OHIO RIVER BASIN
SOUTH BRANCH OF SLIPPERY ROCK CREEK, BUTLER COUNTY
PENNSYLVANIA

GLADES DAM

NDI No. PA 00804
PennDER No. 10-72

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

prepared by
MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15010

AUGUST 1979

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Approved for Public Release
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OHIO RIVER BASIN

GLADES DAM
BUTLER COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI No. PA 00804
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PAGE 1
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
Glades Dam (NDI PA-00804; PennDER No. 10-72), Ohio River Basin, South Branch of Slippery Creek, Butler County, Pennsylvania. Phase I Inspection Report.

Accession For
NTIS CMMI
DOC TAB
Unclassified
Unclassified

Distribution/
Availability Codes
Dist: Available
or special

410 795
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 Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously 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 investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such 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 REPORT
NATIONAL DAM SAFETY PROGRAM

Glades Dam, Butler County, Pennsylvania
NDI No. PA 00804, PennDER No. 10-72
South Branch of Slippery Rock Creek
Inspected 11 May 1979

ASSESSMENT OF
GENERAL CONDITIONS

Glades Dam is owned and operated by the Pennsylvania Game Commission and is classified as a "Significant" hazard-
"Intermediate" size dam.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps
of Engineers, for Phase I Inspection Reports, revealed that the spillway will pass the 1/2 Probable Maximum Flood (1/2
PMF) without overtopping the dam. (Note: A spillway design
flood (SDF) in the range of 1/2 PMF to PMF is required for
Glades Dam. The 1/2 PMF was chosen because the dam is on
the low side of the "Intermediate" size category.) The
spillway is therefore considered "adequate."

The dam was found to be in very good overall condition at
the time of inspection. Several minor items of remedial
work should be performed by the owner as soon as practicable.
These include:

1) Restore the low areas on the dam to the original
design elevation.

2) Fill the eroded areas behind the wing walls of the
outlet structure.

3) Repair the rutting on the crest of the dam.

4) Repair concrete cracks with an appropriate filler
where necessary.

5) Remove debris, when necessary, from the slotted
flip bucket energy dissipator.

6) Periodically observe the three slides on the left
slope of the spillway discharge channel and take
appropriate remedial measures, if necessary.

7) Develop formal procedures for inspection, maintenance,
and operation and keep formal records of these
items.
8) Periodically observe the minor crack on the left abutment.

In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

Submitted by:

MICHAEL BAKER, JR., INC.

C. Y. Chen, Ph.D., P.E.
Engineering Manager-Geotechnical

Date: 24 August 1979

Approved by:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers

Date: 12 Sep 79
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</table>
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
GLADES DAM
NDI No. PA 00804, PennDER No. 10-72

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority - The Dam Inspection Act, Public Law 92-67, 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 of Inspection - 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. Description of Dam and Appurtenances - Glades Dam is a homogeneous earthfill dam with a maximum height of 24 feet and a crest length of 960 feet. The dam, owned and operated by the Pennsylvania Game Commission, is used primarily for waterfowl protection.

The spillway, consisting of a concrete ogee overflow with a slotted flip bucket energy dissipator, is located at the left abutment of the dam. The crest length is 100 feet. The discharge channel is lined with riprap for 130 feet downstream from the flip bucket.

The intake tower and 54 inch outlet conduit are located 400 feet from the left abutment of the dam. Two 3 foot by 5 foot sluice gates (El. 1197.0 feet and El. 1190.0 feet) are used to control the pool elevation. The 54 inch reinforced concrete pressure pipe outlet conduit has four cut-off collars on 26 foot centers along the upstream portion. A discharge basin is located at the downstream end of the outlet conduit.

b. Location - Glades Dam is located in Cherry Township, Butler County, Pennsylvania, approximately 4 miles north of West Sunbury, Pennsylvania. Located approximately 1400 feet downstream from the dam is PA Route 308. The coordinates of the dam are N 41° 03.7' and W 79° 53.7'.
c. **Size Classification** - The maximum height of the dam is 24 feet. The reservoir volume to the top of the dam at El. 1211.0 feet is 8600 acre-feet. Therefore, the dam is in the "Intermediate" size category.

d. **Hazard Classification** - State Route 308 is located approximately 1400 feet downstream from the dam. Three homes are located approximately 3 miles downstream from the dam. These homes are generally at elevations such that loss of life resulting from a failure of the dam would not be likely. Therefore, the dam is classified in the "Significant" hazard category.

e. **Ownership** - The dam and reservoir are owned by the Commonwealth of Pennsylvania, Pennsylvania Game Commission. Mr. Glenn L. Bowers is the current Executive Director of the Pennsylvania Game Commission. (Address: P.O. Box 1567, Harrisburg, PA 17120). Mr. Donald M. Schake is the Division Supervisor for the area.

f. **Purpose of Dam** - The dam and reservoir are used for waterfowl development and protection.


