HUNTERS RUN CONSERVANCY DISTRICT

State of Ohio

AMENDED

P L A N

H U N T E R S R U N W A T E R S H E D

W O R K S O F I M P R O V E M E N T P R O G R A M

July, 1956

OFFICIAL PLAN

OF

HUNTERS RUN CONSERVANCY DISTRICT

Adopted by the Board of Directors
May 14, 1954

Amended

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Note: Exhibits Nos. 4 to 15 inclusive accompanying the original Official Plan show the Location Plan, Site Plan and General Layout for Structures No. 1, 2, 3 and 4, which exhibits are hereby made a part of this Amended Official Plan.

HUNTERS RUN CONSERVANCY DISTRICT

State of Ohio

Official Plan - As Amended

PART I - INTRODUCTION

The Official Plan for the Hunters Run Conservancy District adopted by the board May 14, 1954 and approved by the Court May 25, 1954, is hereby altered and amended to include Works of Improvement on the Hocking and its tributaries above the City of Lancaster, in addition to the improvements planned for the Hunters Run Watershed and to make other minor alterations.

In the original petition to the Court to form the Hunters Run Conservancy District, these reasons were given for the formation of the district:

> "Preventing floods; regulating stream channels by changing, widening, and deepening the same; providing for irrigation where it may be needed; regulating the flow of streams and conserving the waters thereof; diverting, or in whole or in part eliminating watercourses; and incident to such purposes and to enable their accomplishment, to straighten, widen, deepen, change, divert, or change the course or terminus of, any natural or artificial watercourse; to build reservoirs, canals, levees, walls, embankments, bridges or dams; to maintain, operate and repair any of the construction herein named; and to do all other things necessary for the fulfillment of the purposes of the proposed district, such as forestation, and installation of erosion control practices."

The Hunters Run Conservancy District was organized for those purposes by order of the Court, dated December 22, 1951. It came into being, after a chain of events, as the instrument most suited to develop and execute a comprehensive flood control plan for the district.

After the million dollar July 1948 flood, both city and farm people became concerned. For a time they worked independently of each other trying to get something going to forestall a reoccurrence of conditions like those caused by the 1948 flood. Farmers in the watershed recognized that the problem was community-wide and that any solution would likewise have to be worked out on a community basis.

They petitioned the Fairfield Soil Conservation District to have the Soil Conservation Service, USDA, make a survey of the Hunters Run Watershed. This was done and the preliminary plan which was developed integrated soil conservation practices on the land with structure control on the watercourses. This plan was reviewed with the Corps of Engineer, U.S. Army, who at the time were considering a plan for flood control for the entire Hocking River Watershed above the City of Lancaster.

A meeting was called by the Fairfield Soil Conservation District at which representative land owners of the watershed presented the plan to residents, businessmen and officials of the city. Out of this meeting came the idea to form the Hunters Run Conservancy District.

Petitions to organize the district, bearing signatures of over 500 freeholders, were presented to the Common Pleas Court. A hearing was scheduled and, in the absence of a single protest, the Judge established the district and proceeded to appoint the directors.

After the directors had organized and made a thorough study of the preliminary plan, they requested the Soil Conservation Service, through the Fairfield Soil Conservation District, to prepare a final plan in sufficient detail to permit its consideration as an Official Plan for the district and to allow the construction called for in the Hunters Run plan to proceed.

As stated later in this plan under "Flood Problem at Lancaster", damaging floods could result from either of the two streams or by their combined effects. This problem was recognized at the time the Hunters Run plan was presented, however, not considered as part of the Hunters Run plan due to the Corps of Engineers program as planned for the Hocking portion of the watershed. However, after Congressional appropriations to the Corps of Engineers was curtailed and sufficient funds were not available for further work, it was recognized that the Soil Conservation Service would have to make a study of the effects of the Hocking River in relation to the flood problem at Lancaster. At this time the Soil Conservation Service requested and received from the Corps of Engineers the information they had collected.

In the meantime, the Anderson-Hope Bill, which authorized pilot plant watersheds to be set up throughout the United States to demonstrate a Works of Improvement Program on a small watershed basis was passed by the 83rd Congress. The Upper Hocking Watershed at and above Lancaster, which included the Hunters Run tributary, met the intent of this bill and the Soil Conservation Service was asked to consider this watershed as one of the "pilot plant" watersheds. Favorable action was taken on this request in Washington and it was designated as one of two projects in Ohio and fifty some in the United States.

In order to take full advantage of the Federal financial participation and cooperation in the development of a plan for the entire watershed, the limitations and policies fixed by Congress must be recognized.

One of the primary concerns is the provisions for cost-sharing between local interests and the Federal Government. Since the Hunters Run Watershed has been organized into a Conservancy District, and has the powers for securing funds through assessment of benefits, it appeared that the best procedure would be to amend the Official Plan of the Hunters Run Conservancy District to include improvements in the additional area of the Hocking Watershed above Hunters Run needed to provide a suitable plan for the combined areas of the two watersheds.

This amended plan for the Hunters Run Conservancy District is presented in order to carry out more fully the purposes of the District.

