% of the total volume of the permanent pool.

See Table 3a for Summary of Design Features.

Cost estimates were based on current contract costs modified for site conditions.

Geologic Investigation

Soil materials to a depth of two feet below proposed designed grade were described by 60 geological soil borings located along the proposed main and prongs and subprongs. The above borings were made with a hand auger and were three to eight feet in depth. Grain size analyses were carried out on six samples from the above test borings.

Sand (SP,SM,SC,SW) was encountered at design grade elevation in all but four holes in which clay (CL) was encountered. A poorly graded sand (SP) is the predominent material encountered at design grade elevations.

The materials along the Upper Choptank River Main, Prongs and Subprongs, generally occur as described below:

The topsoil consists of highly organic sands and silts.

Topsoil is missing in certain areas of erosion or deposition. The topsoil has an average depth of about 0.8 of a foot. The topsoil was classified in the field as Pt. Poorly graded, silty, clayey sand underlies the topsoil. The material was classified in the field as SP,SM and SC. The average thickness is 4.5 feet. Clean, poorly graded sand underlies the SP, SM and SC. The clean sand was classified SP in the field. The clean sand is at a depth of about five feet. Thickness of the clean sand is over three feet.

Seven range lines were established across Mud-mill Pond. Depth of water and bottom configuration was determined and plotted for each of the range lines. Samples of bottom material were collected and described. Auger holes were located on both sides of the pond and described as to their character (primarily SP).

Seven hand auger holes were located along the centerline of the proposed fish and wildlife structure near Sandtown. Five holes were located in the abutments and two in the valley bottom. These holes were logged using the Unified Soil Classification system. Rate of permeability was established to be approximately 5,000 feet per year in the sands of the left abutment. Sand (SP) is the predominant material in the abutment. Muck (OL) underlain by sand (SP) is found in the valley bottom.

Probable borrow areas were examined in the vicinity of the proposed structure site. The Delaware State Highway Department made available soils data from 29 test pits in the area. The data include 132 grain size analyses,plasticity index for 121 samples and the liquid limit for 27 samples. The data indicate sand (SP) as the primary type with minor amounts of silty and/or clayey sands (SM-SC) and clay (CL).

Land Treatment

The land treatment to be applied as part of this work plan is expressed as the number of acres in each general land use which is planned to receive essential treatment during the project period. In order to determine the essential treatment the acreage of each land use was grouped by well drained and poorly drained soils.

Acreage for each land use with essential conservation

treatment already applied was determined from work unit records. Land treatment goals were developed for the watershed. This included the number of acres of cropland and pasture land which will have received essential land treatment before and during the project period. The acreage to be treated during the project period is the difference between the goals and the acres already treated.

Basic land treatment practices were listed for each land use group. These measures were used to develop cost estimates for treating each group. Composite acre costs were developed with detailed land use and soils data the basis for the percentage amount of any one practice for the composite acre. These costs were applied to the amount of cropland and pasture land to be treated during the project period.

The forest land treatment was developed cooperatively with the Delaware State Forestry Department, Maryland Department of Forests and Parks and the U. S. Forest Service. Information on the hydrologic conditions of the forest land on the watershed was collected in a series of field plots, selected systematically, where measurements of litter, humus, soil type and other hydrologic factors were recorded and analysed.

Economics

The effects of the structural measures were studied in order to make the necessary comparison of benefits and costs. The annual benefits are the monetary expression of the effects of the works of improvement. The structual measures installation costs were amortized at 3 1/8 percent interest for 50 years and added to the annual operations and maintenance costs to achieve an annual cost comparable to the annual benefits.

Soils maps were measured to determine the amount of each soil type and capability for each general land use. An aerial photo mosaic of the watershed was measured to determine the amount of open land and forest land. A copy of the mosaic was marked off in square mile sections. Each alternate section was used as a sample area for the determination of the detailed use of the open land. The use of each field in each sample area was marked on the mosaic and measured. Analysis of this data was made to determine the land use, soils, and problem area of the watershed. The problem area is made up of imperfectly and poorly drained soils.

The watershed is 46 percent forest land and 54 percent open land. About 250 acres are in farmstead and communities. This was determined from soils survey data. About 94 percent of the forest land is poorly drained or imperfectly drained. Approximately 20,166 acres are in crop use with 70.7% having drainage problems. Eighty one percent of the 4,583 acres of pasture has water problems. The survey shows that 5,806 acres were kept out of production during the 1962 crop year. This area includes the acreage in the acreage reserve, feed grain program and similar programs and has about 85.3 percent imperfectly and poorly drained soils.