h. **Normal Operational Procedures** - The pool elevation of Glades Dam is fluctuated throughout the year to provide for proper waterfowl management. The pool level is normally maintained at the crest of the spillway, El. 1200.0 feet, during the months from December through March. During April and May the pool is gradually lowered by means of the upper sluice gate on the intake tower to El. 1198.0 feet and is maintained at this level until September. From September to November the pool level is gradually allowed to rise to the level of the spillway crest.
1.3 PERTINENT DATA

a. Drainage Area (square miles) - 22.0

b. Discharge at Dam Site (c.f.s.) -
   Maximum Flood (Autumn 1975) - 100
   Ungated Spillway Capacity
   (Top of Dam El. 1211.0 ft.) - 12,200

c. Elevation (feet above Mean Sea Level [M.S.L.]) -
   Design Top of Dam - 1211.0
   Minimum Top of Dam - 1209.7
   Normal Pool - 1200.0
   Maximum Pool (Phase I Analysis\(^1\)) - 1207.6
   Spillway Crest - 1200.0
   Streambed at Centerline of Dam - 1187.0
   Maximum Tailwater - Unknown

d. Reservoir (feet) -
   Length of Maximum Pool - 21,600
   Length of Normal Pool - 18,500

e. Storage (acre-feet) -
   Normal Pool (El. 1200.0 ft.) - 1350
   Top of Dam (El. 1211.0 ft.) - 8600

f. Reservoir Surface (acres) -
   Top of Dam (El. 1211.0 ft.) - 1480
   Normal Pool (El. 1200.0 ft.) - 390

g. Dam -
   Type - Homogeneous earthfill
   Length (feet) - 960
   Height (feet) - 24
   Top Width (feet) - 20
   Side Slopes - Upstream - 3H:1V\(^2\)
   Downstream - 3H:1V
   Zoning - None
   Impervious Core - None

\(^1\)See Appendix D
\(^2\)Horizontal to Vertical
Cut-off - An embankment cut-off key was installed just upstream of the centerline of the dam. The base width is 10 feet and the depth is 5 feet.

Drains - None

Drains - Non-e.

h. Diversion and Regulating Tunnel - None

i. Spillway -

Type - Concrete ogee overflow with slotted flip bucket energy dissipator
Length of Crest (feet) - 100
Crest Elevation (feet M.S.L.) - 1200.0
Gates - None
Upstream Channel - Earth-lined approach channel at El. 1196.0 feet.
Downstream Channel - Riprap-lined for 130 feet downstream from flip bucket. The elevation of the riprap is 1190.0 feet near the flip bucket and the remaining trapezoidal earth channel was designed with a one percent slope.

j. Regulating Outlets - The riser tower has two 3 foot by 5 foot sluice gate controls (El. 1197.0 feet and El. 1190.0 feet) for drawdown purposes. The outlet conduit is a 54 inch inner diameter reinforced concrete pressure pipe. Four concrete cut-off collars were installed on approximately 26 foot centers along the 116 foot long conduit. The flow then enters a discharge basin and the outlet channel.
SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The review of information for this dam included Pennsylvania Department of Environmental Resources' (PennDER) File No. 10-72. Included in the file were a microfiche copy of the correspondence and reports and a full size copy of the original design drawings. The microfiche contained the following information:


2) "Hydrological Study Pertaining to Glades Dam and Reservoir, Glades Waterfowl Project, Butler County, Pennsylvania," prepared by Berger Associates, dated May 1969.


4) Various construction progress reports, correspondence, and construction inspection reports by PennDER personnel.

"As built" drawings were forwarded by the Harrisburg office of the Pennsylvania Game Commission. Some of these have been included in this report as Plates 3 through 8.

2.2 CONSTRUCTION

During construction of the dam, a resident inspector was provided by PennDER, Bureau of Engineering and Construction, Division of Resident Supervision. In addition, occasional visits were performed by representatives of the Pittsburgh Region of PennDER. Modifications from the design drawings were incorporated into the "as built" drawings.

2.3 OPERATION

The operation of Glades Dam is the responsibility of the Pennsylvania Game Commission. No formal operation procedures or records are presently maintained. Historically, the reservoir is maintained at the normal pool level except during the waterfowl nesting season (June-August) when the reservoir is drawdown 24 inches.
2.4 EVALUATION

a. Availability - The information is readily available from PennDER's File No. 10-72, the files of the Pennsylvania Game Commission, and Berger Associates of Harrisburg, Pennsylvania.

b. Adequacy - The information available is adequate for a Phase I Inspection of this dam.

c. Validity - Observations and measurements performed during the visual inspection did not indicate any deviations from the information on the "as built" drawings.
SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. **General** - The dam and its appurtenant structures were found to be in very good overall condition at the time of the inspection. No unusual weather conditions were present on 11 May 1979 during the inspection. Noteworthy deficiencies are described below. The complete visual inspection check list and field sketch are given in Appendix A.

b. **Dam** - The embankment had good vegetative cover on both the crest and the downstream slope; the riprap on the upstream slope was in good condition at the time of the inspection. No seepage or signs of instability were observed on the embankment. However, the level survey indicated several low areas on the crest (see Top of Dam Profile, Sheet 3 of 12, Appendix D).

c. **Appurtenant Structures** - The overall condition of the appurtenant structures was good at the time of the inspection. However, minor debris was present in the slotted flip bucket energy dissipator. Cracks were observed in the right training wall of the spillway. The wing wall of the discharge basin was separated from the head wall of this structure and minor erosion was occurring behind the wing wall. Three slide areas (see Photos 11 and 12) have occurred in the slope adjacent to the discharge channel of the spillway.

d. **Reservoir Area** - No problems were observed in the reservoir area.

e. **Downstream Channel** - Two discharge channels were excavated during construction and come together approximately 500 feet downstream from the dam at the original streambed. Approximately 1400 feet downstream from the dam is the roadway embankment and culvert for PA Route 308. Located approximately 14,000 feet downstream from the dam are 3 homes in low-lying areas along the South Branch of Slippery Rock Creek.
SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal emergency procedures in the event of impending catastrophic failure of the dam. The dam is visited frequently by personnel from the Pennsylvania Game Commission.

It is recommended that formal emergency procedures be prepared, prominently displayed, and furnished to all operating personnel.