PART II - SUMMARY OF PLAN AS AMENDED

In preparing the plan, the progress of the raindrop was followed from the point at which it hit the ground, down the slope into the main channel and on through the City of Lancaster. This approach resulted in a plan with five major divisions, namely; (1) land treatment measures; (2) gully stabilization which includes waterway improvement and stabilizing structures; (3) flood water retarding structures; (4) main channel improvement and, (5) stabilization of critical runoff and sediment producing areas.

(1) LAND TREATMENT

The land treatment includes soil and water conservation measures carried out on the land by individual farmers working in cooperation with the Fairfield Soil Conservation District. These measures installed on the land at the expense of the individual farmer are the first line of defense against potential flood water. They are designed to hold water as nearly as possible where it falls and cause it to percolate into the underground storage to be used for crop production, or to come out as spring or stream flow, or to be pumped for beneficial uses.

These measures, among other things, will help reduce the silt carried into waterways, thereby insuring longer life for the structures described below.

(2) GULLY STABILIZATION

When waterways gain such proportions by carrying accumulated water from one, two, or three farms and become unstable to the point that large active gullies form, the gully becomes a community problem. These larger gullies are considered next after land treatment and are controlled by shaping, seeding, and/or sodding plus structures where necessary. Exhibit No. 3 will give the locations for waterway improvement and gully stabilizing structures.

There are two types of gully stabilization structures called for in the plan. Each of these is designed to best meet the problem at hand.

Structure numbers with a prefix of "S" consist of a small earth ridge and a reinforced concrete wall with a rectangular weir notch. These allow water to flow through the notch and drop on a reinforced concrete apron. There are 30 such structures called for.

Structure numbers with a prefix of "R" are small retarding type with a permanent sediment pool designed to serve also as a gully stabilizer for active gullyheads immediately above the structure site. There are 31 such structures.

(3) FLOOD WATER RETARDING STRUCTURES

The plan includes eight flood water retarding structures which will furnish automatic regulation of flood flow by means of fixed outlets designed so that maximum outflow will not exceed channel capacities at points immediately below the structures in case of a design storm. Their location is shown on Exhibit No. 3.

Flood waters in excess of the outlet capacities of the various structures will be temporarily stored in their basins and will automatically flow out after the natural crest of the flood has passed.

(4) CHANNEL IMPROVEMENT

Channel improvement is a part of the design for the total plan. It has been provided to reduce streambank erosion and to provide additional channel capacity where needed.

Approximately six miles of the main channel is to be improved by enlarging, straightening, sloping, and seeding the banks. Specific locations for this work are shown on Exhibit No. 3.

(5) STABILIZATION OF CRITICAL RUNOFF AND SEDIMENT PRODUCING AREAS

There are approximately 12 acres of tree planting required on badly eroded banks along the channel.

These plantings will reduce runoff and erosion from these areas and contribute to the reduction of sediment damages.

PART III - DATA ON WHICH PLAN IS BASED

(1) DESCRIPTION OF AREA

LOCATION AND SIZE

The Upper Hocking Watershed is located in the southcentral part of Ohio; it lies west and north from and includes part of the City of Lancaster.

The Hocking River is a tributary of the Ohio River. The watershed for which this plan has been developed, includes all tributaries at or above the Broad Street bridge in the City of Lancaster. Hunters Run, its largest tributary with a total drainage area of 7,070 acres, rises approximately 6 miles west of Lancaster. From its source Hunters Run flows eastward to enter the Hocking River in the southwest part of the city.

The watershed has an area of 31,500 acres (49.2 sq. mi.) at Broad St. bridge, and comprises approximately 4% of the area of the entire Hocking River Watershed. Of the 31,500 acres in the watershed, 27,843 acres are in farm land and 3,657 acres are in urban area, roads and miscellaneous. This includes 3,202 acres of floodplain, all of which would be presently inundated by a storm producing 6 inches of runoff in approximately 2-½ hours.

Approximately 0.5 square mile of the Clear Creek Watershed discharges into Hunters Run Watershed when runoff from this area exceeds approximately 40 c.f.s.

TOPOGRAPHY

The watershed for the most part lies within the transition area between the glaciated and unglaciated soils, terminal morains extend along the eastern, southern and southwestern boundary. The central and northern portion of the watershed contains more level and gently sloping land characteristic of the glaciated soils of western Ohio, with the exception of the northwestern tip, which within the county extends into the Chestnut Ridge Highlands--the western most terminus of the Allegheny Plateau.

Elevations vary from 1,100 feet mean sea level in the steeper uplands to 900 feet on the more level land. The elevation at Lancaster is slightly above 800 feet and some of the knobs, ridges and peaks at the outer rim of the watershed reach a top elevation of 1,240 feet.

Ordinarily, river valleys widen out toward their mouths. Originally, the Hocking River flowed north. The glacier dammed off its outlet, its flow was reversed, and now the wide valleys are in the headwaters and the valleys become narrower toward the mouth.

SOILS

The upland part of the watershed is composed of glacial soils of late Wisconsin origin developed over sandstones and shales of Mississippian Age. The underlying bedrock, which is predominantly the coarse-grained Black Hand sandstone, is covered by a relatively thick layer of glacial till made up of sandstone, shale, and limestone fragments. This type of parent material has led to the formation of the Alexandria-Cardington-Bennington silt loams and Marengo silty clay loam soil catena. The limestone content of these soils is low, having been leached from the upper horizons, and any indication of lime is usually found at 36 inches or below. However, the lime content has been a factor contributing to the formation of a relatively tight or heavy subsoil leading to a drainage problem in the more level areas and an erosion problem in the areas of better surface drainage.

