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NATIONAL DAM INSPECTION PROGRAM. WARRINGTON TOWNSHIP RETENTION --ETC(U)
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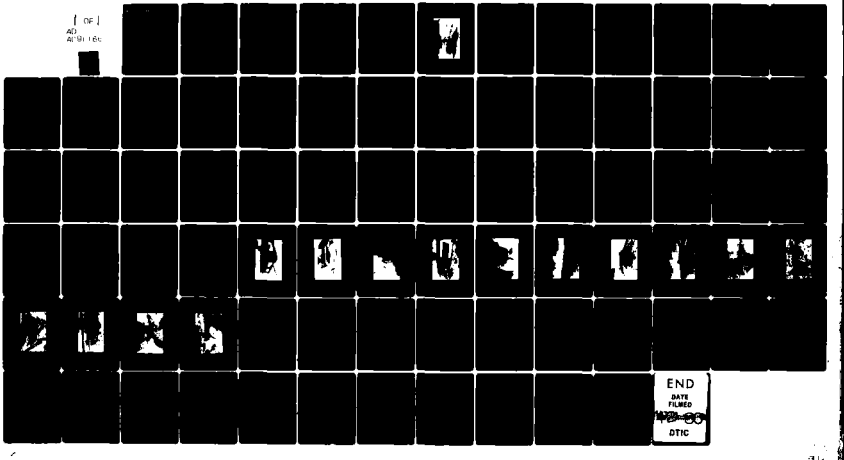

DELAWARE RIVER BASIN

TRIBUTARY TO LITTLE NESHAMINY CREEK, BUCKS COUNTY

PENNSYLVANIA

NDS ID PA. 01066

DER ID 9-176

WARRINGTON TOWNSHIP RETENTION BASIN

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DACW31-80-C-0018

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

AUGUST 1980

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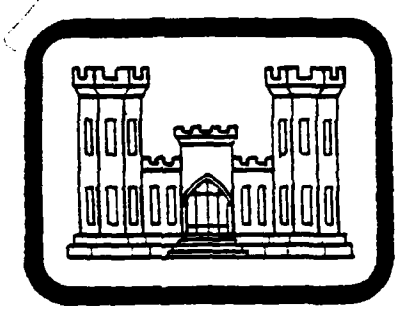

Prepared by:

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DACW31-80-C-0052

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

AUGUST 1980

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Warrington Township Retention Basin Dam
County Located:	Bucks County
State Located:	Pennsylvania
Stream:	Unnamed tributary to the Little Neshaminy Creek
Coordinates:	Latitude 40° 14.2' Longitude 75° 7.6'
Date of Inspection:	June 13, 1980

Warrington Township Retention Basin Dam was built to control storm runoff resulting from upstream residential development. Visual inspection and review of design and construction documentation indicate that the dam and appurtenant structures of Warrington Township Retention Basin Dam are in generally good condition.

In accordance with criteria established by Federal (OCE) Guidelines, the spillway design flood for this "Small" size dam and "Significant" hazard classification is the 100 Year Flood to one-half the Probable Maximum Flood (PMF). Because of the dam's low height and small total capacity, the selected spillway design flood is the 100 year event. Hydrologic and hydraulic computations presented in Appendix D indicate that the spillways are capable of passing the 100 year event without overtopping the embankment under design conditions. Under existing conditions, the spillway capacity is estimated to be overtopped by about 0.2 feet. The spillway system of this structure is considered to be "Inadequate" under assumed existing conditions.

It is recommended that the following measures be taken as soon as practical. These recommendations are presented in order of priority, but this does not infer that the latter recommendations are not important.

1. A detailed hydrologic/hydraulic study should be performed to determine the best method of increasing spillway capacity.

2. In lieu of the above recommendation, alternate trash rack bars should be removed from the high stage orifices in an effort to prevent accumulation and blockages by small debris during a rainstorm.

3. Debris, sediment and the reported board closing of the low stage orifice should be removed to allow the reservoir level to be maintained at its original design normal pool elevation.

4. Leaking joints in the principal spillway conduit should be repaired.

5. Accumulated sediment at the upper ends of the reservoir is reducing floodwater storage capacity and should be removed.

Because of the location of the dam and the potential for property damage with little or no loss of life in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents that high flows are expected and provisions for evacuating these people in the event of an emergency. In addition, a maintenance and operational procedure should be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition. Also included in the operation and maintenance procedures should be procedures to maintain an adequate stand of vegetation, particularly on the crest and downstream slope.

Mary F. Beck, P.E.
Pennsylvania Registration 27447E
Woodward-Clyde Consultants

Date 8/31/80

John H. Frederick, Jr., P.E.
Maryland Registration 7301
Woodward-Clyde Consultants

Date 8/31/80

APPROVED BY:

[illegible]
[illegible], Corps of Engineers
District Engineer

Date 5 Sept 80

OVERVIEW
WARRINGTON TOWNSHIP RETENTION BASIN, BUCKS COUNTY, PENNSYLVANIA

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
WARRINGTON TOWNSHIP RETENTION BASIN DAM
NATIONAL ID NO. PA 01066
DER NO. 9-176

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Warrington Township Retention Basin Dam is a 14.8 foot high homogeneous earth embankment about 600 feet long with an emergency spillway at the left end of the embankment. A key trench was excavated under the dam center line. The embankment and key trench fill were constructed of materials excavated from the reservoir area, identified on test logs as red clay with shale fragments. The key trench bottom width is eight feet with upstream and downstream slopes of 1H:1V. The upstream embankment slope is 3H:1V and is protected with Crownvetch above the waterline. The minimum crest elevation is 248.8, and the ten foot wide crest is protected by a bituminous concrete footpath about three feet wide. The downstream embankment design slope is 3.1H:1V, and the embankment is protected with vegetation. Plan and cross-section views of the dam are shown on Plates 2 and 3, Appendix E.

The principal spillway consists of a concrete riser box, twin 68 foot-72 inch conduits and an impact basin at the downstream toe. Each conduit has two anti-seep collars located 12 feet upstream and downstream of the dam center line. The conduits are reinforced concrete pipe with mortared tongue-and-groove joints. The reservoir drain is located slightly above the base of the riser at an invert elevation of 235.7, and consists of 10 feet of 16 inch cast iron pipe controlled by a gate valve inside the riser, Photograph 3. The

riser has a low stage orifice, one foot wide by four feet high, with an invert elevation of 240.2. There are six basically rectangular shaped orifices, 5.5 feet wide and 2.0 feet high, with invert elevations of 245.2. Reinforcing bars embedded in the concrete wall form the trash rack for the low stage orifice. The large orifices' trash racks consist of No. 6 reinforcing bars at six inch centers.

An emergency spillway is located at the left end of the embankment. The footpath across the entrance channels has a minimum elevation of about 246.6. The emergency spillway has an adverse (uphill) slope for about 100 feet. The crest elevation is 247, and the channel approximates a trapezoidal shape. The emergency spillway discharge joins with the principal spillway discharge immediately downstream of the impact basin. The principal spillway channel and emergency spillway discharge rejoin the original stream channel about 220 feet downstream of the impact basin.

Water enters the retention basin through three storm sewer outlets and two roadway culverts. To prevent houses on the upstream side of the reservoir from being flooded when the reservoir level is at the top of the embankment elevation, a dike was constructed to elevations ranging from 248.4 to 249.9. Inlets upstream of the dike convey water to a 30 inch reinforced concrete pipe located under the basin floor, discharging immediately downstream of the impact basin; see Photograph 4. A second storm sewer collects water from downstream of the detention basin and discharges it through the side of the impact basin, upstream of the baffle, Photograph 5.

b. Location. The dam is located across an unnamed tributary to the Little Neshaminy Creek in Warrington Township, Bucks County, Pennsylvania. The dam is located approximately 0.8 mile northeast of the intersection of Pennsylvania Routes 611 and 132. The dam site is located on USGS Quadrangle entitled "Ambler, Pennsylvania", at coordinates N 40° 14.2' W 75° 7.6'. A regional location plan of Warrington Township Retention Basin Dam is included as Plate 1, Appendix E.

c. Size Classification. The dam is classified as a "Small" size dam by virtue of its less than 40 foot height and less than 1,000 acre-foot total storage capacity to the top of the dam.

d. Hazard Classification. A "Significant" hazard classification is assigned consistent with its location above an urban area and its potential for property damage with few or no lives lost along the stream between the dam and Little Neshaminy Creek.

e. Ownership. Warrington Township Retention Basin Dam is owned by Warrington Township. All correspondence should be sent to Mr. Joseph J. Bonargo, Township Manager, 3400 Pickertown Road, Warrington, Pennsylvania 18976.

f. Purpose of Dam. The purpose of this dam is to control storm water runoff resulting from extensive development of the watershed and to alleviate flooding conditions downstream of the dam.

g. Design and Construction History. The dam was designed by A. W. Martin Associates, Inc.*, the Warrington Township engineers. An application for a construction permit was made on June 9, 1975. Between the date of the application and September 8, 1975, when the permit to construct was issued, several modifications were made to the design at the request of the state. These changes include the addition of the impact basin energy dissipator to the outlet structure, location of the emergency spillway in natural ground at the left abutment, and concrete encasing of a sanitary sewer beneath the reservoir. In lieu of "flowage easements" up to elevation 246 on properties upstream of the reservoir, the dike and drainage inlet bypassing the reservoir were added on the north side of the reservoir. Riprap was shown to be applied to the side slopes of the emergency spillway, and a subdrain was to be installed in the old stream bed. Prior to the start of construction, the design water surface elevations as well as the dam and dike crest elevations were raised and the emergency spillway was relocated.

Construction on the project began in April 1976, under the supervision of the township engineer, A. W. Martin. Contractor for the project was Jude Construction Company; James D. Morrisey, Inc., was the subcontractor responsible for the earthworks. Changes made during construction primarily involved relocating the dike to preserve existing trees and minimize regrading of adjacent properties. As a result, the normal elevation of the reservoir was lowered by two feet. The total capacity of the reservoir was to remain the same. The dam was reported completed on November 1, 1977. A November 9 inspection by the state noted several changes from the design drawings, which are noted on the as-built drawings. It was reported shortly after construction that the township placed a two foot high board in the low stage orifice, raising the normal pool by two feet, or to elevation 242.2.

h. Normal Operating Procedures. Reservoir outflow is controlled by the principal and emergency spillways. Under design conditions, water flows through the low stage principal

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* A. W. Martin Associates, Inc., is now SMC-Martin.

spillway opening at elevation 240.2. Excess water is first stored to the invert of the six large orifices in the riser, and therafter excess water is stored to the emergency spillway crest, elevation 247.0.

1.3 Pertinent Data.

A summary of pertinent data for Warrington Township Retention Basin Dam is presented as follows.

a.	Drainage Area (square miles)	0.82
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood at Dam Site	Unknown
	At Top of Dam	
	Principal Spillway	
	Design	485
	Existing*	215
	Emergency Spillway (est)	340
c.	Elevation (feet above MSL)	
	Top of Dam (Design)	248.0
	(Existing)	248.8
	Emergency Spillway Crest	
	Design	247±
	Existing	247
	Principal Spillway	
	Low Stage Orifice	240.2
	High Stage Orifices (six)	245.2
	Pond Drain Inlet Invert	235.7
	Outlet Inverts	234.5, 234.4
	Impact Basin End Sill	236.1
	Stream Bed	234±
	Downstream Toe	238.2
d.	Reservoir (feet)	
	Length at Normal Pool (240.2)	220
	Length at Maximum Pool	520
e.	Storage (acre-feet)	
	Low Stage Orifice	4
	To High Stage Orifice	16
	To Top of Dam	30

* Assumes high stage trash racks partially blocked by debris

f.	Reservoir Surface Area (acres)	
	Existing Normal Pool	3.3±
g.	Dam Data	
	Type	Homogeneous earth fill
	Length	600 feet
	Maximum Height	14.8 feet
	Top Width	10 feet
	Volume	1,900 cubic yards
	Side Slopes	
	Upstream	
	Design	3H:1V
	Existing (above water level)	3.1H:1V
	Downstream	
	Design	3H:1V
	Existing (minimum)	4.7H:1V
	Cutoff	Trench constructed under dam centerline
	Grout Curtain	None
h.	Principal Spillway	
	Type	Concrete riser box & twin 72" conduits
	Reservoir Drain	16 inch gate valve in riser box
	Low Stage Orifice	
	Elevation	240.2
	Size	1.0' wide, 4.0' high
	High Stage Orifices (six)	
	Elevation	245.2
	Size	5.5' wide, 2.0' high
	Energy Dissipator	Impact basin
i.	Emergency Spillway	
	Type	Channel excavated through rock
	Crest Elevation	247
	Width	50 feet

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of the available engineering data on Warrington Township Retention Basin Dam is attached as Appendix B. Engineering data available for review are contained in a 14 page final drainage report for a permanent retention basin in Warrington Township, prepared by A. W. Martin, April 1975. Also located in Department of Environmental Resources (DER) files are design drawings and as-built drawings also prepared by A. W. Martin. Additional information was obtained from miscellaneous letters and correspondence located in DER files and from conversations with A. W. Martin representatives.

b. Design Features. The principal design features of Warrington Township Retention Basin Dam are illustrated on the plans and profile enclosed in Appendix E as Plates 2 and 3. A detailed description of the design features is also described in Section 1.2, paragraph a, and pertinent data relative to the structure are presented in Section 1.3.