4.2 MAINTENANCE OF DAM

Routine maintenance is performed periodically by the Pennsylvania Game Commission personnel on an as-needed basis.

4.3 MAINTENANCE OF OPERATING FACILITIES

The drawdown facilities are operated several times a year as a part of the normal operating procedures for maintaining the reservoir at different levels for waterfowl protection. Maintenance of the facilities is performed by the Pennsylvania Game Commission.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There are no warning procedures in the event of a dam failure. An emergency warning procedure should be developed.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The condition and maintenance of the dam is adequate; however, formal procedures for inspection, maintenance, and operation should be developed and recorded. Formal records of the maintenance and operation should be kept.
SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data - Hydrologic and hydraulic design calculations were obtained from the files of PennDER. The spillway was designed in accordance with the Pennsylvania "C" Curve and was therefore required to have a capacity of 580 c.f.s. per square mile of drainage basin or a total capacity of 13,050 c.f.s. One year and 100-year frequency storm hydrographs were also developed and routed through the reservoir to determine their effects on the reservoir stage and downstream channel. A hydrograph with a peak discharge equal to the "C" curve discharge (13,050 c.f.s.) was also developed and routed through the reservoir. The results of these three routings are as follows:

<table>
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<th>Storm Hydrograph</th>
<th>Peak Inflow (c.f.s.)</th>
<th>Peak Outflow (c.f.s.)</th>
<th>Maximum Reservoir Elevation (feet)</th>
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<tr>
<td>1-year</td>
<td>782</td>
<td>350</td>
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<td>5400</td>
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<td>&quot;C&quot; Curve</td>
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</table>

These storm hydrographs were developed by using a unit hydrograph and appropriate rainfall amounts from Technical Paper 40 (U.S. Weather Bureau). The unit hydrograph was developed by comparison with stream gage records for eight streams with similar drainage basin characteristics.

Storage-discharge relationships for the reservoir and spillway were also obtained from the design information. The spillway discharge rating was independently evaluated to determine the effects of the tailwater elevation. The rating calculated by the designer was found to be in close agreement and was therefore used in the flood routing analysis.

b. Experience Data - No major floods have occurred since the dam was completed in 1974. According to the owners of the dam, the reservoir rose to a level approximately six inches above the spillway crest in the Autumn of 1975. This corresponds to a discharge from the spillway of approximately 100 c.f.s.
c. **Visual Observations** - The low areas on the crest of the dam could have a minor effect on the hydraulic capability of the reservoir. No other conditions were observed at the time of the inspection that would indicate the dam and appurtenant structures could not operate satisfactorily in the event of a flood.

d. **Overtopping Potential** - Glades Dam is classified as a "Significant" hazard - "Intermediate" size dam requiring evaluation for a spillway design flood (SDF) in the range of the 1/2 Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF). Since the dam is on the low end of the intermediate size category, the 1/2 PMF was chosen as the SDF. The hydrologic capabilities of the dam, reservoir, and spillway were evaluated by routing the 1/2 PMF through the reservoir with the aid of the U.S. Army Corps of Engineers' Flood Hydrograph Package, HEC-1. The 1/2 PMF hydrograph developed as part of this analysis had a peak discharge of 14,975 c.f.s., using a total storm runoff of 12.5 inches. The results of this routing indicate that the dam is capable of passing the 1/2 PMF with a maximum reservoir level of 1207.6 feet or 2.1 feet below the minimum crest of the dam.

e. **Spillway Adequacy** - The dam, as outlined in the above analysis, is capable of passing approximately 75 percent of the PMF without overtopping. The spillway is therefore considered adequate according to the recommended criteria.
SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. **Visual Observations** - No structural inadequacies were noted during the visual inspection of the dam.

b. **Design and Construction Data** - According to the information in PennDER's files, the slopes have satisfactory slope stability safety factors for the dam as constructed and the type of material available at the dam site for construction. Based upon this information and the visual observations of the dam, it is concluded that no further assessment of the structural stability is necessary.

c. **Operating Records** - No formal operating records are maintained. There is nothing in the operation procedures which indicates cause for concern relative to the structural stability of the dam.

d. **Post-Construction Changes** - No changes which would affect structural stability of the dam have been made since construction was completed.

e. **Seismic Stability** - The dam is located in Seismic Zone 1 of the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is a zone of very low seismic activity. Experience indicates that dams in this zone will have adequate stability under seismic loading conditions provided static stability conditions are satisfied and conventional safety margins exist. Glades Dam has been shown to meet the conventional static stability requirements; therefore, further consideration of the seismic stability is not warranted.
SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety - Glades Dam was found to be in very good overall condition at the time of inspection. Glades Dam is a "Significant" hazard-"Intermediate" size dam requiring a spillway capacity in the range of 1/2 PMF to PMF. The 1/2 PMF was chosen as the SDF because the dam is on the low side of the "Intermediate" size category. As presented in Section 5, the spillway and reservoir are adequate to pass the 1/2 PMF without overtopping the dam.

b. Adequacy of Information - The information available and the observations made during the field inspection are considered sufficient for this Phase I Inspection Report.

c. Urgency - The owner should initiate the action discussed in paragraph 7.2 as soon as practicable.

d. Necessity for Additional Data/Evaluation - No further investigation is necessary.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection revealed certain items of remedial work which should be performed by the owner. These include:

1) Restore the low areas on the dam to the original design elevation.

2) Fill the eroded areas behind the wing walls of the outlet structure.

3) Repair the rutting on the crest of the dam.

4) Repair concrete cracks with an appropriate filler where necessary.

5) Remove debris, when necessary, from the slotted flip bucket energy dissipator.