POPULATION

The population of the watershed, including the City of Lancaster, is about 28,000. Of this total 1,500 is rural.

LAND OWNERSHIP

The entire area of the rural part of the watershed is in private ownership. There are 287 farms, seventy-six of which are twenty acres or less in size. The average size of the full-time farming operation is 150 acres and almost all of them are owner-operated.

TYPES OF FARMING

General grain-livestock farming predominates. The entire amount of feed grown is fed to livestock on the farm with the exception that some of the wheat produced is sold.

The rank in importance of the farm enterprise based on gross cash income from the sale of agricultural products is: first, hogs; second, dairy; third, beef; and fourth, poultry.

ROADS AND RAILROADS

There are 20.4 miles of U.S. and State highways; 37.8 miles of county highway and township roads; 27.1 miles of private roads; and lanes constitutes 28 miles. There are 10.1 miles of railroad traversing the watershed. Much of this roadbed is in the flood plain and is subject to inundation and serious damage from major storms.

INDUSTRIAL ACTIVITY

Some 50 wholesale, retail, and/or small manufacturing concerns are in the flood plain within the City of Lancaster. Five of these suffered heavy losses of merchandise and disruption of business in the 1948 flood, while 27 suffered damages of a less serious nature. A new Y.M.C.A. and a new school have been contracted for construction during 1956 in the flood plain.

Public utilities were seriously affected in the 1948 flood. Electric service was disrupted for two days and telephone service was out for five days. Municipal gas, water and sewage systems were completely stopped.

(2) METEOROLOGY, HYDROLOGY, AND HYDRAULICS.

PRECIPITATION

The mean annual precipitation of 41.29 inches is fairly evenly distributed with the greatest amounts occurring in June and July. Individual rains of excessive amounts which occur at irregular intervals during the year cause serious erosion and flood damage. The minimum recorded annual rainfall of 23.65 inches occurred in the year 1930, while the maximum annual rainfall of 57.45 inches fell in the year 1935.

RUNOFF

Based on stream gaging station records over a 30 year period in adjacent areas, the average annual runoff is estimated to be about 14 inches.

FLOODS

Frequent flooding has occurred over the past several years in the Upper Hocking Valley and the Hunters Run Branch, which joins the main channel in Lancaster. The most recent disastrous floods occurred in 1935 and again in 1948. Although the damage in 1948 was calculated at $1,000,000, it would have been much higher if the rainfall had been as intense over the entire watershed as it was in the Hunters Run area.

In this area, excessive rainfall can be expected several times annually and at any time of the year, but it is most likely to occur from June through September. It has been estimated that the July 1948 storm over the Hunters Run Watershed produced 5.1 inches of runoff, with an average rainfall of 6.9 inches. An analysis of the isohyetal map prepared for this storm by the Division of Water, Ohio Department of Natural Resources, indicates that the storm pattern could have shifted to a position over the watershed that would have produced 8.2 inches of runoff over a 2.0 square mile area.

A public hearing was held by the District Engineers, Huntington District, Corps of Engineers, U.S. Army at Lancaster on November 9, 1948. The following is quoted from their report on Hunters Run:

"Flood conditions. Flash floods of a minor nature occur almost annually in the Hunters Run Basin and are generally of the late spring or summer variety. Although systematic flood records have not been maintained in the Hunters Run Basin, floods of disastrous proportions are known to have occurred on 28 July 1935 and 22 July 1948. In the more recent of the two floods, the presently utilized developments were affected as follows: (1) disruption of a large portion of electric and telephone service for two and five days, respectively; (2) complete stoppage of much of the municipal gas, water, and sewage systems; (3) loss of a large quantity of supplies and merchandise, destruction of many buildings and facilities, and disruption of business activity for an extended period at five wholesale and/or small manufacturing concerns; (4) damages of less serious nature to 27 other wholesale and retail businesses; (5) flooding of 369 residences above first floor level, many with four to six feet of water, and a few smaller residences with eight to twelve feet of water; (6) flooding of basements in 85 additional houses; (7) removal of three residences from foundations; (8) collapse of one or more basement or foundation walls at approximately 25 residences; (9) flooding of grounds at 25 additional houses; (10) flooding of approximately 75 cars, many of which were completely covered by water; (11) severe damage to several outbuildings, many being completely destroyed or washed away; (12) extensive damage to agricultural land and crops; (13) serious damage to a bridge of the Pennsylvania Railroad and tracks of the Chesapeake and Ohio Railway; (14) severe damage to U.S., State and County highways and bridges (two bridges being completely washed out and two others sustaining serious damage to approaches; and (15) flooding of one church..."