2.2 Construction.

The known construction history is presented in Section 1.2, paragraph g.

2.3 Operational Data.

There are no operational records maintained by the Owner's engineer. There are no minimum flow requirements for the downstream channel. There are no water level measurements or rainfall records maintained within the watershed.

2.4 Evaluation.

a. Availability. All engineering data evaluated and reproduced for this report were provided by DER and supplemented by conversations with the Owner's engineer.

b. Adequacy. Data included in state files are not sufficient to evaluate the dam and appurtenant structures.

c. Validity. There is no reason to question the validity of the limited available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix A, and are summarized and evaluated as follows. In general, the embankment is considered to be in good condition, the vegetation in poor condition, and the principal spillway conduits are considered to be in fair condition.

b. Dam. During the visual inspection, there were no indications of distortion in alignment or grade that would be indicative of movement of the embankment or foundation. Vegetative cover on the downstream face of the embankment is considered to be in poor condition with patchy areas, particularly at the maximum section. At the time of the inspection, there was very little damage evident as a result of the poor vegetative cover on the downstream face. There is some erosion or foot traffic damage adjacent to the sides of the impact basin. The crest is protected from foot traffic damage by a bituminous pavement footpath, Photograph 8, and vegetation is sparse. A chain-link fence is along the upstream edge of the crest, as shown on Sheet 5A and Photograph 8. Vegetation on the upstream embankment consists of Crownvetch and grass, and is very heavy. Foot traffic has created a path around the water's edge, as shown in Photograph 9.

The vertical and horizontal alignments were checked and found to be satisfactory. Junctions between the embankment and abutment were judged to be in good condition with no excessive erosion or deterioration. No seepage was noted either at or beyond the toe of the embankment.

c. Appurtenant Structures.

1. Principal Spillway. As shown on the plates, the riser box is located at the upstream toe of the embankment. The exterior portion of the riser above the waterline and the interior of the riser were inspected and found to be in good condition with no signs of excessive concrete deterioration, spalling or other structural deficiency or defects. There was some seepage through one riser wall with leachate deposits. The access hatch lid is missing from the top of the riser. As-built drawings indicate a gate valve stem extending through the top of the riser, permitting the gate valve to be operated from the top of the riser. There is no valve stem and

therefore, the gate valve can now only be operated by entering the riser. Shortly after the dam was completed, a board was installed in the low stage orifice to raise the normal pool level by two feet. Since then, debris and sediment have blocked the remaining two feet of the low stage orifice, raising the normal pool to its present level.

The principal spillway conduits are twin 72 inch reinforced concrete pipes with mortared tongue-and-groove joints. In each conduit, the first joint from the upstream end was dripping water from the top, had leachate deposits and fine-grained material along the joints. The second joint in each conduit from the upstream end had a slight leakage of water through them. Other joints had missing mortar, leachate deposits, were wet or had some cracking through the mortar but no horizontal displacement was noted.

As shown in Photograph 1, trash racks over the large orifices in the riser are reinforcing bars spaced six inches on center. Such close spacing allows small debris to build up on the trash racks during a storm, partially or completely clogging them.

The impact basin at the downstream toe was inspected. A 48 inch corrugated metal storm sewer outlets through the left sidewall of the impact basin upstream of the baffle. The interior and exposed exterior portions of the impact basin were inspected and judged to be in good condition, with no signs of excessive concrete deterioration, spalling or other structural deficiency or defects. Debris and sediment were noted on the impact basin floor.

2. Emergency Spillway. The grass-lined emergency spillway at the left abutment was inspected and found to be stable and in good condition, with the exception of some minor gullying occurring near the downstream end of the channel. The vegetative cover on the emergency spillway is only in fair condition, although it is to be noted that rock is at or near the surface in this area. The as-built drawings indicate that the emergency spillway section is 58 feet wide and 2.5 feet deep, with side slopes of 2H:1V. The appearance of the emergency spillway approach channel is that of a wide, shallow swale rather than a trapezoidal channel, with a minimum elevation of 246.6. The channel has an adverse (uphill) slope for about 100 feet. The crest elevation is 247, and the channel bottom width is about 50 feet at the control section.

d. Reservoir. At the time of the inspection, the water in the reservoir was at elevation 244.4, 4.2 feet above the as-built normal pool elevation of 240.2. Because of upstream construction, considerable sediment has accumulated in the

reservoir, partially blocking the low stage discharge orifice and accumulating at the upper ends of the reservoir. Photograph 12 shows a point bar forming from sediment entering the reservoir from the northwest corner. Similar deposits were observed at the northeastern upper end of the reservoir. Reservoir side slopes are grassed to the water's edge along the northern edge of the reservoir. Along the southern side of the reservoir to the left of the emergency spillway, considerable patchiness and exposed rock were noted.

e. Downstream Channel. As shown on Plate 1, Appendix E, the discharge channel from the dam flows through a residential area before discharging into Little Neshaminy Creek. About 400 feet downstream of the dam, the channel passes behind the backyards of homes. The channel is about 11 feet wide, and the height of the banks ranges from about three to four feet. In areas, the stream is contained within gabion structures or stone masonry walls. About 1000 feet downstream of the dam, discharge flows under Palomino Road through a pipe arch culvert about 75 inches high and 112 inches wide; see Photograph 14. Between the dam and Palomino Road are at least six houses approximately two feet above the channel bank, with another seven within four feet of the top of the channel bank.

3.2 Evaluation.

Inspection of the dam and appurtenant facilities disclosed no evidence of apparent past or present movement that would indicate existing instability of the dam or emergency spillway. The principal spillway was inspected, and the riser and impact basin are in good condition. However, joints of the twin 72 inch conduits are in poor condition and in need of repair. It has also been noted that the trashrack bars on the principal spillway orifices are very close together. It is recommended that every other bar be removed from the trashrack, resulting in a 12 inch spacing between bars. Erosion noted outside the impact basin, or adjacent to the impact basin, and in the emergency spillway is minor at the present time. Therefore, the embankment is considered to be in good condition although the vegetation cover is poor. The overall condition of the dam is considered to be good.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Operational procedures are discussed in Section 1.2. Operation of the dam does not require a dam tender. Under design conditions, flow would discharge through the low stage orifice and through the twin 72 inch conduits at the base of the embankment. Excess water would first be stored to the inverts of the six large orifices and then discharged through the orifices and through the conduits. Additional excess water is then stored and discharged over the crest of the emergency spillway. As reported by the Owner's representatives, water has never flowed over the emergency spillway. Although, in the summer of 1979, the reservoir level rose almost to the emergency spillway crest as a result of small debris clogging the trash racks on the riser. There are no written operation or maintenance procedures for this structure.

4.2 Maintenance of the Dam.

The dam is maintained by Warrington Township personnel who periodically check the embankment, mow the grass and remove debris as required.

4.3 Maintenance of Operating Facilities.

Township personnel provide any required maintenance to the gate valve.

4.4 Warning Systems In Effect.

There are no written warning procedures to be followed in the event of high precipitation. The practice followed by the township is to observe the dam during periods of high precipitation. This would be done under the direction of the township manager or the road master. When the reservoir level rose in the summer of 1979, it was the township engineer who, by using a boat, removed debris from the trashracks to permit discharge through the principal spillway.

4.5 Evaluation.

It is judged that the current operating procedure, which does not require a dam tender, is a realistic means of operating the relatively simple control facilities at Warrington Township Retention Basin Dam. There are no written operation, maintenance or warning procedures. Maintenance and operation procedures should be developed, including a checklist of items to be observed, operated and inspected, and maintained on a regular basis.

Since a formal warning procedure does not exist, one should be developed and implemented during periods of extreme rainfall. Procedures should consist of a detailed method of notifying residents downstream if potentially high flows are imminent or if a dangerous condition is developing.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. The original hydrologic and hydraulic design is in the Department of Environmental Resources files and was available for review. These calculations were prepared in 1975, and do not reflect the changes made in the design of the dam subsequent to that date.

The small watershed has a maximum width of about 1.5 miles and a maximum length of about a mile. Elevations range from about 410 to the normal pool elevation, currently about elevation 245. The watershed has a total area of about 0.82 square miles. The watershed is located in a rapidly urbanizing area, and it can be expected that the entire watershed will be developed.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "Significant" hazard classification is the 100 Year Flood to one-half the Probable Maximum Flood (PMF). Because of the very small size of the dam and the short distance to Little Neshaminy Creek, the selected spillway design flood is the 100 year event.

The original spillway design flood for this structure was the 100 Year Event. The original design parameters and results are summarized in Appendix D.

b. Experience Data. There are no records of reservoir levels or rainfall kept for this dam. It was reported that during the summer of 1979, the reservoir level increased to near the emergency spillway crest as a result of small debris blocking the trash racks during a rainstorm. It was necessary to obtain a boat and remove debris from the trash racks to allow flow through the principal spillway.

c. Visual Observations. On the date of the inspection, the only condition noted that would indicate a reduced spillway capacity during a rainstorm was the very close spacing (six inches) of the trash rack bars for the large orifices. The purpose of the trash rack is to prevent large debris from entering the riser and clogging the principal spillway conduit. Frequently used spacings on trash rack bars range from one-quarter to one-half the diameter of the conduit, in this case, 1.5 to 3.0 feet. Because of the relative ease with which small debris could be removed from

inside the riser box, it is recommended that trash rack bars be removed from the large orifices in an effort to prevent small debris from accumulating and blocking the orifices during a rainstorm. Other observations regarding the condition of the downstream channel, spillway and reservoir are located in Appendix A and are discussed in greater detail in Section 3.

d. Overtopping Potential. The overtopping potential of this dam was estimated using the HEC-1, Dam Safety Version, computer program. A brief description of the program is included in Appendix D. The 100 year inflow hydrograph was developed according to procedures established for Phase I Investigations. The peak inflow value is about 665 cfs, less than the value determined by the Soil Conservation Service (SCS) method used in the original design. The SCS procedure for determining peak inflows to reservoirs is an adequate and conservative procedure. The flood routing was done assuming both design conditions and existing conditions. The principal spillway capacity with the reservoir level at the top of the embankment is estimated to be 485 cfs. Flow through the emergency spillway would be about 360 cfs under design conditions. Under existing conditions, the maximum principal spillway capacity is estimated to be about 215 cfs and, in fact, may be much lower when the trash racks are blocked by small debris. Under design conditions, the combined spillways can pass the 100 year event without overtopping the embankment. Under assumed existing conditions, the embankment is overtopped by about 0.2 feet.

e. Spillway Adequacy. As the spillways cannot pass the selected spillway design storm under existing conditions without overtopping the embankment, the spillway is considered "Inadequate". If alternate trash rack bars are eliminated and the normal pool level reduced to design elevation, the spillway classification would be "Adequate".

f. Downstream Conditions. The downstream channel is described in Section 3. A typical channel section is located about 1,000 feet downstream of the dam. Six houses are located at about elevation 224.7 and seven houses at elevation 228. The culvert under Palomino Road is estimated to discharge about 600 cfs without overtopping the roadway. While few or no lives are expected to be lost in the event of a dam failure, property damage to houses and outbuildings can be expected, thus justifying a "Significant" hazard classification.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations detected no evidence of potential instability of the dam or its components. Downstream slopes are uniform and quite flat with no signs of significant erosion or sloughing in spite of the poor vegetation cover. Some erosion was noted adjacent to the basin, but is not considered significant at this time. The crest is protected by the bituminous pavement footpath and is not damaged by foot traffic. The upstream slope and vegetation is generally in good condition except for the footpath worn around the water's edge.