6) Periodically observe the three slides on the left slope of the spillway discharge channel and take appropriate remedial measures if necessary.

7) Develop formal procedures for inspection, maintenance, and operation and keep formal records for these items.
8) Periodically observe the minor crack on the left abutment.

In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.
SECTION A-A
Scale: 1" = 5'-0"
CUT-OFF COLLAR

ELEVATION
NO SCALE

PLAN
NO SCALE

DETAIL A
ELEVATION
SCALE 1" = 5'-0"
PLATE 7

Refer to drawings S-4 & S-5 for structural details.

NOTE: " Indicates as built information 11-8-74

THE PENNSYLVANIA GAME COMMISSION
HARRISBURG, PENNSYLVANIA

GLADES DAM
BUTLER COUNTY, PENNSYLVANIA

ELEVATION & PLAN VIEWS
CONTROL TOWER & OUTLET WORKS

BERGER ASSOCIATES, INCORPORATED
CONSULTING ENGINEERS
HARRISBURG, PENNSYLVANIA

DRAWN BY: M. MURPHY
CHECKED BY: G. H. GHRAGGL

NOTE: This is a schematic drawing of the structural elements at Glades Dam, including the concrete apron, foot bridge, and pipe railing. The drawing refers to drawings S-4 & S-5 for more detailed structural information. The note indicates that the " indicates as-built information from 11-8-74.
APPENDIX A

CHECK LIST - VISUAL INSPECTION
AND FIELD SKETCH
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<tr>
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<td>PA</td>
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<td>000804</td>
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<td>Permit #</td>
<td>08-72</td>
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<tr>
<td>Date of Inspection</td>
<td>11 May 1979</td>
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<tr>
<td>Weather at Time of Inspection</td>
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<tr>
<td>Temperature</td>
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<tr>
<td>Tailwater at Time of Inspection</td>
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*All elevations referenced to the crest of the spillway (EL 1200.0 ft).*

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<tr>
<td>Jay Swagert (part-time)</td>
</tr>
<tr>
<td>Robert H. Sopher (part-time)</td>
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<tr>
<td>Michael Baker, Jr., Inc.:</td>
</tr>
<tr>
<td>Rodney E. Holderbaum</td>
</tr>
<tr>
<td>James G. Ulinski</td>
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<p>| Vertical and Horizontal |                           |                           |</p>
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| Monolith Joints |                           |                           |

| Construction Joints |                           |                           |

Name of Dam: GLADES DAM
NDI #: PA 00804

CONCRETE/MASONRY DAMS - Not Applicable
<table>
<thead>
<tr>
<th><strong>Name of Dam:</strong> GLADES DAM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NDI #: PA 00804</strong></td>
</tr>
</tbody>
</table>

**EMBANKMENT**

<table>
<thead>
<tr>
<th><strong>VISUAL EXAMINATION OF</strong></th>
<th><strong>OBSERVATIONS</strong></th>
<th><strong>REMARKS OR RECOMMENDATIONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SURFACE CRACKS</strong></td>
<td>A surface crack was observed in the abutment immediately to the left of the spillway training wall. The crack is 2 ft. long longitudinally to the dam axis, 1 ft. deep, and 0.5 in. wide.</td>
<td>The crack is not a problem at the present time but should be examined and recorded in future inspections.</td>
</tr>
<tr>
<td><strong>UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE</strong></td>
<td>None observed</td>
<td></td>
</tr>
<tr>
<td><strong>SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES</strong></td>
<td>The embankment adjacent to the right spillway training wall is rutted and low in a few minor areas. Maintenance vehicles have caused rutting and removal of the cover vegetation at the access to the dam crest on the right abutment of the dam.</td>
<td>Both areas should be regraded, restored to the original crest elevation, and reseeded with an appropriate mixture.</td>
</tr>
<tr>
<td><strong>VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST</strong></td>
<td>Visual inspection of the horizontal alignment indicated no problems. The level survey of the top of the dam showed several low areas on the dam. (See Top of Dam Profile, Sheet 3 of 12, Appendix D.)</td>
<td>The low areas should be restored to original crest El. 1211.0 ft. and reseeded with an appropriate mixture.</td>
</tr>
<tr>
<td><strong>RIPRAP FAILURES</strong></td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>EMBANKMENT</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLADES DAM</td>
<td>No other problems other than the rutting, low areas, and vertical crack previously presented on page A-4.</td>
</tr>
<tr>
<td>ANY NOTICEABLE SEEPAGE</td>
<td>None</td>
</tr>
<tr>
<td>STAFF GAGE AND RECORDER</td>
<td>None installed</td>
</tr>
<tr>
<td>DRAINS</td>
<td>None</td>
</tr>
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</table>
### OUTLET WORKS

<table>
<thead>
<tr>
<th>Name of Dam: GLADES DAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOI #: PA 00804</td>
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</table>

#### VISUAL EXAMINATION OF CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT

Since the conduit was flowing approximately half full at the time of inspection, no assessment of its condition could be made.