The area inundated in Lancaster by the flood of July 1948 is shown by a heavy dashed line on the map of the city, which also shows the flood plain area affected by this and other storms of lesser or greater intensity. (See Exhibit No. 2)

It is further stated in the Corps of Engineers' report:

"Flood problem at Lancaster. The flood problem at Lancaster is caused by overbank stages of both Hunters Run and Hocking River. Damaging floods may result from either of the two streams or by their combined effects. Lancaster suffered major damages from the general floods of March 1907 and March 1913. During 1914 a section of Hocking River from Hooker downstream through Lancaster, a reach of about 6 miles, was widened, straightened and leveed by Fairfield County under the laws of the State. This improvement successfully passed the floods of January 1937 and May 1938. However, the basin-wide flood of April 1940 broke through the levees and flooded 11 houses on first floors and surrounded about 100 others. Floods originating from Hunters Run caused major damages at Lancaster in July 1935 and July 1948. Although Hocking River has been dredged and maintained at Lancaster, no such improvements have been accomplished on Hunters Run. Local interests have stated that a plan of improvement on Hunters Run is more complicated than that which was accomplished on the Hocking River. The dredging of Hunters Run would require the removal of a few residences and business buildings, whereas in the dredging of Hocking River the right-of-way was donated and the removal of buildings was not required."

Bulletin No. 18, "Local Floods in Ohio During 1948" published by the Ohio Water Resources Board (now the Division of Water, Department of Natural Resources) contains considerable data concerning the July 1948 flood in Hunters Run. Concerning this flood they state, "The area of Hunters Run was in the edge of the storm, but intensities were very high, and the resulting flood was terrific. Worse small area floods have occurred in Ohio but never where there was so much property to destroy or damage."

CHANNEL CAPACITIES

The present channel capacities for the Hunters Run Tributary are as follows:

Miles above Confluence	Capacity Sec. Ft.
0.21	5000
0.33 @ Lincoln Ave.	4000
0.47	2000

With a relatively small amount of improvement, the channel capacity will be increased to 3000 sec. ft. at river mile (0.47), at an estimated cost of $2000.

The present channel capacities for Hocking River is as follows:

Miles above Mouth	Capacity Sec. Ft.
83.8 @ Broad St.	4500
84.6 @ Lincoln Ave.	3500
85.1 @ Sixth Ave.	3000
85.3 @ Fair Ave.	3000

In the rural area the channel capacity varies considerably depending upon past maintenance. Capacities range from less than 400 sec. ft. near the headwaters to over 3,700 sec. ft. above the railroad bridge at which the 1948 flood measurement was taken.

Part IV - DEVELOPMENT OF THE PLAN

(1) THE DESIGN STORM AND DESIGN FLOOD

Since the July 1948 flood on Hunters Run is the largest on record in this locality, it was used for the base of the project design flood. The average weighted rainfall over the Hunters Run watershed in July 1948 was 6.9 inches in two and one-half hours. This produced 5.1 inches of runoff. This was determined by routing this flood downstream and reproducing the peak runoff, computed by the U.S. Geological Survey as 11,200 c.f.s. at the Pennsylvania Railroad bridge just west of the city. By proportionately increasing the runoff from this flood to six inches of runoff, the project design storm was developed for Hunters Run.

After it was determined that the Soil Conservation Service would develop the flood control plan for the entire Upper Hocking Watershed a different analysis had to be undertaken. Either or both streams could cause flood damage in the city. The six inch runoff flood was synthesized by transposing the July 1948 storm over the Hocking River basin so that maximum rainfall depth could be obtained. This resulted in 8.3 inches average weighted rainfall depth over the Hocking River portion of the watershed. Using a theoretical approach to runoff analysis the average weighted runoff depth was determined as 5.6 inches. This runoff proportionately increased to 6 inches of runoff is the project design flood for the Hocking River Watershed.

Combining the routed flow from both streams at Lancaster this synthetic 6 inch runoff flood for the entire area produces a peak of 28,800 c.f.s. which would inundate 97 city blocks all west of Memorial Drive to, or over, first floor levels. This is in comparison to July 1948 flood with a peak of 13,100 c.f.s. and inundating 41 of the same city blocks.

A 6 inch runoff flood has not occurred in modern history over the entire watershed, but in July 1948 it almost occurred over 11.7 square miles of it. The frequency of occurrence of the 6-inch runoff flood over the whole watershed is of such magnitude that it is indeterminate. This does not mean, however, that it is of such a magnitude that it could not happen this year or even next year.

The floodwater Retarding Structures are designed to pass a spillway design flood with a runoff of 12-inches from the area above the dam, varying in time from 415 to 660 minutes, depending upon the characteristics of the drainage areas above the structures.

The 12 inch runoff flood was determined by using the maximum observed point rainfall at a first order station from a meteorologically homogeneous area, occurring within a single storm period; thence, doubling the resulting rainfall and proportioning to 12 inches of runoff.

The generalized estimate for maximum possible precipitation in this area for 10 square miles in 6 hours is 28 inches of rainfall (reference-Section 4, National SCS Engineering Handbook). It, therefore, must be assumed that a storm of comparable or greater intensity to the spillway design storms could occur in the future. This degree of protection is provided because of the highly developed industrial and residential areas lying within the flood plain.

In general, the structures are designed to control the runoff from the two and one-half hour storm producing 6 inches of runoff before the high stage principal spillway goes into operation and 9 inches of runoff before the emergency spillway goes into operation (exceptions on Structures Nos. 3, 6, 8 and 9; explained under structure phase).

(2) SEDIMENT DAMAGE

A considerable part of the damage of any flood results from silt carried by flood waters. Silt likewise reduces the effective storage capacities of retarding or impounding structures. Based upon the age old axiom that "an ounce of prevention is worth a pound of cure", the erosion control practices, mentioned in the petition to form the district, are preventive measures which will significantly reduce the sediment damages.