The spillway is judged to be in good condition, with repairs required to conduit joints.

b. Design and Construction Data. All available documentation, drawings and data received from the Department of Environmental Resources, and supplemented by conversations with the township engineer, A. W. Martin, were assessed and reviewed. The stability analysis of the embankment was not included. Based on the lack of visual signs of significant deterioration and its geometric configurations, it is qualitatively assessed that the stability of the embankment is adequate.

c. Operating Records. There are no operational or maintenance records maintained for this dam.

d. Post-Construction Changes. There is no record nor is there any evidence that any major modifications were made to this dam since construction.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. As the dam is qualitatively assessed to be stable under static loading conditions, it can be reasonably assumed to be safe under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection and review of design and construction documentation indicate that the dam and appurtenant structures of Warrington Township Retention Basin Dam are in generally good condition.

In accordance with criteria established by Federal (OCE) Guidelines, the spillway design flood for this "Small" size dam and "Significant" hazard classification is the 100 Year Flood to one-half the Probable Maximum Flood (PMF). Because of the dam's low height and small total capacity, the selected spillway design flood is the 100 year event. Hydrologic and hydraulic computations presented in Appendix D indicate that the spillways are capable of passing the 100 year event without overtopping the embankment under design conditions. Under existing conditions, the spillway capacity is estimated to be overtopped by about 0.2 feet. The spillway system of this structure is considered to be "Inadequate" under assumed existing conditions.

b. Adequacy of Information. The combined visual inspection and review of available data and simplified calculations, presented in Appendix D, were sufficiently adequate to determine that further investigations may be required for this structure.

c. Urgency. It is recommended that the measures presented in Section 7.2 be implemented as specified.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following measures be taken as soon as practical. These recommendations are presented in order of priority, but this does not infer that the latter recommendations are not important.

1. A detailed hydrologic/hydraulic study should be performed to determine the best method of increasing spillway capacity.

2. In lieu of the above recommendation, alternate trash rack bars should be removed from the high stage orifices in an effort to prevent accumulation and blockages by small debris during a rainstorm.

3. Debris, sediment and the reported board closing of the low stage orifice should be removed to allow the reservoir level to be maintained at its original design normal pool elevation.

4. Leaking joints in the principal spillway conduit should be repaired.

5. Accumulated sediment at the upper ends of the reservoir is reducing floodwater storage capacity and should be removed.

b. Operation and Maintenance Procedures. Because of the location of the dam and the potential for property damage with little or no loss of life in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents that high flows are expected and provisions for evacuating these people in the event of an emergency. In addition, a maintenance and operational procedure should be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition. Also included in the operation and maintenance procedures should be procedures to maintain an adequate stand of vegetation, particularly on the crest and downstream slope.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Warrington Twp. Dam* County *Bucks* State *Pennsylvania* National ID # *PA 01066*

Type of Dam *Earth* Hazard Category *High*

Date(s) Inspection *6/13/80* Weather *Sunny* Temperature *70's*

Pool Elevation at Time of Inspection *244.4* M.S.L. Tailwater at Time of Inspection *234.2* M.S.L.

Inspection Personnel:

Mary F. Beck (Hydrologist) *Vincent McKeever (Hydrologist)*

Raymond S. Lambert (Geologist)

Richard E. Mabry (Geotechnical/ Civil)

Mary F. Beck Recorder

Remarks:

Mr. Don Borden, Mr. John Craven and Mr. Antonio Alessandina, of SMC - Martin, the township engineer, were on site and provided assistance to the inpsection team.

Sheet 1 of 11

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

Sheet 2 of 11

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

Sheet 3 of 11

EMBANKMENT

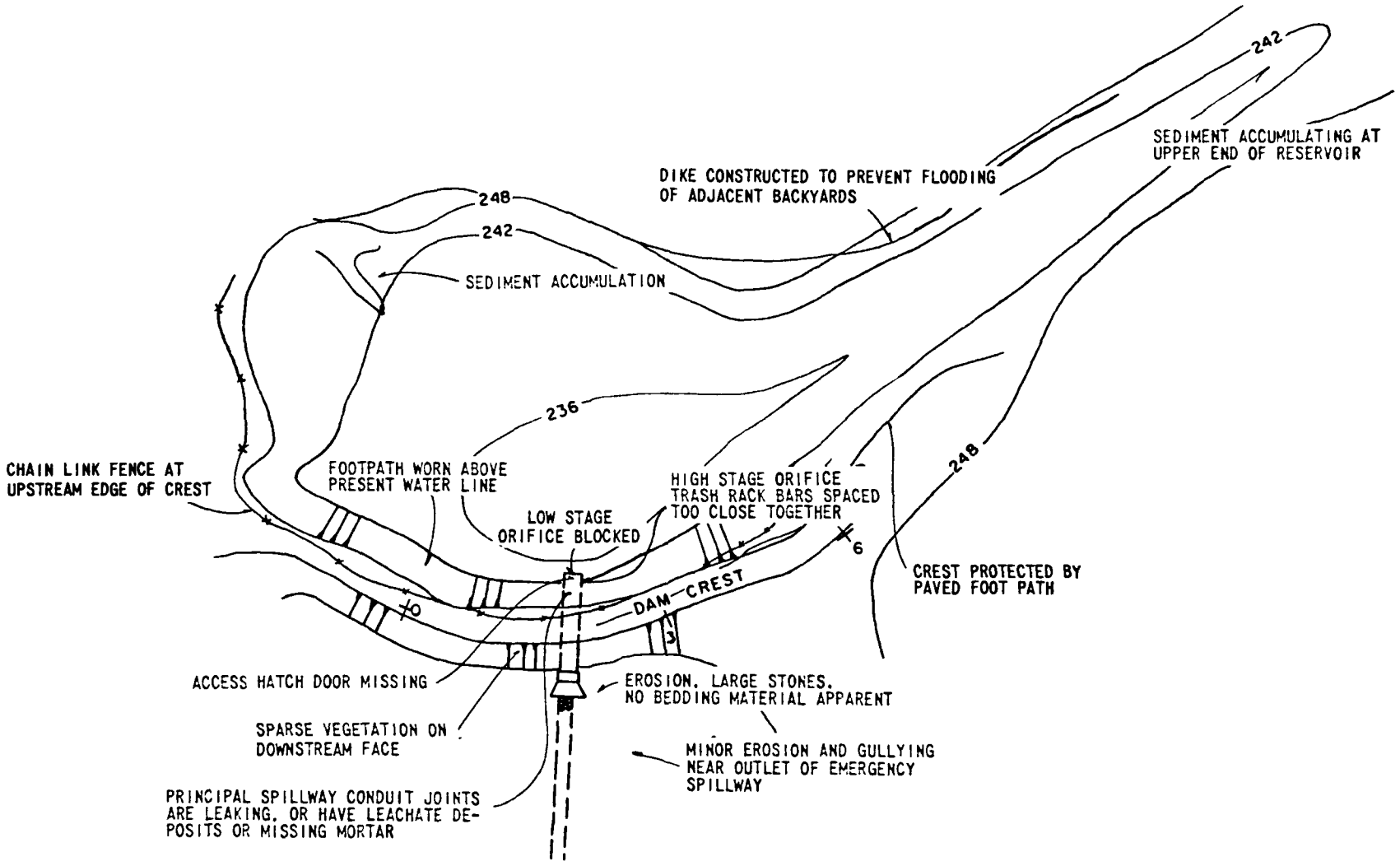
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*Little or no erosion has occurred on downstream face. Upstream face along water line has been damaged by foot traffic.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*See Sheet 5B of 11.*	
RIPRAP FAILURES	*No riprap.*	

Sheet 4 of 11

EMBANKMENT

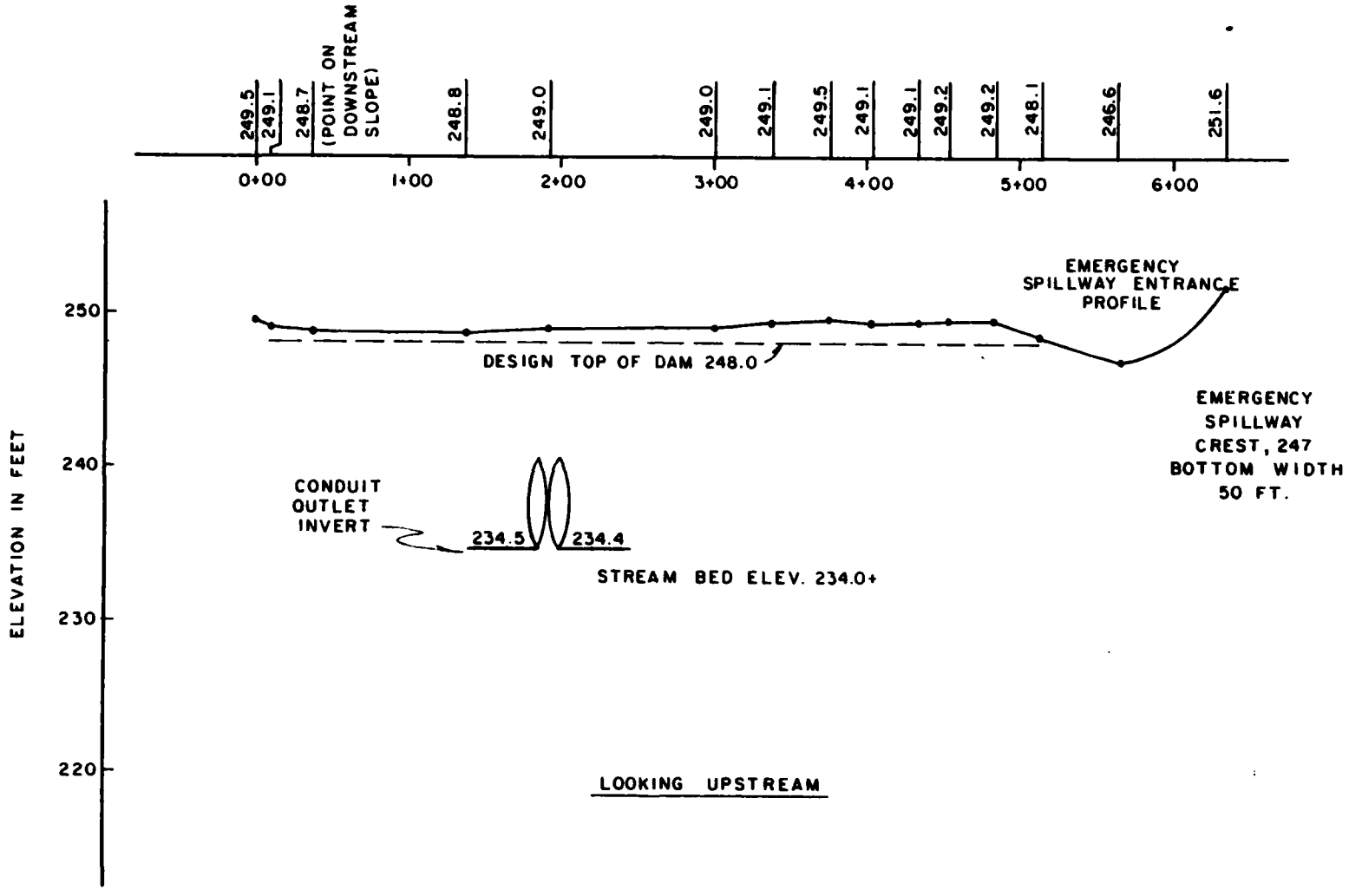
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	*Conditions of vegetation ranges from good to poor. On downstream face grass is sparse. Crownvetch and grass on upper portion of upstream face is in good condition. Grass near water line is in fair condition.*	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*Upstream and downstream junctions of abutment and embankment in good condition. Erosion has occurred at the downstream end of the outlet structure. Large stone with no bedding material is placed where erosion has occurred, See Photograph 11.*	
ANY NOTICEABLE SEEPAGE	*None observed.*	
STAFF GAGE AND RECORDER	*None*	
DRAINS	*None*	

Sheet 5 of 11



FIELD OBSERVATION PLAN
WARRINGTON TOWNSHIP RETENTION BASIN

SHEET 5A OF 11



FIELD OBSERVATION PROFILE
WARRINGTON TOWNSHIP DAM

SHEET 5B OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*Twin 72 inch RCP form outlet conduit. Mortar joints on inside are very rough with some joints leaking, or have leachate deposits or missing mortar.*	
INTAKE STRUCTURE	*Both interior and exterior portions above water line appear in good condition. Some leaking with leachate deposits on one wall. No other concrete deterioration noted. Access hatch missing from top of structure.*	
OUTLET STRUCTURE	*Appears in good condition with no spalling, cracking or other concrete deterioration noted.*	
OUTLET CHANNEL	*Appears in good condition with minor erosion along banks.*	
EMERGENCY GATE	*A 16-inch gate valve located at base of riser. Gate valve not operated because of sediment build up resulting from upstream construction.*	