<table>
<thead>
<tr>
<th>INTAKE STRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good condition. No deterioration of the concrete was observed. The gates and gate controls are also in good condition.</td>
</tr>
<tr>
<td>The gate controls should be lubricated periodically.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTLET STRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some separation at the construction joints (approximately 0.5 in.) was observed between the main head wall and the wing walls of the outlet structure.</td>
</tr>
<tr>
<td>The separation is considered minor and should be repaired during routine maintenance.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTLET CHANNEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some minor erosion has occurred at the end of the stilling basin adjacent to the wing walls and approximately 50 ft. downstream from the end of the stilling basin.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EMERGENCY GATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 54 in. dia. gated outlet can be used for emergency drawdown of the lake.</td>
</tr>
<tr>
<td>The gates are operated annually to assure proper operation.</td>
</tr>
</tbody>
</table>
**UNGATED SPILLWAY**

<table>
<thead>
<tr>
<th>Name of Dam:</th>
<th>GLADES DAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDI #</td>
<td>PA 00804</td>
</tr>
</tbody>
</table>

### VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

<table>
<thead>
<tr>
<th>CONCRETE WEIR</th>
<th>Very good condition. No deterioration of the concrete surfaces in the form of spalling or cracking was observed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPROACH CHANNEL</td>
<td>No problems observed</td>
</tr>
<tr>
<td>DISCHARGE CHANNEL</td>
<td>Three small slides have occurred on the left bank of the outlet channel approximately 300 ft. downstream from the spillway crest. According to PA Game Commission personnel, these slides occurred during construction. Periodically observe this area and take action if necessary.</td>
</tr>
<tr>
<td>BRIDGE AND PIERS</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>SPILLWAY TRAINING WALLS</td>
<td>Minor cracking was observed on the inside of the right training wall downstream from the concrete weir. Minor flow was exiting from the first two weep holes on the left side. The middle weep hole on the right side appeared clogged. The cracks should be repaired with an appropriate filler.</td>
</tr>
<tr>
<td>CONCRETE SILL</td>
<td>OBSERVATIONS</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>APPROACH CHANNEL</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>DISCHARGE CHANNEL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>BRIDGE AND PIERS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>GATES AND OPERATION EQUIPMENT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>INSTRUMENTATION</td>
<td>OBSERVATIONS</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>GLADES DAM</td>
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</tbody>
</table>

| NAME OF DAM:     | GLADES DAM  |                           |
| NO. 1 PA 080044 |             |                            |

<table>
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<tr>
<th>VISUAL EXAMINATION</th>
<th>KOMPARTMENT/SURVEYS</th>
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<table>
<thead>
<tr>
<th>OBSERVATION WELLS</th>
<th>WEIRS</th>
<th>PIEZOMETERS</th>
<th>OTHER</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
### SLOPES

The reservoir slopes are mildly sloping and well vegetated.

### SEDIMENTATION

Judging from the age of the reservoir and the watershed cover, sedimentation should not be a significant problem.
## DOWNSTREAM CHANNEL

<table>
<thead>
<tr>
<th>Name of Dam:</th>
<th>GLADES DAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>NID #:</td>
<td>PA 00804</td>
</tr>
</tbody>
</table>

### OBSERVATIONS

**CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)**

A road bridge is located several hundred ft. downstream from the dam. Although numerous trees and brush are located in the downstream channel and over the banks areas, no serious obstructions to discharges from the dam were observed.

The bridge should not affect discharges from the dam even during large storms.

**SLOPES**

The slopes adjacent to the downstream channel are moderately sloped and primarily well vegetated. The slope of the downstream channel is mild, dropping approximately 5 ft. per mi.

**APPROXIMATE NO. OF HOMES AND POPULATION**

Approximately 1400 ft. downstream from the dam is PA Route 308. Approximately 14,000 ft. downstream from the dam are 3 homes in low-lying areas along the south branch of Slippery Rock Creek.
APPENDIX B

CHECK LIST - ENGINEERING DATA
<table>
<thead>
<tr>
<th>ITEM</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLAN OF DAM</td>
<td>See Plate 3 of this report.</td>
</tr>
<tr>
<td>REGIONAL VICINITY MAP</td>
<td>See Plate 1 of this report, a portion of a U.S.G.S. 15 minute topographic quadrangle for this area.</td>
</tr>
<tr>
<td>CONSTRUCTION HISTORY</td>
<td>The dam was designed by Berger Assoc. of Camp Hill, Pennsylvania and constructed by the Fowker Construction Co. of Youngstown, Ohio. The construction period was from June 1973 to November 1974. Resident inspection during construction was provided by PennDER.</td>
</tr>
<tr>
<td>TYPICAL SECTIONS OF DAM</td>
<td>See Plates 4, 5, 6, 7, and 8 of this report.</td>
</tr>
<tr>
<td>HYDROLOGIC/HYDRAULIC DATA</td>
<td>The design calculations are contained in the files of PennDER and are summarized in Section 5 of this report.</td>
</tr>
<tr>
<td>OUTLETS - PLAN and DETAILS</td>
<td>See Plates 7 and 8 of this report.</td>
</tr>
<tr>
<td>- CONSTRAINTS</td>
<td>Two sluice gated outlets are incorporated into the intake tower. Details are included in the Design Plans.</td>
</tr>
<tr>
<td>- DISCHARGE RATINGS</td>
<td>are contained in the Hydrology Design Report and are summarized in Appendix D of this report.</td>
</tr>
<tr>
<td>RAINFALL/RESERVOIR RECORDS</td>
<td>Rainfall and stream gage records for streams in western PA, with drainage basin characteristics similar to Glades Dam drainage basin, are contained in the PennDER files.</td>
</tr>
</tbody>
</table>
Design Reports
1) "First Interim Report for Glades Dam" by Berger Assoc., February 1969.
2) "Hydrological Study Pertaining to Glades Dam and Reservoir" by Berger Assoc., May 1969.
Both of these reports are available in the PennDER file.

Geology Reports
See Appendix E of this report.

Design Computations
Hydrology & Hydraulics
The summary results of the hydrology and hydraulics computations are contained in
the "Hydrological Study Pertaining to Glades Dam and Reservoir," available in the
PennDER file. The summary results of the dam stability analyses are contained in
the "First Interim Report for Glades Dam," available in the PennDER file.