From a comprehensive study of the sources of erosion in this watershed it was determined that approximately 3/4 of the sediment came from sheet erosion on the farms and the other 1/4 from the major gullies, stream banks, valley trenching and scour on the flood plain. This study pointed up the significance of the land treatment phase of an overall watershed protection and flood prevention plan.

Part V - THE OFFICIAL PLAN AS AMENDED

(1) LAND TREATMENT

A study was made to determine what land treatment measures were needed to bring about a complete soil and water conservation program. This consists first of putting each acre to its proper use and then treating it according to its needs; specifically, it involved the shifting of some steep land to pasture and protected woods; improving crop rotations; the use of additional lime and fertilizer and applying the following practices: strip cropping, contour cultivation, terracing, terrace outlets, construction of diversions, small waterway establishmant and improvement, farm ponds, and protection of woods from grazing.

The proposed land use in addition to being based upon the capability of the land, also considers the needs of the farm operator. Of the land used for crops it is expected that 25 percent will be in corn, 25 percent in wheat, and 50 percent in meadow and rotation pasture. This distribution will vary on individual farms depending on land capability and needs of the farm enterprises. The general trend in livestock numbers and land use pattern in this area is for an increase in number of roughage-consuming animals such as dairy and beef, and a decrease in the acres of grain crops. In line with this trend, the emphasis is being placed on improvement of both meadow stands and permanent pasture.

These measures will also contribute a small degree of peak runoff reduction by providing greater infiltration rates and improved water retention capacity in the soil. This will amount to from 5 to 11 percent reduction based upon the degree of land use changes and improvements installed.

The total estimated cost of installing the land treatment measures needed is $161,696. Since the benefits to be derived by the individual land owners from these measures will greatly exceed the cost, the measures will be installed at the expense of the individual land owners as stated previously in Part II - Summary of Plan.

(2) GULLY STABILIZATION

Many of the larger watercourses were found to be in a very unstable condition. Active gully heads and raw banks exist which are contributing from 12-15 percent of the total sediment load of the streams.

Approximately 37 miles of waterway improvement are shown on the map (Exhibit No. 3) consisting principally of stabilizing existing waterways. The work will consist of removal of brush and/or trees, shaping, seeding or sodding, and in some cases fencing. Generally the work will involve earth moving by dragline, bulldozer, and/or grader.

Where vegetative means alone are not sufficient to stabilize the waterways, structural control will be used to protect the existing or newly developed waterways from erosion and sedimentation. A total of 61 such structures will be needed.

As described briefly in Part II - Summary of Plan, 30 of these structures will be used to stabilize active gully heads. These are designated on Exhibit No. 3 with the prefix "S".

The other 31 structures have a two or three-fold purpose. They will be retarding type structures consisting of an earth dam with a fixed draw down tube to (1) reduce and retard flood flows in order to provide a more economical system of gully stabilization measures; (2) provide a sediment trap for any sediment not completely stabilized; and, (3) the structures designated with the prefix "R" are to have a permanent sediment and water conservation pool maintained to stabilize active gullies at the upstream end of the pool. The design of these structures is based upon retarding flows produced by storms up to a recurrence interval of one in fifty years. Emergency spillways are provided to protect the embankment for storms of greater intensity.

This work is estimated to cost approximately $109,641. When gullies attain such size that they can no longer be corrected by the ordinary farm equipment and/or they must serve as water courses for runoff from several farms, the proportion of the benefits derived by the individual land owner is small compared to the proportion of the off-site benefits. For these reasons such improvement work becomes a community problem and the costs for such work are included as part of the total Federal-District total.

(3) FLOOD WATER RETARDING STRUCTURES

The primary objective, in the development of the structure phase of the flood control plan, was the selection of sites that would give, at reasonable costs, the following: (1) maximum flood water detention, (2) meet gully stabilization and sediment storage requirements, (3) greatest reduction in peak flows below the structures, and reduction of flood crests in the City of Lancaster.

Eight structure sites were selected (Exhibit No. 3) providing controlled flow from 49.6 percent of the total watershed. Four of these structures will be on the Hunters Run tributary controlling 72.5 percent of its watershed. Three structures will be located in the upland areas of Hunters Run and the other structure (No. 3) will be located in the valley bottom to supplement and in combination with two of the upland structures (Nos. 1 and 2). Of the four structures in the Upper Hocking Watershed (Exhibit No. 4), three, providing controlled flows for 31.6 percent of the watershed will be located in the upland areas; and the fourth will be located on a valley bottom reservoiring an additional 10.8 percent of the area on higher flows in series combination with one of the upland structures. Feasible sites to control a larger part of the Upper Hocking above Hunters Run are not available at reasonable costs.

As adequate stream flow data were not available, a detailed hydrologic study was made and synthetic unit hydrographs were developed for each structure site and each intervening area below. Flood hydrographs were derived for the design flood and routed through the selected reservoirs.