Sheet 6 of 11

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*None- channel excavated through shale bedrock.*	
APPROACH CHANNEL	*None*	
DISCHARGE CHANNEL	*Discharges into stream immediately downstream of the impact basin.*	
BRIDGE AND PIERS	*None*	

Sheet 7 of 11

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

Sheet 8 of 11

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

Sheet 9 of 11

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Reservoir side slopes are flat to moderate and grassed to water's edge. Some grassed areas are patchy. A considerable amount of debris is in water, which has been reported to have blocked orfices on riser last summer (1979).*	
SEDIMENTATION	*Sediment has accumulated below water level at the riser and above water level at upper ends of reservoir, see Sheet 5A of 11.*	

Sheet 10 of 11

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*The downstream channel is generally in good condition. Shale bedrock is frequently exposed in the bottom or sides of the channel. Gabions are used as retaining walls along portions of the stream. Vandals have opened two baskets and stone is missing.*	
SLOPES	*The valley gradient is about 0.0062.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*Discharge flows through urban residential are for about 3500 feet before entering Little Neshaminy Creek. About 400 feet downstream of the dam are two houses about 4 feet above channel bank. About 1000 feet downstream of the dam, 6 houses about 2.5 feet and 7 houses, 3.5 feet above channel bank.*	

Sheet 11 of 11

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Warrington Township Retention Basin*
ID # *PA 01066*

ITEM	REMARKS
AS-BUILT DRAWINGS	*Located in DER files and the Owner's Engineer's files.*
REGIONAL VICINITY MAP	*Plate 1, Appendix E.*
CONSTRUCTION HISTORY	*See text, Section 1.2*
TYPICAL SECTIONS OF DAM	*See Appendix E.*
OUTLETS - PLAN	*Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*Appendix D.*
RAINFALL/RESERVOIR RECORDS	*None*

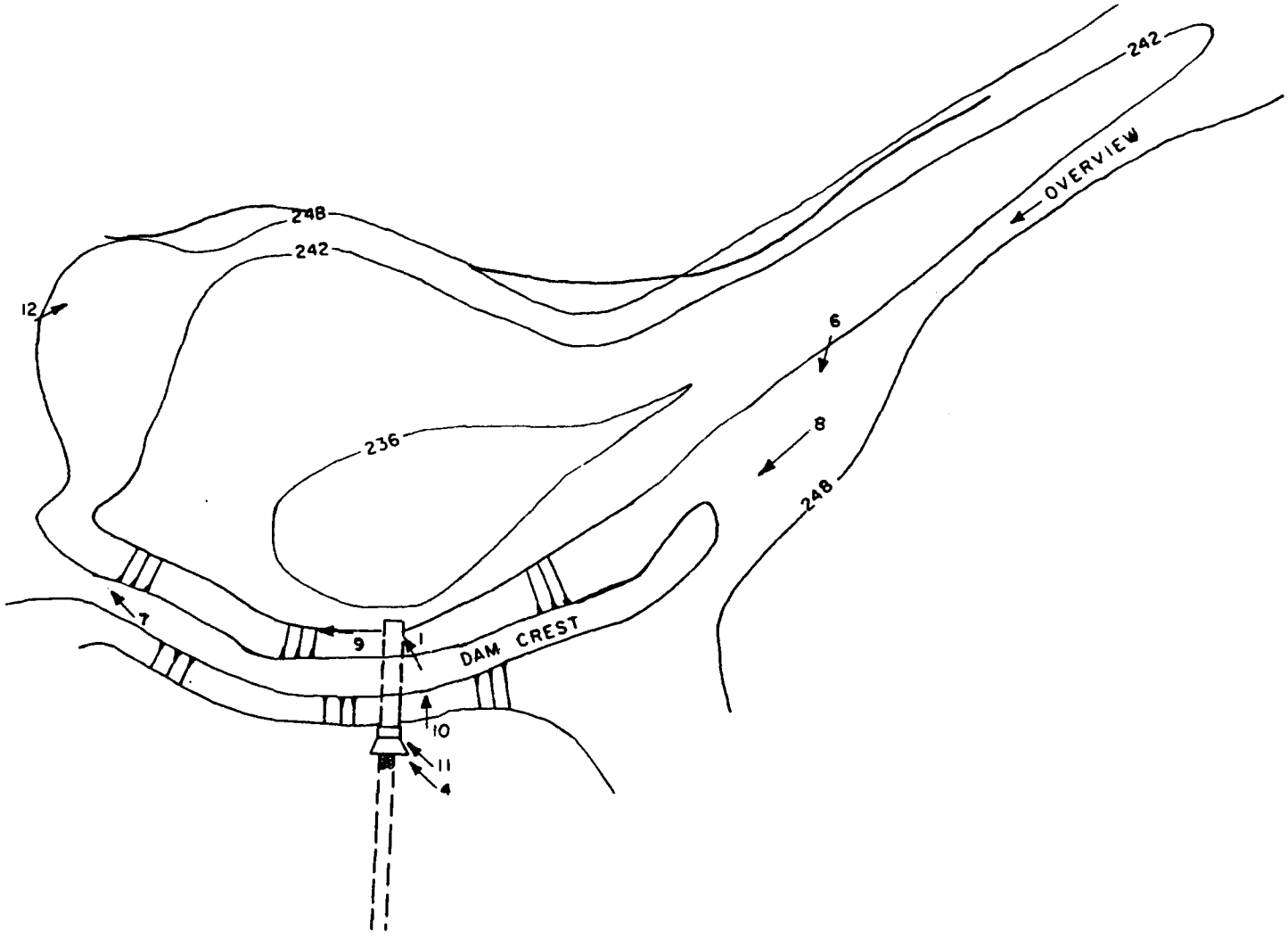
ITEM	REMARKS
DESIGN REPORTS	*Hydrology and hydraulic report prepared by designer, A.W. Martin Associates, April 1975.*
GEOLOGY REPORTS	*See Appendix F.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*Hydrology and hydraulic computations only.*
MATERIALS INVESTIGATIONS BORING RECORDS	*Test pits, see Appendix E.*
LABORATORY FIELD	*Tests made to determine optimum water content and field w_n tests made during construction.*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*Reservoir area.*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*None*
HIGH POOL RECORDS	*None*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*Appendix E.*
OPERATING EQUIPMENT PLANS & DETAILS	*No plans or details available for gate valve in riser*
MISCELLANEOUS	*The following is located in DER files.* 1. *Design and "as-built" drawings* 2. *"Final Drainage Report for Permanent Retention Basin", A.W. Martin, April 1975.* 3. *Specifications prepared by A.W. Martin.* 4. *"Report Upon the Application prepared by the state, August 29, 1975.* 5. *Correspondence and memorandum.* 6. *Ten color photographs.*

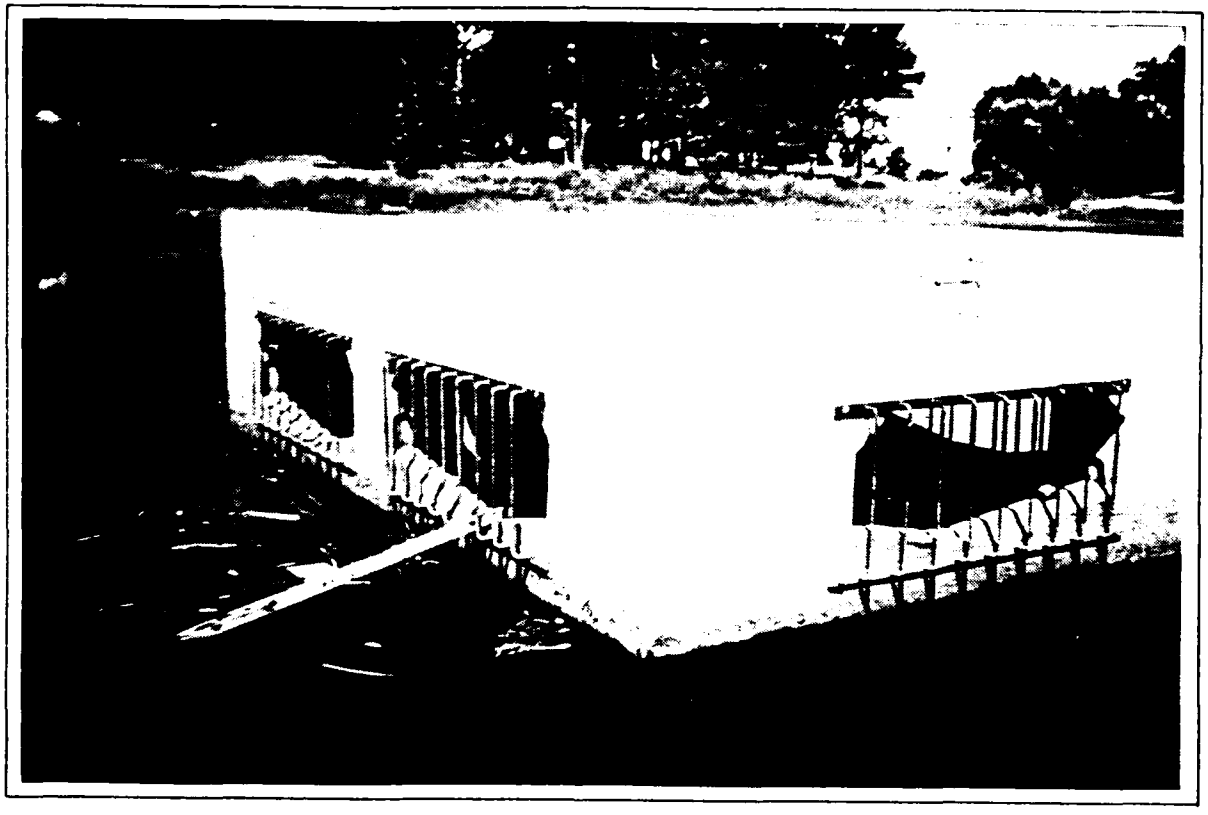
APPENDIX

C



PHOTOGRAPH LOCATION PLAN
WARRINGTON TOWNSHIP RETENTION BASIN

PLATE C-1



RISER WITH INSIDE DIMENSIONS OF
8 FEET BY 14.7 FEET.

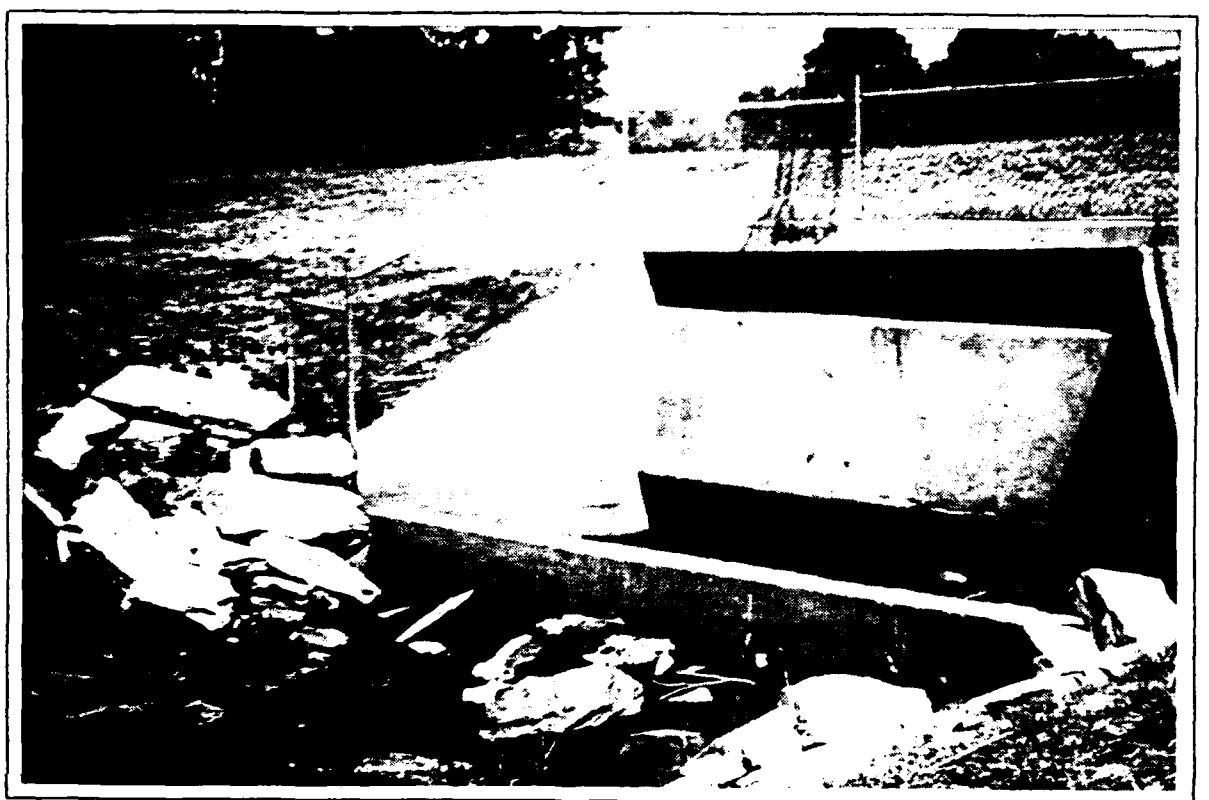
PHOTOGRAPH NO. 1

INTERIOR OF RISER. NOTE VERY LITTLE FLOW THROUGH LOW STAGE ORFICE.