Landowners and operators were interviewed to determine problems, production practices, yields, future land use and needs. Soil Conservation Service and Extension Service published data and general knowledge of the soils and farming methods also provided a basis for these determinations. Crop production practices were found to be similar to those employed in watersheds recently planned. Production costs developed for these projects were used in the evaluation of project benefits.

The economic evaluation of the structural measures is based on increased net farm income expected in the problem area. For evaluation purposes the land kept out of production was considered as corn land. Soils survey data showed six percent of the watershed as idle therefore the remaining out of production acres was evaluated as corn land with and without the project. The six percent idle land was added to the corn acreage with the project. The minor amount of truck crop acreage was evaluated as soybean land. The evaluation of the primary affects of the structural measures was based on the 21,684 acres of imperfectly drained and poorly drained cropland and pasture.

Long term prices were used for production costs and returns. The pamphlet "Agricultural Prices and Cost Projections," September 1957, A.R.S.,U.S.D.A. was the source used for the long term prices. The estimated increased long term income is $883,533.

Associated costs of $159,256 for on farm drainage, cover crops and clearing brushland were deducted from the increased income to determine the increased net income. The increased net income was discounted based on the assumption

that there would be a lag in accrual of about 15 years after the project is completed to determine primary benefits.

The primary benefits are the results of the joint flood prevention and agricultural water management purposes of the project. The agricultural water management problem will be solved with the project. The flood prevention benefit is from the floodwater damage reduction and more intensive use of the land. It was estimated that ten percent of the flood prevention benefits will be from more intensive land use after analysis of the with and without crop budgets. The relationships between (1) without project conditions, (2) with project conditions, and (3) flood free conditions show the extent of floodwater damage reductions. Indirect damages were estimated to be ten percent of the direct floodwater damages.

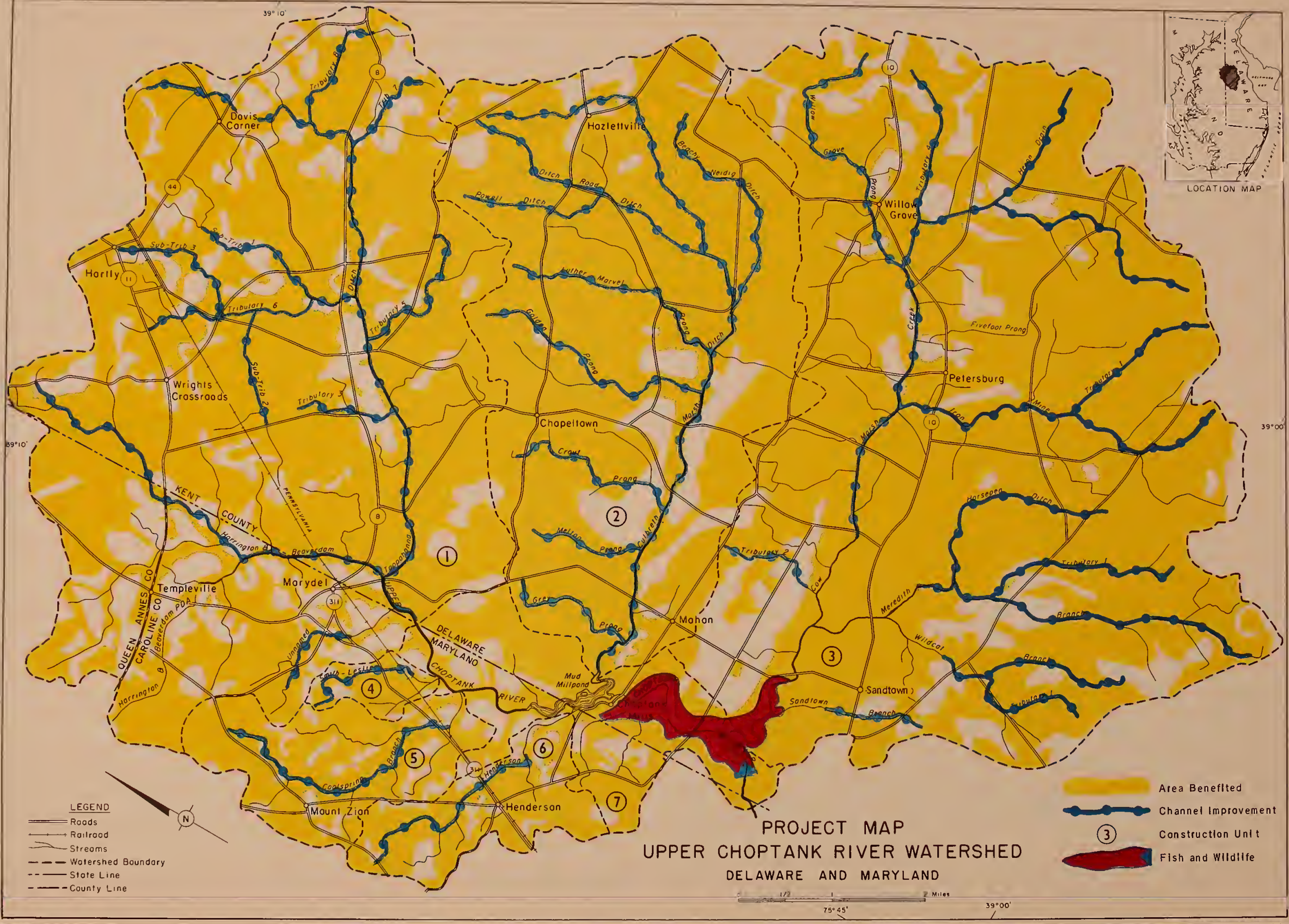
Local secondary benefits stemming from the project and induced by the project were determined from increased returns from crop production and increased production costs brought about by the project. The secondary benefits stemming from the project were estimated to be ten percent of the increased production cost incurred by the primary producers.