Design Computations
Dam Stability

Materials Investigations

Boring Records
Laboratory
Field
The boring records and material investigations are presented on Sheets B-1 through
B-7 of the design drawings. The summary results of the laboratory and field
testing programs are presented in the "First Interim Report for Glades Dam" by
Berger Assoc., February 1969. All of this information is available in PennDER's
file.

Post-Construction Surveys of Dam
No information available

Borrow Sources
The borrow sources for the dam were from the excavation of the spillway and spillway outlet
channel and from an area in the right portion of the reservoir approximately 400 to 1200 ft.
upstream from the centerline of the dam. Soil classification tests performed on the borrow
material indicated that the area consisted primarily of CL, ML, and CL-ML soils.
Name of Dam: GLADES DAM
NDI # PA 00804

<table>
<thead>
<tr>
<th>ITEM</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MONITORING SYSTEMS</td>
<td>None</td>
</tr>
<tr>
<td>MODIFICATIONS</td>
<td>None</td>
</tr>
<tr>
<td>HIGH POOL RECORDS</td>
<td>None</td>
</tr>
<tr>
<td>POST-CONSTRUCTION ENGINEERING</td>
<td>None</td>
</tr>
<tr>
<td>STUDIES AND REPORTS</td>
<td></td>
</tr>
<tr>
<td>PRIOR ACCIDENTS OR FAILURE OF DAM</td>
<td>None</td>
</tr>
<tr>
<td>DESCRIPTION REPORTS</td>
<td></td>
</tr>
<tr>
<td>MAINTENANCE</td>
<td></td>
</tr>
<tr>
<td>OPERATION RECORDS</td>
<td>No formal records are maintained.</td>
</tr>
<tr>
<td>ITEM</td>
<td>REMARKS</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
</tr>
<tr>
<td>SPILLWAY PLAN,</td>
<td></td>
</tr>
<tr>
<td>SECTIONS, and DETAILS</td>
<td>See Plates 5 and 6 of this report. Additional structural details of the spillway are shown on design drawings S-1 and S-2.</td>
</tr>
<tr>
<td>OPERATING EQUIPMENT PLANS &amp; DETAILS</td>
<td>See Plate 8 of this report.</td>
</tr>
</tbody>
</table>
CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 22.0 sq.mi. (primarily farmland and forests)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1200.0 ft.

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1209.7 ft.

ELEVATION MAXIMUM DESIGN POOL: 1208.0 ft.

ELEVATION TOP DAM: 1211.0 ft.

CREST: Spillway

a. Elevation 1200.0 ft.
b. Type Concrete ogee with flip bucket energy dissipator
c. Width 100 ft.
d. Length Approximately 500 ft. including discharge channel
e. Location Spillover At left abutment of dam
f. Number and Type of Gates None

OUTLET WORKS:

a. Type Concrete intake riser and 54 in. concrete conduit
b. Location Approximately 600 ft. from right abutment
c. Entrance inverts El. 1197.0 ft. and El. 1199.0 ft.
d. Exit inverts El. 1188.0 ft.
e. Emergency draindown facilities 3 ft. x 5 ft. sluice gate

HYDROMETEOROLOGICAL GAGES: None installed

a. Type ____________________________
b. Location ____________________________
c. Records _____________________________

MAXIMUM NON-DAMAGING DISCHARGE Unknown
APPENDIX C

PHOTOGRAPHS
DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam from Right Abutment

Photo 1 - View of Spillway and Reservoir from Left Abutment Hillside

Photo 2 - Close-up View of Spillway and Slotted Flip Bucket Energy Dissipator

Photo 3 - View Looking Downstream at Discharge Channel from Spillway

Photo 4 - View of Intake Control Tower

Photo 5 - Close-up View of Three Foot by Five Foot Intake at El. 1197.0 feet (The sluice gate was designed to be in the inverted position.)

Photo 6 - View of Downstream Embankment, Outlet Structure, and Discharge Channel for the Outlet Conduit

Photo 7 - Close-up View of Outlet Structure (Note: Backwash and erosion around wing walls.)

Photo 8 - View Looking Downstream at Discharge Channel for the Outlet Conduit

Photo 9 - View of Downstream Area

Photo 10 - View of Drainage Ditch on the Left Abutment of the Dam

Photo 11 - View of One of Three Small Slides on the Left Side Slope of the Spillway Discharge Channel

Photo 12 - View of Another Small Slide on the Left Side Slope of the Spillway Discharge Channel

Note: Photographs were taken on 11 May 1979.
PHOTO 1. View of Spillway and Reservoir from Left Abutment Hillside

PHOTO 2. Close-up View of Spillway and Slotted Flip Bucket Energy Dissipater
GLADES DAM

PHOTO 3. View Looking Downstream at Discharge Channel from Spillway

PHOTO 4. View of Intake Control Tower
PHOTO 5. Close-up View of Three Foot by Five Foot Intake at El. 1197.0 feet
(The sluice gate was designed to be in the inverted position.)