PHOTOGRAPH NO. 2

GATE VALVE ON RISER FLOOR.

PHOTOGRAPH NO. 3



IMPACT BASIN AT DOWNSTREAM TOE.
BAFFLE IS

PHOTOGRAPH NO. 4

INSIDE IMPACT BASIN. ONE OF TWIN
72 INCH CONDUITS TO THE LEFT AND
48 INCH STORM LINE TO THE RIGHT.

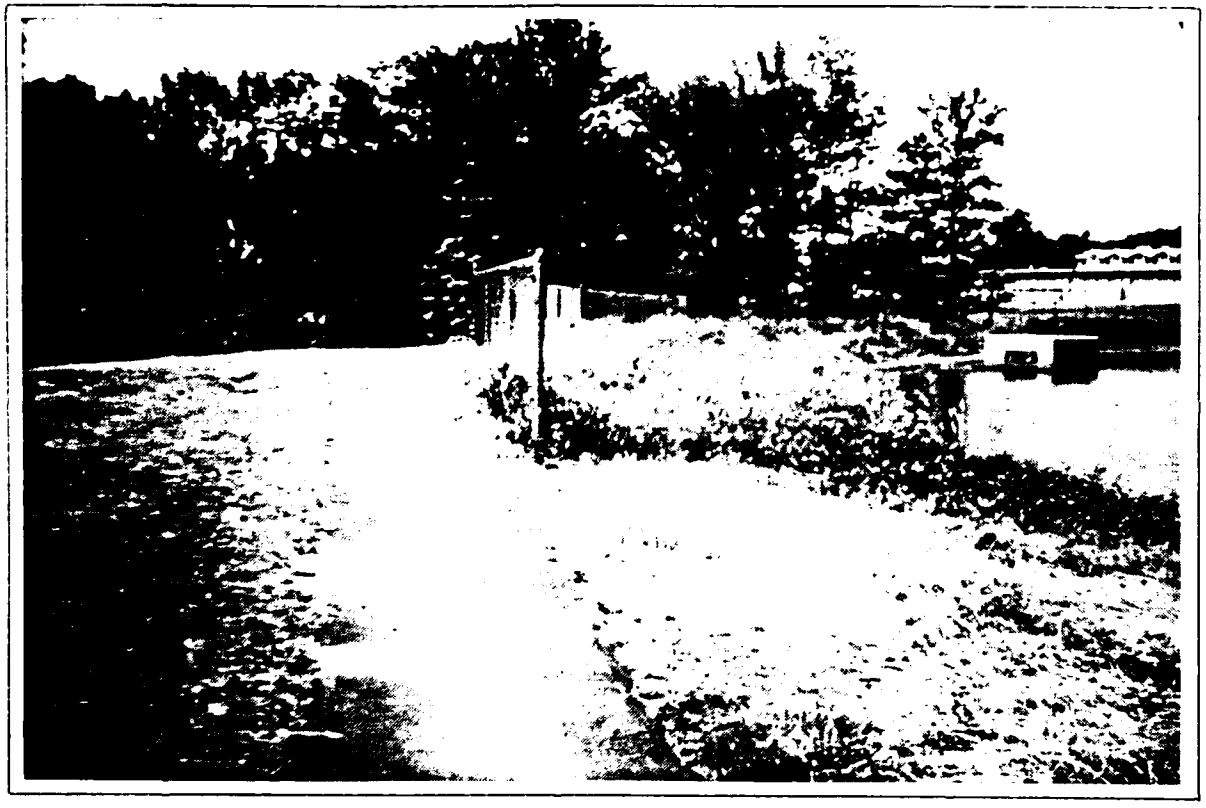
PHOTOGRAPH NO. 5

EMERGENCY SPILLWAY LOOKING DOWNSTREAM.

PHOTOGRAPH NO. 6

DOWNSTREAM FACE, VEGETATION IS SPARCE.

PHOTOGRAPH NO. 7

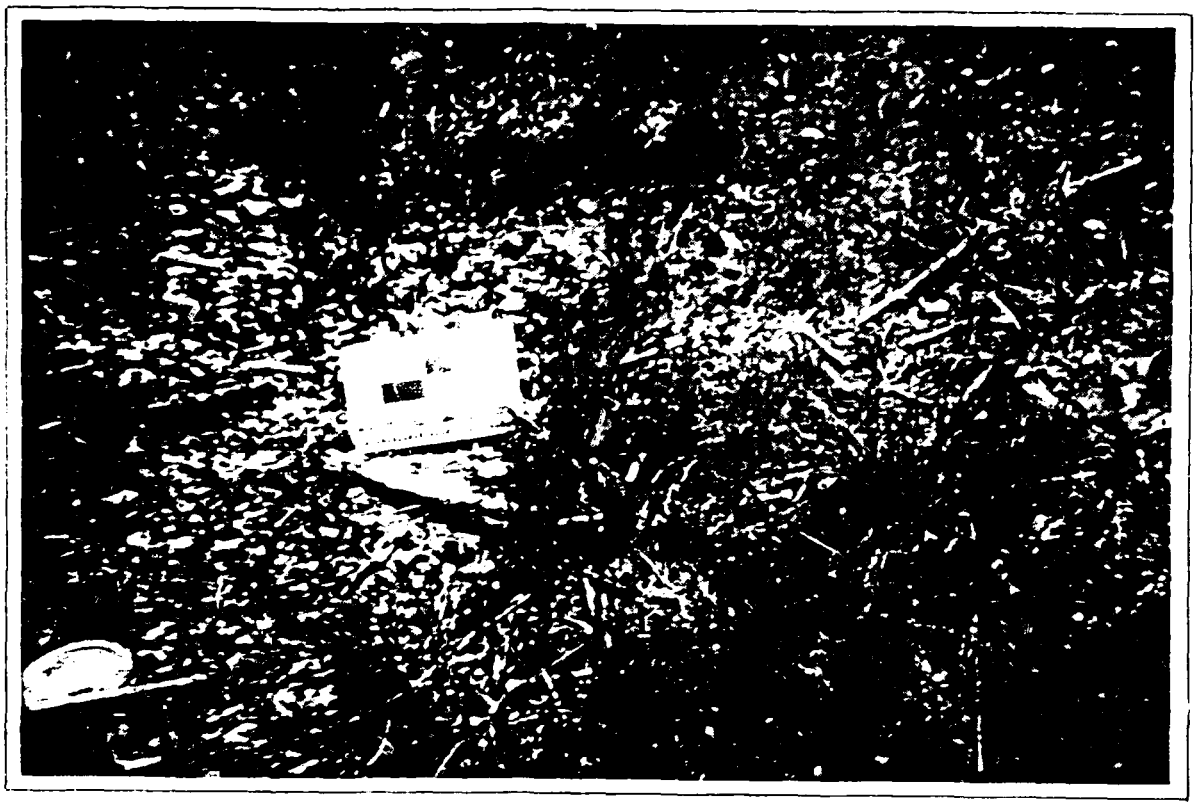


VIEW ALONG CREST.

PHOTOGRAPH NO. 8

UPSTREAM FACE IS BENCHED ABOVE WATER-
LINE BY FOOT TRAFFIC.

PHOTOGRAPH NO. 9



TYPICAL OF SPARSE VEGETATION ON
DOWNSTREAM FACE.

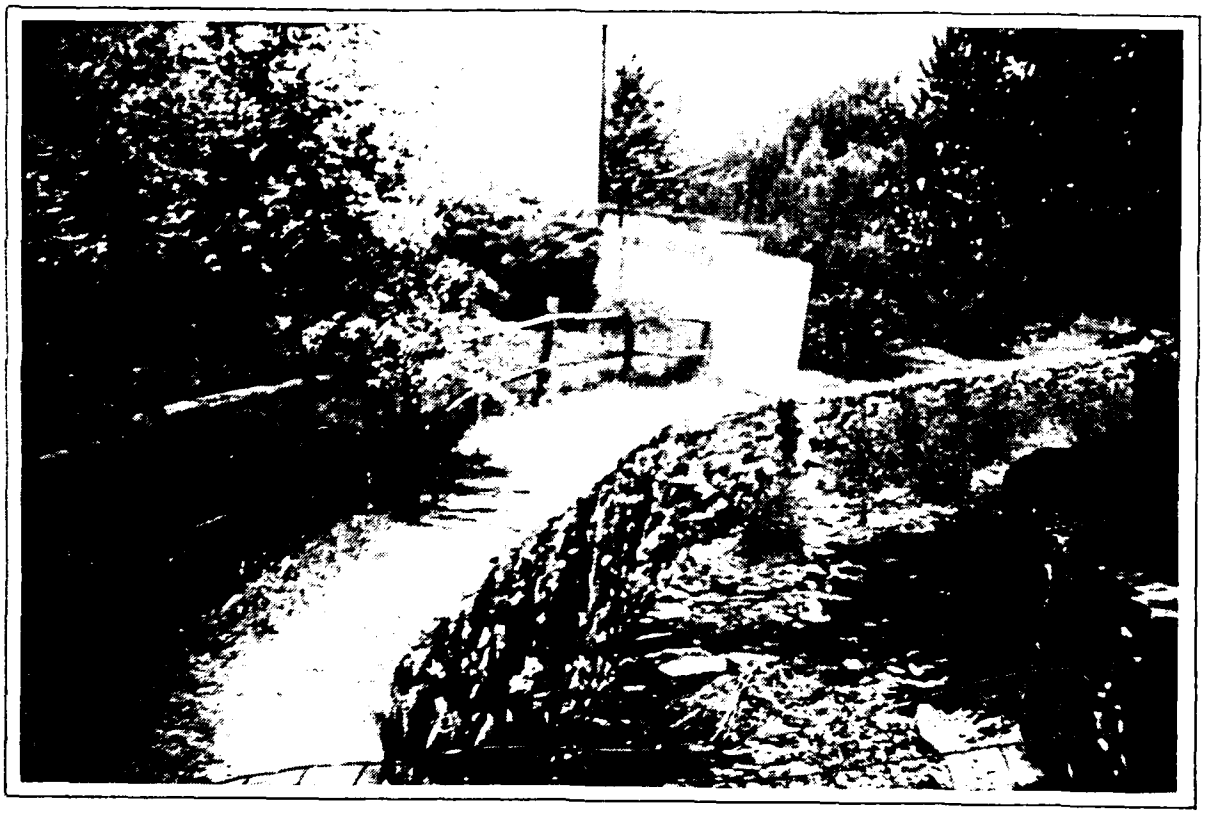
PHOTOGRAPH NO. 10

LARGE ROCK OVER ERODED AREAS AROUND
IMPACT BASIN.