In the design of structures Nos. 1, 2, 4, 5, 8 and 9, three stages or elevations of maximum flood storage requirements are determined through the flood routing. The crest of the low stage spillway is the permanent pool stage required for gully stabilization and sediment storage. This pool stage is set at 12 to 16 feet, with the exception of structure No. 9 which is 26 feet above the grade of the channel. The crest of the high stage spillway is set at the elevation of the maximum storage requirement for a selected design storm with the structure spillways in operation. The elevation of the emergency spillway was set by routing a higher intensity design storm through the structure and establishing the new maximum pool elevation. This emergency spillway is then designed to pass safely the emergency spillway design storm, which in the design of all structures was 12 inches of runoff occurring uniformily over the whole basin above each structure. The maximum height of storage reached by this routed flood plus from 1 foot to 3.5 feet of freeboard was used to set the height of the settled fill.

Due to the difference in available storage, and also for economic reasons, there will be two major types of structure designs; the drop inlet type with drawdown tubes (Structures Nos. 1, 2, 4, 5, 8 and 9), and the box culvert type with no provision for a permanent pool (Structures Nos. 3 and 6).

The drop inlet type of structure was adapted in three different designs, separate low and high stage risers connected by drawdown tubes (Structures Nos. 1, 2, and 4); double orifices in the high stage riser serving as the low stage riser (Structures Nos. 5 and 8); and a special case of only a low stage riser (Structure No. 9).

Structures Nos. 1, 2, 4 and 5 are designed on the basis of flood hydrographs developed for hypothetical storms producing an average of 6 inches, 9 inches, and 12 inches of runoff in a period of from 2½ hours to 6 hours. These storms were routed through the structures to establish the maximum pool elevations (maximum storage) that would be reached.

When a storm produces the type of flood resulting in 9 inches of runoff at the site, the following chain of events will take place at this drop inlet type of structure. First, the storage area behind the earth dam will begin to fill with water and a very limited flow will automatically be discharged through the low stage spillway. This discharge will be a mere trickle since the lower inlet is purposely designed to "throttle down" the flow to a small quantity. The storage volume behind the dam will have a capacity of 6 inches of runoff before the high stage spillway goes into effect. With 6 inches of runoff capacity the maximum (average full flow) discharge for Nos. 1, 2, and 4 is 90 to 95 c.f.s.and 275 c.f.s. for site No. 5. As soon as the upper spillway goes into operation there will be an increased flow in the channel below the dam since the outflow from the lower conduit will be augmented by the flow from the upper spillway. However, even with the two spillways discharging, the flow in the channel will be small in comparison to normal unregulated discharges which would have occurred had the dam not been there. The high stage spillway has a similar "throttling" effect which permits the water level in the reservoir pool to rise until it reaches the elevation of the emergency spillway. By the time the water level reaches this elevation, approximately 9 inches of runoff from the drainage area above the dam will have reached the retarding structure, all of which will have been stored in the reservoir except for the flow which has been permitted to continue downstream through the low and high stage spillway.

The areas within the reservoir limits will be dry above the permanent sediment pool level except for the short periods during floods when the flood flows are detained and outletted at safe rates.

Structure No. 5 will operate similar to Nos. 1, 2 and 4 except that in place of the two separate low and high stage risers the low stage riser will be 3' by 2' double orifices in a 6.12' by 4' vertical high stage riser.

Structure No. 8 will be constructed similar to No. 5 except in smaller proportions, 2' by 1½' double orifices and a 3½' by 5' high stage riser.

Structure No. 9, a large detention type structure located on the main channel below Rock Mill, controls approximately 8 square miles. In principal it is similar to structures mentioned above except that it has no high stage principal spillway. The flood water is retained behind the structure, with the drop inlet type low stage spillway, a 5' by 7' riser with a 5' by 5' drawdown conduit discharging below the dam until the emergency spillway goes into operation. The maximum full flow capacity of the drop inlet during a 6 inch runoff flood ranges from 880 cfs to 900 cfs. It will empty the flood control portion of the reservoir in about two days at maximum stage. By having no high stage inlet on Structure No. 9, the natural available storage is utilized to its maximum. The storage of flood water simply builds up into reservoir to a stage which has stored approximately 6 inches of runoff from the watershed until the crest of the emergency spillway is reached. This change in design for the level of the emergency was brough about by three factors: First, the economical storage in relation to the outflow of the drop inlet showed that by using the 9 inch runoff to set the level of storage the increased size of drop inlet required would necessitate above bankfull discharge below the dam; Second, the possible frequency of a flood of this type on the Upper Hocking is above three digits;

Third, in figuring benefits derived from flood control, no benefits can be assumed from floods over the theoretical 6 inch runoff flood.

Structure No. 8, although it has a high stage inlet, its crest is proposed at the pool elevation resulting from 2.4 inch runoff, and the crest of the emergency spillway is designed for a 6 inch runoff similar to Structure No. 9. However, on both of these structures the emergency spillway can still safely pass the 12 inch runoff design storm before overtopping the dam.

The box type culvert retention structures Nos. 3 and 6, are designed with the entrance set at channel grade due to limitations on the storage of flood waters in the flood plain, without spreading out over a much wider area with increased stages.