PHOTO 6. View of Downstream Embankment, Outlet Structure, and Discharge Channel for the Outlet Conduit
GLADES DAM

PHOTO 7. Close-up View of Outlet Structure (Note: Backwash and erosion around wing walls)

PHOTO 8. View Looking Downstream at Discharge Channel for the Outlet Conduit
GLADES DAM

PHOTO 9. View of Downstream Area

PHOTO 10. View of Drainage Ditch on the Left Abutment of the Dam
PHOTO 11. View of One of Three Small Slides on the Left Side Slope of the Spillway Discharge Channel

PHOTO 12. View of Another Small Slide on the Left Side Slope of the Spillway Discharge Channel
APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS
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</thead>
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<td>Watershed Plan</td>
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<td>Top of Dam Profile</td>
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<tr>
<td>Stage vs. Storage</td>
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</tr>
<tr>
<td>Spillway Rating</td>
<td>5</td>
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<tr>
<td>Tailwater Rating</td>
<td>6</td>
</tr>
<tr>
<td>Location Plan</td>
<td>7</td>
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<tr>
<td>Computer Analysis</td>
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PREFACE

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.
RAINWATER DATA: DRAINAGE AREA IS LOCATED IN ZONE 2 FOR HMR-33

\[ P_{6\text{HR}} = 107\% \text{ PMP} \]
\[ P_{12\text{HR}} = 117\% \text{ PMP} \]
\[ P_{24\text{HR}} = 130\% \text{ PMP} \]
\[ P_{48\text{HR}} = 140\% \text{ PMP} \]

HYDROLOGIC DATA: DRAINAGE AREA IS LOCATED IN ZONE 27; \( C_p = 0.40 \)
\[ C_2 = \text{PLATE 0.3; } \delta = 2.7(1.1)^{0.5} \]
\[ L = 3.22 \text{ mi.} \]

\[ t_p = 2.7(1)^{0.6} \]
\[ t_f = 2.7(3.22)^{0.6} \]
\[ t_p = 8.45 \text{ HRS.} \]

\[ t_i = 0.50/5.5 \]
\[ t_i = 0.545/5.5 \]
\[ t_i = 0.99 \text{ HRS.} \]

\[ t_{PR} = t_p + 0.25 (t_f - t_i) \]
\[ t_{PR} = 5.45 + 0.25 (0.5 - 0.99) \]
\[ t_{PR} = 5.33 \text{ HRS.} \]

* Since the centroid of the basin falls within the reservoir.
Subject: Glades Dam
Stage vs. Storage

<table>
<thead>
<tr>
<th>Elev. (feet)</th>
<th>Storage (A.F.)</th>
</tr>
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<tbody>
<tr>
<td>1190</td>
<td>0</td>
</tr>
<tr>
<td>1195</td>
<td>200</td>
</tr>
<tr>
<td>1200</td>
<td>1350</td>
</tr>
<tr>
<td>1201</td>
<td>1730</td>
</tr>
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<td>1202</td>
<td>2120</td>
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<td>1208</td>
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</tr>
<tr>
<td>1209</td>
<td>6700</td>
</tr>
<tr>
<td>1210</td>
<td>7600</td>
</tr>
</tbody>
</table>

Note: This information was taken from design data.

Storage (AF x 10^-3)
Subject: Glades Dam

Tailwater Rating

S.O. No. ___________________________ Sheet No. 6 of 12

Drawing No. _______________________

Computed by _________________________ Checked by _______________________

Date 3-21-79

---

Note: This data was taken from design information.

Elevation (ft)

1184 1190 1192 1194 1196 1198 1200

Discharge (cfs x 10^-3)

0 2 4 6 8 10 12
**National Program for Inspection of Non-Federal Dams**

**Hydrologic and Hydraulic Analysis of Glades Dam Proj. 22**

**Probable Maximum Flood PFU UNIT GRAPH BY SNYDER'S METHOD**

<p>| | | | | | |</p>
<table>
<thead>
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</tr>
<tr>
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<td>23</td>
<td>107</td>
<td>117</td>
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<tr>
<td>O</td>
<td>5.23</td>
<td>0.4</td>
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</tr>
<tr>
<td>P</td>
<td>-1.5</td>
<td>0.95</td>
<td>2.0</td>
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<tr>
<td>Q</td>
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</tbody>
</table>

**Snyder's Unit Hydrograph for South Branch of Slippery Rock Creek**

**This is a Routing for Glades Dam**

**Sheet 5 of 12**
NATIONAL PROGRAM FOR INSPECTION OF NON-PELLET DAMS
HYDROLOGIC AND HYDRAULIC ANALYSES OF GLADES DAM NO. 22
PROPOSED MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDER'S METHOD

JOB SPECIFICATION

NO  NHR  NMIN  IDAY  NHR  NMIN  METRC  IJPLT  IPRT  NSTAT
300  0  30  0  0  0  0  4  0  0

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

RTIO= 1.00  0.75  0.50

********  ********  ********  ********  ********

SUB-Basin RUNOFF COMPUTATION
SNYDER'S UNIT HYDROGRAPH FOR SOUTH BRANCH OF SLIPPERY ROCK CREEK
ISTAQ  ICOMP  IECOA  ITAPE  IJPLT  IPRT  INAME  ISTATE  IAUTO
1  0  0  0  0  0  0  1  0  0

HYDROGRAPH DATA
INHG  IUNG  TAREA  SNAP  TRSPC  RATIO  ISNOW  ISAME  IECMA
1  1  21.97  0.0  21.57  0.0  0.0  0  0  0

PRECIP DATA
SPF  PMS  Po  P12  R24  R48  P12  R48  R72
0.0  25.70  107.00  117.00  130.00  140.00  0.0  0.0  0.0
TRSPC COMPUTED BY THE PROGRAM IS 0.326

LOSS DATA
LECP  STEK  DELK  RTNIL  FRAIN  STKRA  KTDO  STREL  CNSTL  ALSNK  KTIMP
0  0.0  0.0  0.0  0.0  0.0  0.0  1.00  0.00  0.0  0.0