PHOTOGRAPH NO. 11

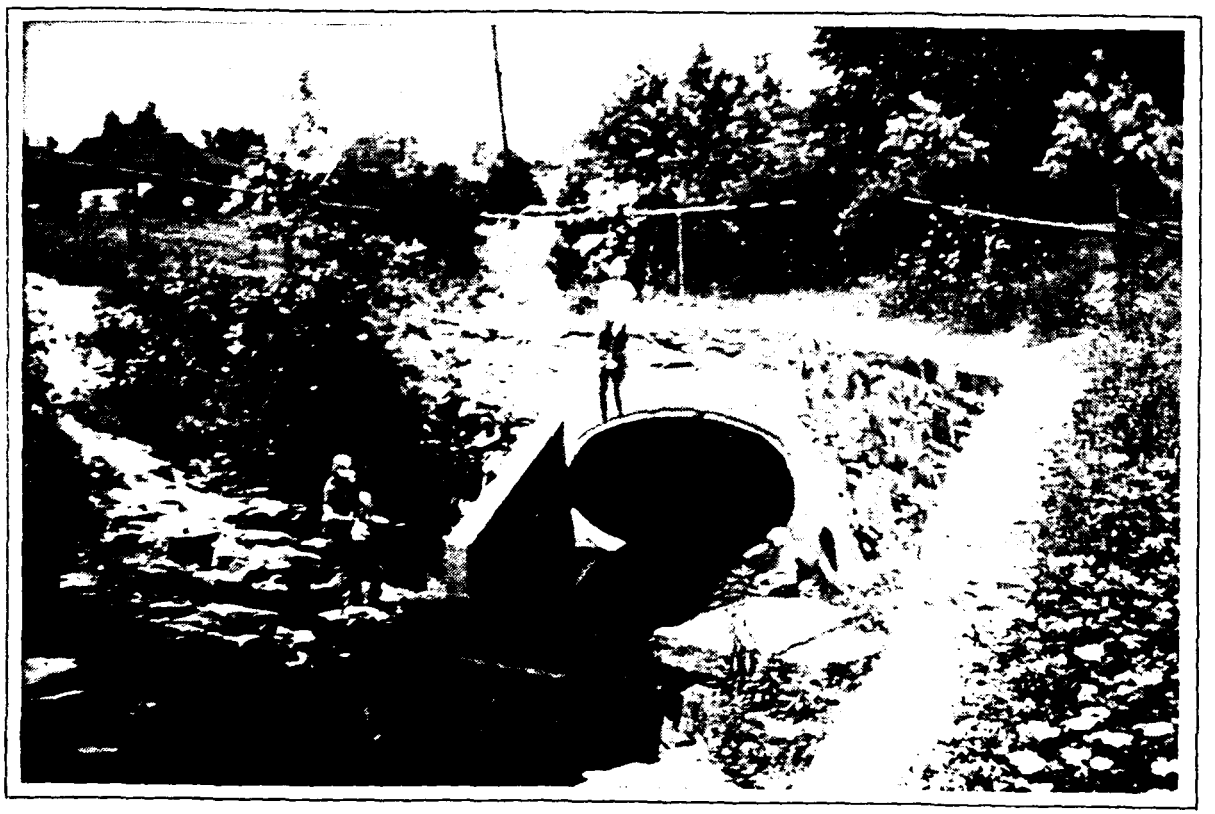
SEDIMENT IS ACCUMULATING IN RESERVOIR.

PHOTOGRAPH NO. 12



HOMES ARE BUILT ADJACENT TO STREAM.

PHOTOGRAPH NO. 13



FIRST DOWNSTREAM ROAD. CULVERT SIZE
IS 75 INCHES HIGH AND 112 INCHES WIDE.

PHOTOGRAPH NO. 14

APPENDIX

D

WARRINGTON TOWNSHIP RETENTION BASIN

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Urban area.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *245.0 feet (16 Acre-Feet) existing.*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *248.8 feet (30 Acre-Feet).*

ELEVATION MAXIMUM DESIGN POOL: ---

ELEVATION TOP DAM: *248.8 feet.*

EMERGENCY SPILLWAY

a. Elevation *247.0 feet*

b. Type *Channel excavated through rock.*

c. Width *50 feet at narrowest point.*

d. Length *400 feet.*

e. Location Spillover *Left abutment.*

f. Number and Type of Gates *None*

OUTLET WORKS:

a. Type *Concrete riser box, twin 72 inch conduits and impact basin.*

b. Location *At maximum section.*

c. Entrance inverts *Low stage orfice, 240.2; high stage orfices (6) 245.2.*

d. Exit inverts *234.4 and 234.5 feet.*

e. Emergency draindown facilities *16 inch gate valve at base of riser.*

HYDROMETEOROLOGICAL GAGES:

a. Type *None within watershed.*

b. Location *N/A*

c. Records *N/A*

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined.*

BY MEB DATE 7/18/80 SUBJECT Warrington Township SHEET 2 OF 11
CHKD. BY REM DATE 7/24/80 Retention Basin JOB No.
Hydrology / Hydraulics

Hydrologic Base Data

Drainage Area 0.82 sq mile, design value checked against USGS maps

100 yr - 24 hr event Rainfall - Ref. Technical Paper 40.
7.0 inch rainfall distributed in the pattern shown on sheet 8

Soil Conservation Hydrograph Parameters

Design Runoff Curve Number - 76
Design Peak Runoff Value - 1027 cfs

Evaluation Peak Runoff Value
determined from regression analysis - 611 cfs

Evaluation Peak Runoff Value - 664 cfs
generated by computer program using
Runoff Curve Number 63
Watershed Lag 0.90

Spillway Capacity at Maximum Water Level 248.8 ft
Design Conditions
Normal Pool at 240.2
Principal Spillway - 485 cfs
Emergency Spillway - 341 cfs
Existing Conditions, Orifices Blocked
Normal Pool at 245.2
Principal Spillway - 215 cfs
Emergency Spillway - 341 cfs
Existing Conditions, Orifices not Blocked
Principal Spillway - 430 cfs
Emergency Spillway - 341 cfs

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

BY MEB DATE 2/18/80 SUBJECT Warrington Township SHEET 4 OF 11
CHKD. BY R&M DATE 2/24/80 Retention Basin JOB No
Hydrology / Hydraulics

Classification. (Ref- Recommended Guidelines for Safety Inspection of Dams)

1. The hazard classification is rated as "Significant" as there would be appreciable economic loss with few or no lives lost.

2. The size classification is "Small" based on its less than 40 ft. height and less than 1000 Ac-Ft total storage capacity.

3. The selected spillway design flood, based on size and hazard classification, is the 100yr event.

Hydrology and Hydraulic Analysis

1. Original Data.
The design was available for review. The spillway design flood was the 100yr event. Peak runoff was estimated from Soil Conservation Service charts for 7.0 inch rainfall, Runoff Curve Number of 76, and drainage area of 0.82 sq. miles. Qp = 1027cfs The SCS short-cut flood routing was done with the basin sized to store 37.6 Ac-Ft (maximum), 22.2 Ac-Ft (minimum), the estimated increase (22.2) in runoff volume. The required peak discharge (Q_o) was 7.39 cfs. The maximum reservoir capacity was 37.5 Ac-Ft at elevation 243.5 feet. In an effort to reduce rock excavation, the final crest elevation was about 2488 feet. Analysis of hydraulic characteristics of the as-built riser box and an as-built stage-storage curve were not available.

2. Evaluation Data.
Inflow hydrograph parameters are shown on sheet 2. Regression analysis shown on sheet 11.

Stage-Storage Data - shown on sheets 5 & 9. Areas were measured from the as-built reservoir drawing. The volume was calculated.

BY MEB DATE 2/18/80 SUBJECT Warrington Township Retention Basin Hydrology / Hydraulics SHEET 5 OF 11

CHKD. BY RSM DATE 2/24/80 JOB No.

Elevation (Ft)	Surface Area (Ac)	Volume (Ac-Ft)
235.6	0	0
236	0.4	.08
238	1.0	1
240	1.3	4
242	2.2	7
244	3.0	12
246	3.6	19
248	4.2	27
250	5.4	36

The maximum capacity at 248.8, 30 Ac-Ft. is less than the total volume presented in the original calculations.

Stage - Discharge Data - shown on sheets 8 AND 10

At low heads, orfices act as weirs.

$Q = C_w L H^{3/2}$

For orfice, $Q = C_o A \sqrt{2gH}$

$C_w = 3.1$ } Soil Conservation Service

$C_o = 0.6$ } National Engineering Handbk, Sec 5

Water Surface	Low Stage Orfice Invert 240.2 1 ft wide x 4 ft H	Q	High Stage Orfices (6) Invert 245.2 5.5 ft wide x 2 ft high H	Q x 6	Q	Total Q
240.2	0	0				0
244.2	4 (weir)	24.8				25
245.2	3 (orfice)	33.4	0			33
246.6	4.4	40.4	1.4 (weir)	28.2 x 6 =	169.5	210
247.2	5.0	43.1	2 (weir)	48.2 x 6 =	289.3	
			1 (orfice)	45.14 x 6 =	270.8	
			orfice area 9.325			314
248.8	6.4	48.7	2.6	72.8 x 6 =	436.7	485
250.2	8.0	54.5	4.0	90.3 x 6 =	541.7	596

Above assumes orfice, or inlet, control.

Check required to verify assumption Ref SCS Design Note 8

$H_o = {}^{V_b}/_{2g} (1 + K_e + K_p L_p)$

H_o = total head measured from tailwater elevation or conduit ℄ at outlet.

K_e = entrance Loss = 1.2, a minimum value

K_p = 0.0038 L_p = 68 ft

$H_a = 248.8 - 234.5 + 3 = 11.4$ ft

$11.4 = V_3^2/2g\,(1 + 1.2 + 0.0038 \cdot 68)$

$V = 17.27$

$Q = a\,V = \frac{\pi 6^2}{4} \cdot 17.27 = 488$ cfs/conduit

$2 \times 488 = 976$ cfs > 596 cfs through orifices, therefore, capacity of principal spillway is controlled by the orifices.

Existing spillway conditions -

1. the low stage orfice is blocked assume
2. reservoir level at start is at inlet of large orfices 245.2
3. because of debris blocking trash rack, reduce flow through orfices by 50%, sheet 10

W.S.	Q
245.2	0
246.2	50 cfs
246.6	85
247.2	135
248.8	215
250.2	270

Emergency Spillway

The profile across the emergency spillway was entered as part of dam crest profile (sheet 8) The program estimates discharge over the crest (and through the emergency spillway) by critical flow conditions.

3. Spillway Adequacy - as the spillway will not discharge the 100yr-event under existing conditions without overtopping the embankment, the spillway is considered "Inadequate." If the normal pool level is lowered to the low stage orfice, the spillway would be considered "Adequate." If extra bars are removed from high stage orfices, the peak discharge would be greater than Q_I and the spillway would be considered "Adequate"

BY MFB DATE 7/10/80 SUBJECT Warrington Township SHEET 7 OF 11

CHKD. BY RGM DATE 7/24/80 Retention Basin JOB No.

Hydrology / Hydraulics

The peak inflow value used in the computer must be within 10% of the value determined from regression analysis or by the procedure contained in DER, Water Resources Bulletin No. 13, Floods in Pennsylvania.

The site is located within Flood Region 5

$Q_{100} = C A^{X} P_i^{P}$

$A = 0.82$ sq. miles
$C = 42.2$
$X = 0.751$
$P_i = 44$
$P = 0.744$

} Bulletin No. 13

$Q_{100} = 42.2 (0.82)^{0.751} 44^{0.744}$
$= 607$ cfs

Computer value must be between 668 and 544 cfs, therefore, computer value 644 cfs OK

It is to be noted that the design Q = 1027 cfs may better approximate the peak value from this small, urban watershed.

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	IN
ROUTE HYDROGRAPH TO	OUT
ROUTE HYDROGRAPH TO	DS1
END OF NETWORK	

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 80 07/23.
TIME= 05.09.43.

WARRINGTON TOWNSHIP RETENTION BASIN
NAT ID NO. PA 01066 DER NO. 9-176
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= 1.00

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
IN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SMAP	IRSDA	IRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	.82	0.00	.82	0.00	0.000	0	1	0

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-63.00	0.00	0.00

CURVE NO = -63.00 WEINESS = -1.00 EFFECT CN = 63.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .90

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

0 END-OF PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	7.00	2.90	4.10	6418.
										(178.)	(74.)	(104.)	(181.79)

0 96 7INCHES OF RAINFALL IS DISTRIBUTED ACCORDING TO THE FOLLOWING PATTERN

01.016	.016	.016	.016	.016	.016	.016	.016	.016	.016
01 .016	.016	.016	.016	.016	.016	.016	.0166	.016	.016
01 .016	.016	.024	.024	.04	.04	.04	.04	.04	.04
01.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
01 .04	.04	.04	.04	.04	.04	.06	.06	.06	.06
01 .06	.06	.06	.06	.06	.06	.2	.2	.2	.2
01.275	1.125	1.125	.275	.1	.1	.1	.1	.07	.07
01 .06	.06	.024	.024	.016	.016	.016	.016	.016	.016
01 .016	.016	.016	.016	.016	.016	.016	.016	.016	.016
01 .016	.016	.016	.016	.016	.016				

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH - DESIGN CONDITIONS

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-240.	-1

STAGE	240.20	244.20	245.20	246.60	247.20	248.80	250.20	
FLOW	0.00	25.00	33.00	210.00	314.00	485.00	596.00	
SURFACE AREA=	0.	0.	1.	1.	2.	3.	4.	4.	5.
CAPACITY=	0.	0.	1.	4.	7.	12.	19.	27.	36.
ELEVATION=	236.	236.	238.	240.	242.	244.	246.	248.	250.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
240.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
248.8	0.0	0.0	0.