Structure No. 3 will be used as a road crossing incorporating flood detention controls. The culvert will discharge 2000 cfs at the stage of the 6 inch runoff design storm. This structure, with No. 1 and No. 2 in operation, will be so designed that it will not impound water during an annual rain over approximately one hour. During a more intense rainfall, to be expected once in ten years, the overbank storage might be expected to remain one to three hours. The storms that were routed through Structures Nos. 1 and 2 were combined with similar storms on the remaining watershed and routed through the detention reservoir of Structure No. 3. Had these structures been installed prior to the 1948 storm, the storage of flood water at Structure No. 3 would have inundated approximately 100 acres for eight hours. It can be expected that all flood flow above Structure No. 3 will remain within bankfull stage except for the occasional storage of flood water at the reservoir site.

Structure No. 6 is very similar in design features as Structure No. 3. This structure, with No. 5 installed above it, will not impound water during an annual rain over approximately one hour. Had structure No. 6 been installed prior to the 1948 storm, the storage of flood water would have inundated approximately 20 acres for less than 8 hours. Since No. 6 has less storage facilities than No. 3, the crest of the emergency spillway will be that maximum stage reached by approximately a three inch runoff flood. The emergency spillway design will still successfully help pass the 6-inch, 9-inch, and 12-inch runoff flood.

The proposed location of Structure No. 6 could be subject to change if the necessary arrangements and timing can be arranged with the State Highway Department when the present U.S. Route 33 is relocated. It is possible through such arrangements to reduce the costs to the District of Structure No. 6.

Structure No. 8 could also be used as a road crossing to replace a bridge washed out in 1948 which was never replaced.

With a small additional cost the permanent sediment pools for Structures Nos. 4, 8 and 9 could be expanded to provide water for recreational purposes. Preliminary discussions have been held with the Division of Wildlife of the Ohio Department of Natural Resources concerning the possibilities of incorporating such facilities into Structure No. 4 without reducing its contribution to flood control below that contemplated in the Official Plan.

Exhibits 5 through 17 show locations, layouts, and elevations for the four Hocking structures. The Hunters Run structure layouts were a part of the original plan.

The construction program should follow the order of the numbering series for these structures. In no case should structure No. 3 be installed before Structure Nos. 1 and 2, or Structure No. 6 installed before Structure No. 5.

The total cost of these eight structures is estimated to be $995,636. Since this phase of the plan provides the major flood protection, the benefits from these measures will accrue to those lands within the floodplain below the structures. This includes, among other things, the lands, transportation facilities, utilities, commercial and industrial property, residences and the City of Lancaster.

A summary of the data for the eight retarding structures is presented in the following Tables I and IA.

TABLE I

FLOOD WATER RETARDING STRUCTURE DATA

HUNTERS RUN

Site No.	Drainage Area	Runoff	INFLOW Time	Peak Rate	OUTFLOW Max. Rate	Elev. Max. Pool	Sed. Pool	Storage Capacity Det. Pool	Total	Surface Area Top of Sed. Pool	Surface Area Top of Det. Pool
	Sq. Mi.	Inches	Minutes	CFS	CFS	Ft.		Acre Feet		Acres	Acres
1	1.06	6	415	1800	90	1005.3	15.5	295	310.5	4.97	30.09
		9	"	2700	380	1008.5	"	404	419.5	"	40.55
		12	"	3600	818	1011.1	"	545	560.5	"	46.12
2	1.87	6	440	3000	94	959.0	57.0	552	609	8.83	29.97
		9	"	4500	402	965.3	"	760	817	"	35.21
		12	"	6000	1700	969.0	"	892	949	"	38.30
3	3.81 1/	6	529	5080	1590	890.5	0	640	640	0	121.61
		12	"	10763	2000	898.0	"	1880	1880	"	214.00
4	1.74	6	544	2250	93	937.7	67.0	495	562	0.52	43.41
		9	"	3375	395	941.5	"	687	754	"	56.47
		12	"	4500	975	944.1	"	840	907	"	65.75

1/ Excluding the areas from which runoff is controlled by structures No. 1 and No. 2.

TABLE I-A

FLOOD WATER RETARDING STRUCTURE DATA

UPPER HOCKING

Site No.	Drainage Area	Runoff	INFLOW Time	INFLOW Peak Rate	OUTFLOW Max. Rate	Elev. Max. Pool	Sed. Pool	Storage Capacity Det. Pool	Storage Capacity Total	Surface Area Top of Sed. Pool	Surface Area Top of Det. Pool
	Sq. Mi.	Inches	Minutes	CFS	CFS	Feet		Acre Feet		Acres	Acres
5	1.54	6	368	2950	275	940.8	33.0	408	441	6.5	37.5
6	4.04 1/	2.4	630	2470	1230	850.5	0	188	188	0	37.0
		6.0	640	6000	5340	854.4	0	358	358	0	57.0
7 2/											
8	2.36	2.4	435	1800	132	936.5	36.2	268	304.2	6.6	26.5
		6.0	390	4600	325	948.0	36.2	677	713.2	6.6	46.5
9	7.97	6.0	600	10900	890	950.0	152.3	2100	2252.3	16.6	85.2

1/ Excluding area from which runoff is controlled by Structure No. 5.

2/ Site No. 7 was given serious consideration, but found to be not feasible as a part of the flood water retarding structure system. It, however, will be designed as a stabilizing and sediment control structure.

(4) MAIN CHANNEL IMPROVEMENT

As shown in Exhibit No. 3, portions of the main channel below each of the eight flood retarding structures will be improved principally to obtain better downstream alignment. Better alignment will help to prevent cutting of the stream banks, thereby reducing sedimentation and destruction of land. This part of the channel work will consist mainly of slight channel changes; bank sloping, fencing; seeding; sodding; and tree, shrub, and vine planting.