UNIT HYDROGRAPH DATA
TP= 5.33  CP=0.40  NTI= 0

RECESSION DATA
STRTG= -1.50  QECMN= -0.05  RTIUR= 2.00

UNIT HYDROGRAPHIC END-OF-PERIOD ORDINATES, LAG= 5.32 HOURS, CP= 0.40, VOL= 0.49
27.  102.  209.  353.  463.  637.  783.  903.  999.  1062.
139.  192.  298.  421.  579.  690.  783.  808.  823.  840.
674.  641.  610.  581.  522.  529.  530.  495.  478.  430.
270.  247.  224.  204.  184.  164.  144.  127.  117.  108.
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**HYDROGRAPH ROUTING**

**THIS IS A ROUTING FOR GLADES DAM**

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<th>ISTAT</th>
<th>ICOMP</th>
<th>LECIN</th>
<th>ITAPE</th>
<th>JPLT</th>
<th>JPRAT</th>
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**ROUTING DATA**

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**STAGE**

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<th>ELEVATION</th>
<th>CHEF</th>
<th>SPWID</th>
<th>COW</th>
<th>EXPW</th>
<th>ELEV</th>
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**DAM DATA**

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<th>EXPW</th>
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**Crest Length**

| Crest Length | 0.0 | 7.0 | 21.0 | 41.0 | 880.0 | 925.0 |

**Peak Outflow**

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<td>10634.0, AT TIME 51.00 HOURS</td>
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<tr>
<td>Peak Outflow</td>
<td>7183.0, AT TIME 52.00 HOURS</td>
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**Sheet 10 of 12**
### 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)**

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APPENDIX E

REGIONAL GEOLOGY
GLADES DAM
NDI No. PA 00804, PennDER No. 10-72

REGIONAL GEOLOGY

Glades Dam is located on the South Branch of Slippery Rock Creek in the Kanawha section of the Appalachian Plateaus Physiographic Province. Although the area has not been glaciated, the dam site is located approximately 3.5 miles east of the border of the Illinoian drift.

A design report for the dam describes the area as having relatively uniform foundation conditions. Beneath a one foot vegetative mat is a 15 foot deposit of brown and gray clayey silt, underlain by 30 feet of gray clay. Because the area is poorly drained, the water table is close to the surface. However, beneath the silt and clay deposits is a stratum of granular material which contains water under a high hydrostatic head; during design test drilling, the static head was measured at El. 1203 feet. This is 8 feet above the ground surface El. 1195 feet. It was concluded at that time, however, that no adverse effects would occur from this head since construction would not penetrate the granular stratum.

The soil deposits were possibly formed as the result of glacial impoundment of Slippery Rock Creek to the west.

As shown on the geologic map on the following page, the dam is located close to the contact between the Pottsville and Allegheny Formations, Pennsylvanian System. Bedrock dips gently to the southeast from the axis of the Harrisville Syncline. Rock units in the Pottsville Formation are typically sandstones and conglomerates, whereas the Allegheny consists of cyclic sequences of sandstone, shale, limestone, and coal. The Pottsville/Allegheny contact is marked by the Brookville coal. Two test borings on the left abutment, S-2 and S-3, penetrated coal at El. 1184.6 feet and El. 1183.3 feet respectively. This seam, possibly the Brookville, is between 0.5 and 1.4 feet thick and apparently pinches out within a short distance. The bedrock noted in the borings, in addition to the coal, is decomposed shale and sandy shale.
GEOLOGIC MAP
Glades Dam
NDI No. PA 00804 Butler County


Scale: One Inch Equals Approximately Four Miles
See Legend, Next Page
PERMIAN

Greene Formation
Cyclic sequences of sandstone, shale, red beds, limestone and coal, base at the top of the Upper Washington Limestone.

PERMIAN AND PENNSYLVANIAN

Washington Formation
Cyclic sequences of sandstone, shale, limestone and coal, some red shale, some bluish coal, base at the top of the Wagonerburg Coal.

PENNSYLVANIAN

APPALACHIAN PLATEAU

Monongahela Formation
Cyclic sequences of sandstone, shale, limestone and coal, limestone prominent on northern outcrop, some bluish sandstone and sandstone increase, sandstone, commercial coal present, base at the bottom of the Pittsburgh Coal.

Conemaugh Formation
Cyclic sequences of red and gray shales and siltstones with thin limestones and coals, massive Metamorphic Sandstone commonly present at base, over limestones, middle of section, Braddock Limestone in lower part of section.

Allegheny Group
Cyclic sequences of sandstone, shale, limestone and coal, numerous commercial coals, limestones thicker toward westward, Vanport Limestone in lower part of section, Grandview, Porter, Maddock, and Clarion Formations.

Pottsville Group
Predominantly sandstones and conglomerates with thin shales and coals, some coals recoverable locally.

ANTHRACITE REGION

Post-Pottsville Formations
Brown or gray sandstones and shales with some conglomerates and numerous recoverable coals.

Pottsville Group
Light gray to white, coarse grained sandstone and conglomerates with some recoverable coal, includes Sharp Mountain, Schofield, and Tumbling Run Formations.

MISSISSIPPIAN

Mauch Chunk Formation
Red shales with brown to greenish-gray shaly sandstones, includes Iron-rich Limestone to Fayette, Westmoreland, and Somerset counties, Ligonier Limestone at the base in northwestern Pennsylvania.

Pocoma Group
Predominantly gray, hard, mottled, coarse-grained sandstones and sandstones with some shale, includes in the Appalachian Plateau, Upper Carbondale, Supercacus, Cassano, Cassano, Cooper, and Kettle Formations. Includes part of the formations of M. L. Fuller in Potter and Tioga counties.