CREST LENGTH	0.	50.	75.	540.	550.
AT OR BELOW ELEVATION	247.0	247.5	248.8	249.5	252.0

Emergency Spillway ← | → Embankment Crest

HYDROGRAPH ROUTING

SECTION 1000 FEET DOWNSTREAM OF DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DS1	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMOT	ELMAX	RLNTH	SEL
.0400	.0350	.0400	220.0	230.0	1000.	.00620

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 230.00 30.00 228.10 82.00 224.50 82.00 220.00 93.00 220.00
93.00 222.50 142.00 224.70 192.00 230.00

STORAGE	0.00	.13	.27	.40	.53	.67	.91	1.29	1.81	2.46
	3.33	4.33	5.48	6.78	8.23	9.84	11.60	13.52	15.60	17.84
OUTFLOW	0.00	11.90	35.74	66.22	102.73	143.38	196.29	272.97	380.75	532.09
	751.95	1029.97	1372.43	1785.29	2274.29	2844.98	3500.70	4248.49	5095.37	6046.73
STAGE	220.00	220.53	221.05	221.58	222.11	222.63	223.16	223.68	224.21	224.74
	225.26	225.79	226.32	226.84	227.37	227.89	228.42	228.95	229.47	230.00
FLOW	0.00	11.90	35.74	66.22	102.73	143.38	196.29	272.97	380.75	532.09
	751.95	1029.97	1372.43	1785.29	2274.29	2844.98	3500.70	4248.49	5095.37	6046.73

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00
HYDROGRAPH AT	IN	.82 (2.12)	1	664. (18.79)(
ROUTED TO	OUT	.82 (2.12)	1	634. (17.94)(
ROUTED TO	DS1	.82 (2.12)	1	646. (18.29)(

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	240.20	240.20	248.80
STORAGE	4.	4.	30.
OUTFLOW	0.	0.	826.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	248.36	0.00	28.	634.	0.00	16.75	0.00

PLAN 1 STATION DS1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	646.	225.0	16.75

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH - EXISTING CONDITIONS, TRASH RACKS BLOCKED

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-245.	-1

STAGE	245.20	246.20	246.60	247.20	248.80	250.00			
FLOW	0.00	50.00	85.00	135.00	215.00	270.00			
SURFACE AREA=	0.	0.	1.	1.	2.	3.	4.	4.	5.
CAPACITY=	0.	0.	1.	4.	7.	12.	19.	27.	36.
ELEVATION=	236.	236.	238.	240.	242.	244.	246.	248.	250.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
245.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
248.8	0.0	0.0	0.

CREST LENGTH	0.	50.	75.	540.	550.
AT OR BELOW ELEVATION	247.0	247.5	248.8	249.5	252.0

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	245.20	245.20	248.80
STORAGE	16.	16.	30.
OUTFLOW	0.	0.	556.

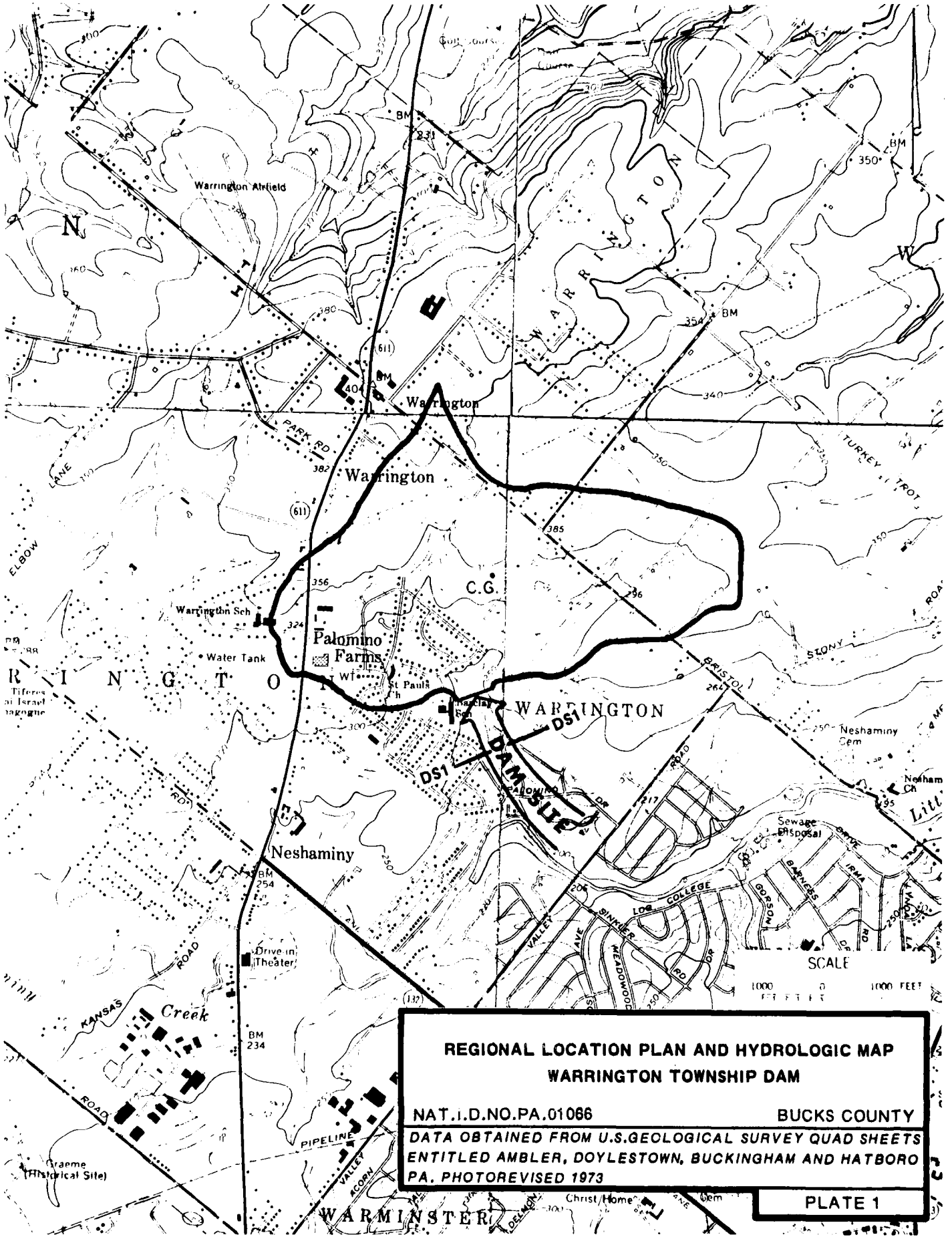
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	248.98	.18	31.	645.	.50	16.50	0.00

PLAN 1 STATION DS1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	641.	225.0	16.75