Benefits from the fish and wildlife structure were based on an estimate of annual use prepared by the U. S. Fish and Wildlife Service. A value of one dollar per user day was used to establish a value of the use. This value is based on the extent of development of facilities foreseen. The total value was discounted for a five year lag in accrual to determine the average annual benefits.

The structural measures costs are based on 1963 prices. The costs of the stream channel improvements were allocated to flood prevention and agricultural water management. All of the costs are joint costs; therefore, 50 percent was allocated to flood prevention and 50 percent to agricultural water management. Public Law 566 funds will bear 100 percent of the construction cost allocated to flood prevention, 50 percent of that cost allocated to drainage, and 100 percent of the installation services. Other funds will bear 50 percent of the construction cost allocated to drainage, 100 percent of the land, easements and rights of way costs and 100 percent of the administration of contracts costs.

Public Law 566 will also bear 50 percent of the construction cost of the single purpose fish and wildlife structure and 100 percent of its installation services costs. Other funds will bear 50 percent of the construction cost, 100 percent of the land, easements and rights of way costs and 100 percent of the administration of contracts costs of this structure. Other funds will also bear the costs of operations and maintenance of all the structural measures.

The Watershed Protection Handbook and the Economics Guide were used as technical guides. Publications by the University of Delaware and the University of Maryland were used as technical references. The 1959 census of Agriculture was used as a general reference.


39°10'
39°00'
75°45'
Davis Corner
Hazlettville
Willow Grove
Petersburg
Hartly
Wrights Crossroads
Chapeltown
Templeville
Marydel
Mahon
Sandtown
Henderson
Mount Zion
Tributary 8
Tributary 7
Tributary 6
Tributary 5
Tributary 3
Sub-Trib 1
Sub-Trib 2
Sub-Trib 3
Ditch
Powell Ditch
Road Ditch
Beachy Neidig Ditch
Luther Marvel Ditch
Golden Prong
Crow Prong
Melvin Prong
Gray Prong
Marsh Ditch
Willow Grove Prong
Tributary 4
Tributary 2
Tributary 1
Hixon Drain
Fivefoot Prong
Creek
Marsh Drain
Horsepen Ditch
Meredith Branch
Wildcat Branch
Sandtown Branch
Unnamed
Smith-Leslie
Coolspring Branch
Henderson
Harrington Br.
Beaverdam
Beaverdam PDA
Choptank River
Mud Millpond
Choptank Marsh
Delaware
Maryland
Kent County
Queen Annes Co.
Caroline Co.
Pennsylvania
Upper
1
2
3
4
5
6
7
8
10
11
44
311
LOCATION MAP
LEGEND
Roads
Railroad
Streams
Watershed Boundary
State Line
County Line
N
Area Benefited
Channel Improvement
Construction Unit
Fish and Wildlife
PROJECT MAP
UPPER CHOPTANK RIVER WATERSHED
DELAWARE AND MARYLAND
0 1/2 1 2 Miles
USDA SCS-HYATTSVILLE, MD. 1965