It is estimated that this work will cost approximately $20,804 and is included in the Federal-District total costs.

(5) STABILIZATION OF CRITICAL RUNOFF AND SEDIMENT PRODUCING AREAS

Areas along transportation routes and railroads which are without adequate vegetative cover are contributing to the runoff and sediment damage originating within the watershed. Several high, raw banks also exist which are too steep to be used as pasture land. The work will consist of such items as tree planting, seeding, sodding, and establishment of shrubs and vines.

The benefits derived from stabilizing these areas generally are not of sufficient magnitude at the site of installation to be conducive for the land owner to perform the work. The primary purpose of these measures, therefore, is the reduction of runoff and sediment damages beyond the site of installation.

The United States Forest Service, U.S. Department of Agriculture, in cooperation with the Ohio Division of Forestry, Department of Natural Resources, have been given authority to conduct this work.

The cost is estimated to be $390 and is to be handled from Federal funds.

(6) COORDINATION WITH PLANS DEVELOPED BY OTHER AGENCIES

In order to take advantage of the possibilities for Federal financial participation and cooperation in the development of a plan for the District, recognition had to be made of the limitations and policies fixed by Congress for such participation and cooperation.

One such condition is the inclusion in the total cost of the project the amount necessary for program evaluation as required by Congress for the Pilot Plant Watershed Protection authorization. This evaluation will consist of the installation and maintenance of the necessary continuous stage records for the measurement of stream flow, maintenance costs for flood flow measurements, and installation and maintenance of rainfall recorders.

(7) ADAPTION OF DETAILS OF PLAN TO CONDITIONS

While surveys and investigations have been made with sufficient accuracy to enable plans to be made that set forth the location and character of the work and to make estimates of the cost of doing the work, it will be necessary to make minor variations to adapt the work to detail conditions that are found during the preparation of the more detailed plans and the progress of the work. The Official Plan does not attempt to define these conditions beyond reasonable limits, and such adjustments to actual detail conditions are understood to be within the limits of the Official Plan, and are not to be considered as changes, alterations, or additions, to the Official Plan.

Part VI - PROPERTY WHICH MAY BE BENEFITED, OR MAY BE DAMAGED, OR TAKEN BY THE DISTRICT

(1) PROPERTY WHICH MAY BE BENEFITED

Properties within and without the district which may be benefited by the execution of the Official Plan as amended include all properties within the corporation limits of the City of Lancaster lying west of Memorial Drive, Front Street and South Broad Street. Outside of the City of Lancaster corporation benefited areas are all properties in Hocking, Bloom, Greenfield, and Amanda Townships lying within the flood plains in, along, and adjacent to the stream channels as shown by Exhibit No. 1 that have heretofore been flooded or are now subject to flooding in case of a project 6 inch runoff flood; and including also all public corporations, as political entities, having lands within such areas.

Roads, bridges, streets, and other public installations are included in the benefited area.

(2) PROPERTY WHICH MAY BE DAMAGED OR TAKEN BY THE DISTRICT

Properties which may be damaged or taken include all of those on which flood water retarding structures are shown on Exhibit No. 3. This includes the structure sites together with flooded areas above the structures, also all properties on which channel improvement work is required as shown by Exhibit No. 3.

The lands affected by the Flood Water Retarding Structures are shown in more detail on Exhibit Nos. 4, 7, 10 and 13 of the original Official Plan and Nos. 5, 8, 11 and 14 attached hereto.

Part VII - SUMMARY OF COST ESTIMATES

	Hunters Run	Amended Portion	Total Combined Plan
Land Treatment Measures (To be done by land owners and therefore not a part of the Federal - District total)	$ 61,295.00	$100,401.00	$161,696.00
(Other Private costs not included in Federal-District total)		18,811.00	18,811.00
Gully Stabilization (Including Waterway Improvement)	36,758.00	74,951.00	111,709.00
Floodwater Retarding Structures	359,000.00	636,636.00	995,636.00 1/
Stream Channel Improvement	10,000.00	31,182.00	41,182.00
Stabilization of Critical Area	513.00		315.00 2/
Program Evaluation, Technical Services, etc.	24,375.00	50,227.00	74,602.00
Total Federal-District Cost	$430,646.00	$792,798.00	$1,223,444.00
Share of Upper Hocking Pilot Plant Watershed Appropriation	$274,372.00	$515,033.00	$ 789,405.00
Balance to be Raised by District	$156,274.00	$277,765.00	$ 434,039.00 3/

1/ of this amount $153,141.00 represents estimated value of land easements, and rights-of-way.

2/ Reduced from original $513.00 as part of Federal-District costs as result of going program of State Division of Forestry.

3/ Of this amount $27,000.00 is the anticipated contribution toward land easements and rights-of-way. which may or may not be contributed. The $434,039 is the maximum amount of the cost of the project to be paid by the District in case actual costs exceed the estimates.

The cost of legal, engineering, land acquisition expenses, administration and other expenses of the District incident to the development and execution of the Official Plan and not paid with funds from preliminary assessments or other sources is estimated to be $26,000. This added to the $434,039 in the preceding summary gives a total estimated cost to the District of $460,039.