APPENDIX

E

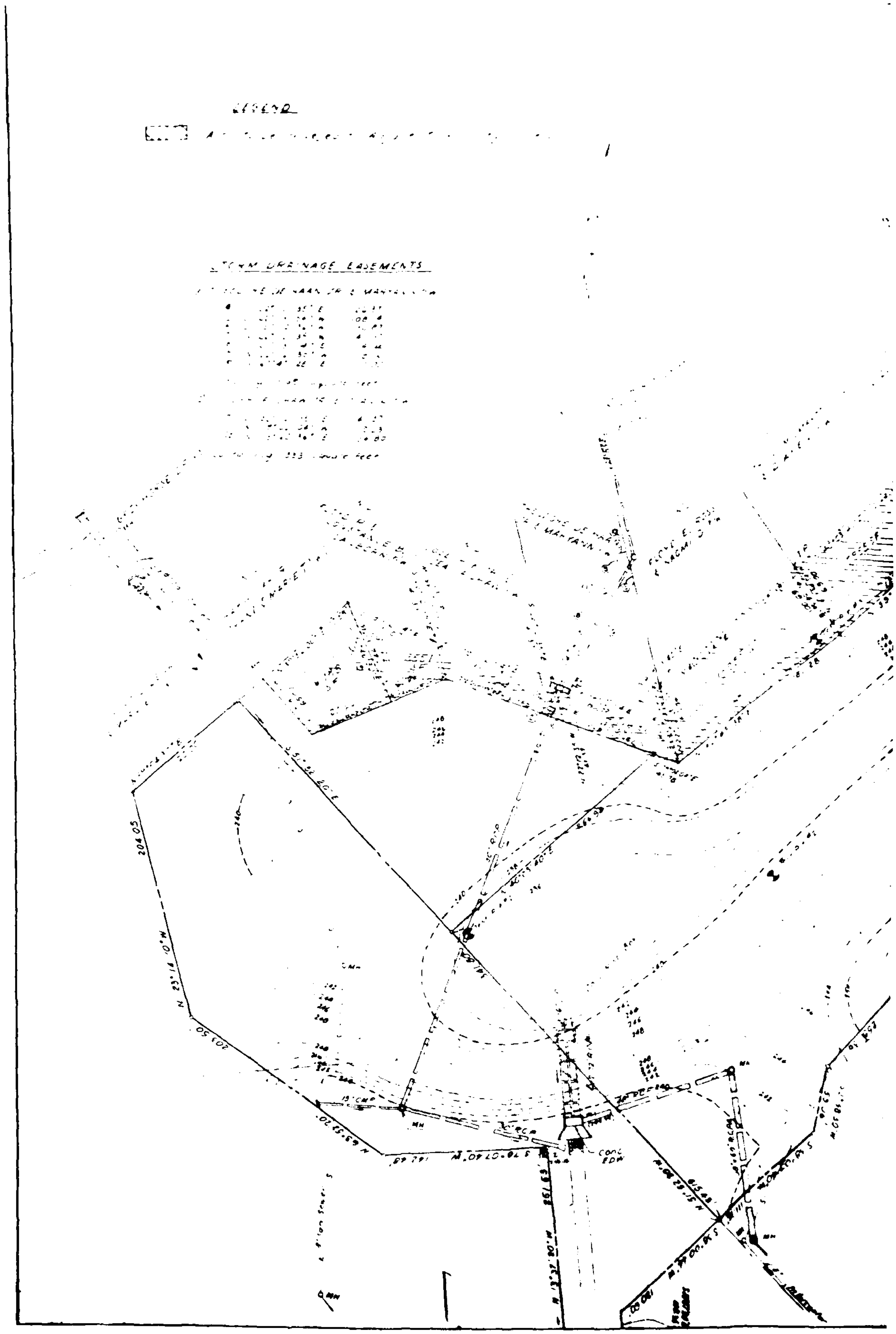


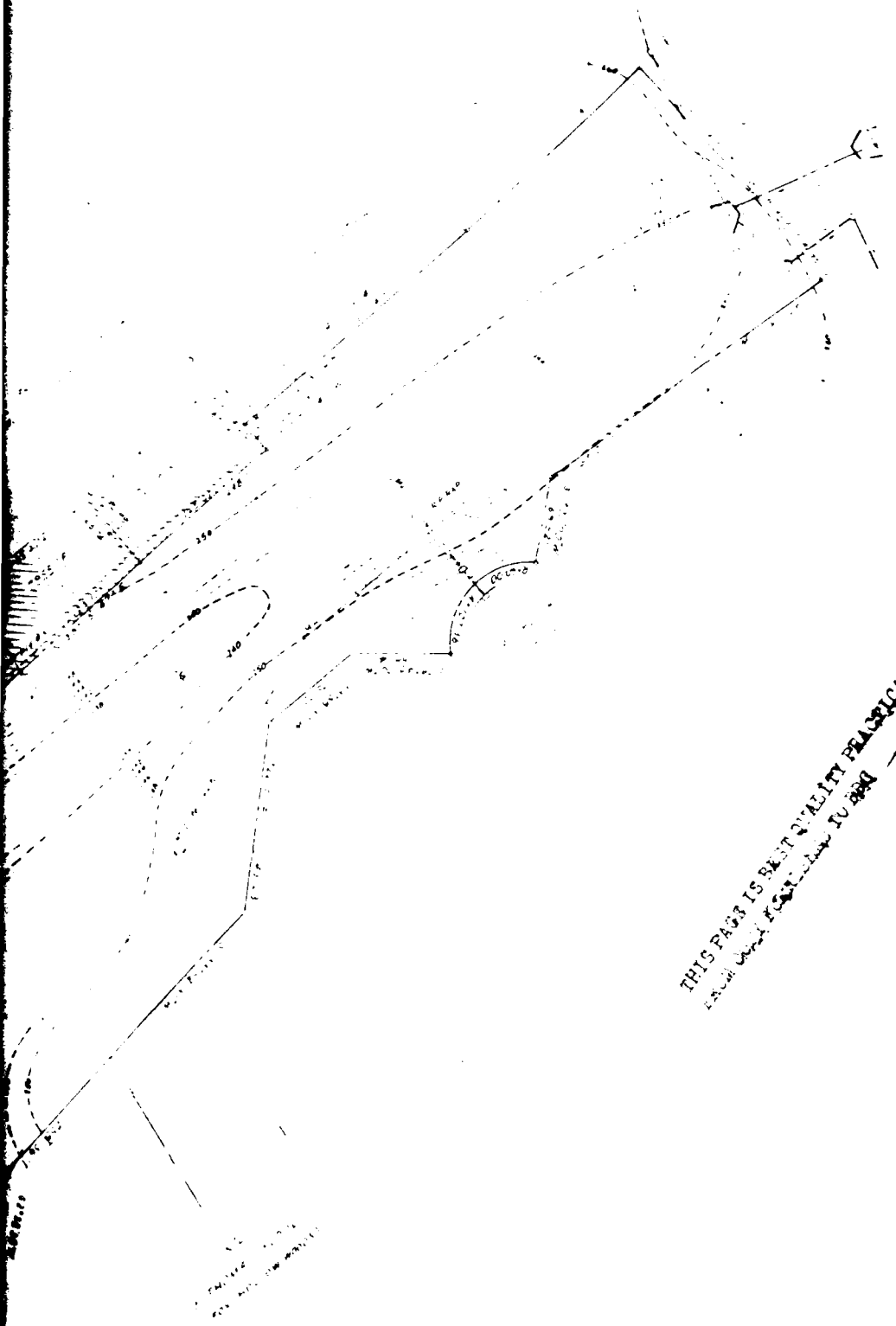
REGIONAL LOCATION PLAN AND HYDROLOGIC MAP
WARRINGTON TOWNSHIP DAM

NAT.I.D.NO.PA.01066 BUCKS COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEETS ENTITLED AMBLER, DOYLESTOWN, BUCKINGHAM AND HATBORO PA. PHOTOREVISED 1973

PLATE 1


LEGEND
STORM DRAINAGE EASEMENTS
204.05
203.50
15" CMP
MH



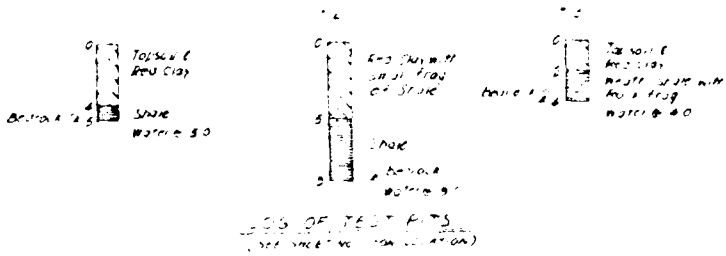
AS BUILT PLAN PALOMINO GLEN
STORM WATER RETENTION BASIN

WARRINGTON TOWNSHIP
BUCKS COUNTY PA

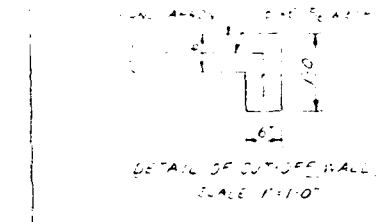
A.D. MARTIN ASSOCIATES INC
Consulting Engineers

DATE	SCALE	DESIGNED BY	PLAN NO.	SHEET NO.
9-10-77	1"=40'	TBB	3530-17	1.

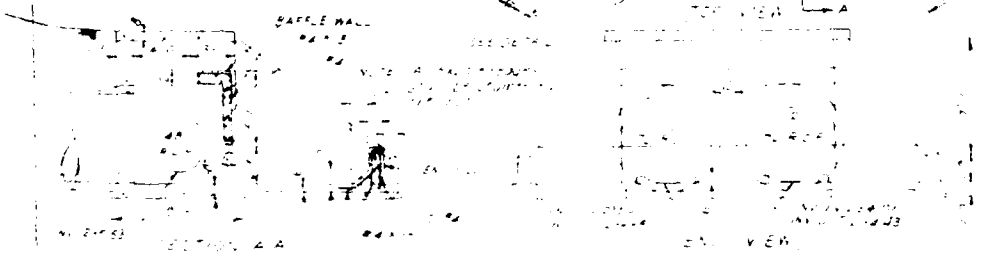
PLATE 2



LOG OF TEST PITS



DETAIL OF CUTOFF WALL
SCALE 1"=1'-0"

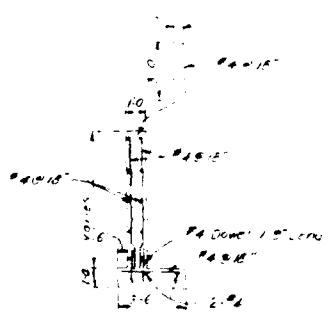


CONC APRON

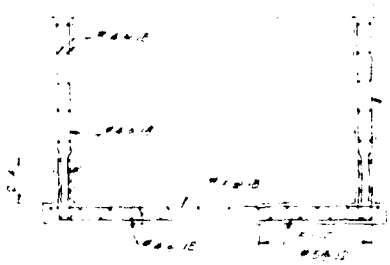
PLAN VIEW

SECTION A-A

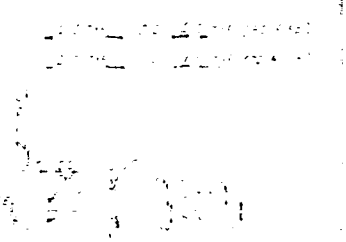
END WALL
SCALE 3/16" = 1'-0

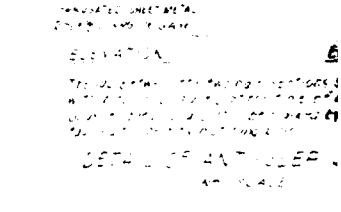


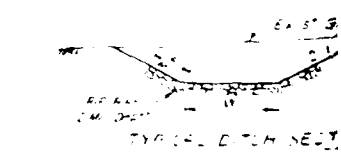
TYP WING SECTION
SCALE 1/2" = 1'-0



SECTION B-B
SCALE 1/2" = 1'-0







TYPICAL EMERGENCY SPILLWAY
NO SCALE

REVISIONS		
NO	DESCRIPTION	DATE
1		
2		
3		

A.W. MARTIN ASSOCIATES INC
Consulting Engineers
KING OF PRUSSIA PA

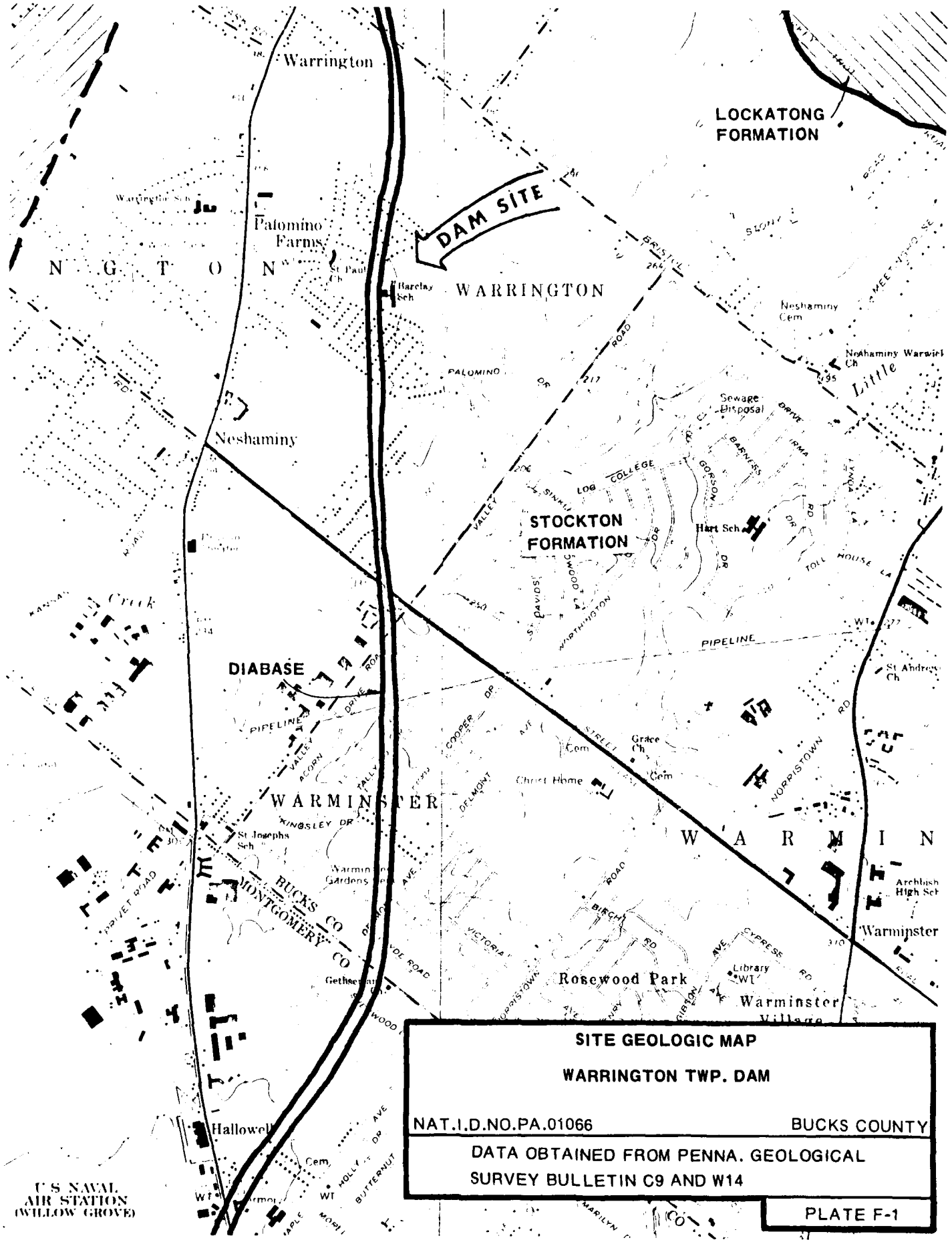
PLATE 3

APPENDIX

F

SITE GEOLOGY
WARRINGTON TOWNSHIP DAM

Warrington Township Dam is located in the Triassic Lowland Section of the Piedmont Physiographic Province. As shown in Plate F-1, the dam site and surrounding region is underlain by the Stockton formation of Triassic age. The Stockton in the Warrington area typically consists of red to brown siltstone, shale and arkosic sandstone. Bedrock is poorly exposed in isolated areas of the emergency spillway. Here the siltstone is fractured having joints striking west-northwest dipping 50 degrees to the southwest and north-northwest dipping 75 degrees to the northwest. Bedding strike and dip could not be determined but in this area the overall strike is to the northeast with dips usually around 10 degrees to the northwest. A northerly striking diabase dike (intrusive rock) is located approximately 500 feet west of the dam. The closest mapped major fault in the area is located approximately 3 miles to the north. This fault strikes east-west and is approximately 24 miles long.



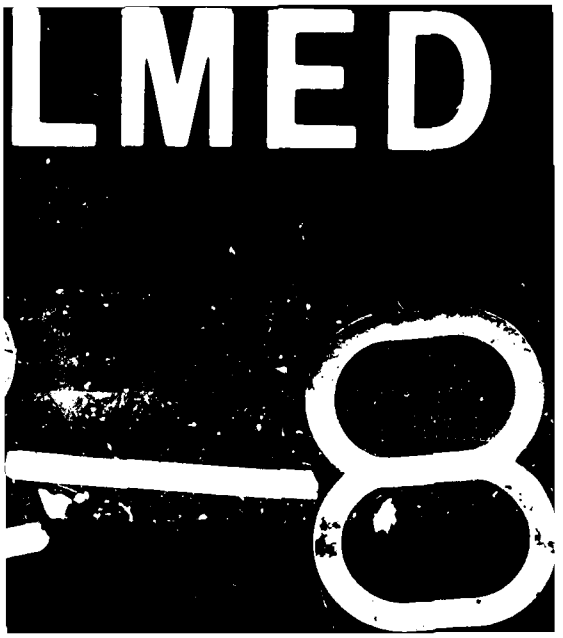
SITE GEOLOGIC MAP

WARRINGTON TWP. DAM

NAT.I.D.NO.PA.01066 BUCKS COUNTY

DATA OBTAINED FROM PENNA. GEOLOGICAL SURVEY BULLETIN C9 AND W14

PLATE F-1


LMED
8