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NATIONAL DAM INSPECTION PROGRAM. GRAVEL LICK DAM (NDI PA-807), --ETC(U)
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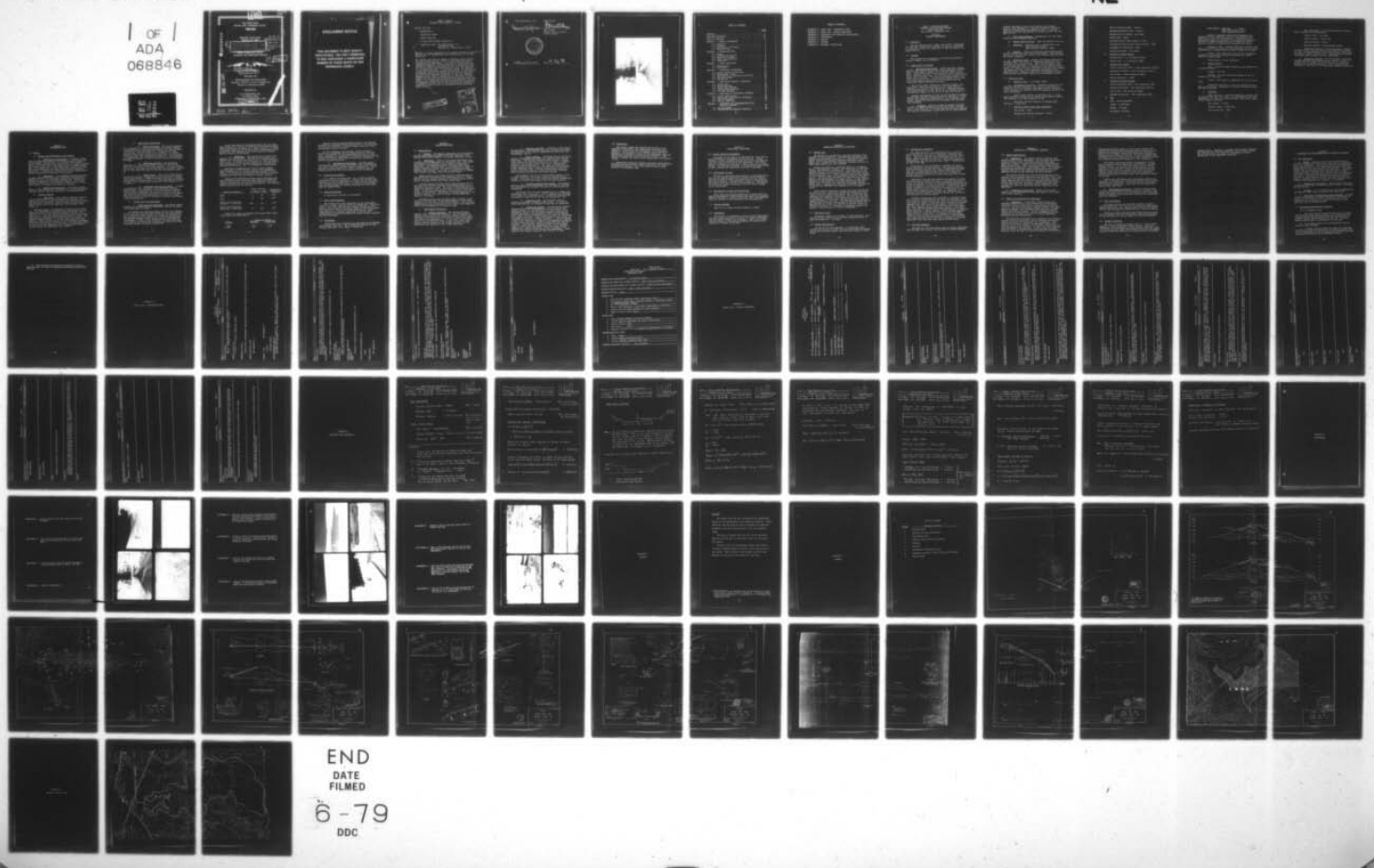

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PENNSYLVANIA

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GRAVEL LICK DAM
NDI No. Pa.-807

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MAY 23 1979

(6) National Dam Inspection Program. Gravel Lick Dam (NDI PA-807), Ohio River Basin, Gravel Lick, Clearfield County, Pennsylvania. Phase I Inspection Report.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

(12) 85 p.

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PREPARED FOR

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
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PHASE I REPORT
National Dam Inspection Program

Gravel Lick Dam

Pennsylvania

Clearfield County

Gravel Lick Run

27 June 1978 (visual inspection)

Inspection Team - GAI Consultants, Inc.
570 Beatty Road
Monroeville, Pennsylvania 15146

ABSTRACT

Based on a visual inspection and available engineering data, Gravel Lick ~~the~~ dam and its appurtenances are considered to be in fair condition.

The spillway and dam are capable of passing and/or storing the flow resulting from a storm of PMF magnitude without overtopping the embankment. As a result, the spillway is considered adequate. Seepage through the downstream slope, steadily increasing pore pressures near the downstream toe and erosion below the downstream bench level are apparent. It is recommended that: 1) the owner engage the services of a qualified registered professional engineer to investigate the seepage through the downstream face and evaluate the increasing pore pressure conditions at the toe; (remedial measures should then be implemented as required); 2) the erosion gullies along the downstream face be backfilled and seeded; 3) a formal warning system be implemented to protect those persons downstream who may ultimately be affected by an embankment breach; and 4) the dam should be inspected on a periodic basis to check for hazardous conditions which might develop.

ABSTRACT

GAI Consultants, Inc.

Bernard M. Mihalcin

Bernard M. Mihalcin, P.E.

Date August 28, 1978

Approved by:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date 10 Sep 78

Overview Photograph of Gravel Lick Dam

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
GRAVEL LICK DAM
NDI# PA-807, PENNDER# 17-109

SECTION 1
GENERAL INFORMATION

1.0 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.

1.1 Purpose.

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

1.2 Description of Project.

a. Dam and Appurtenances. Gravel Lick Dam, locally known as Lake Bimini Dam, is an earthen embankment approximately 1,800 feet in length with a maximum height of 75 feet. Incorporated into this facility are both a service and an emergency spillway. The spillways are located at the (west) right abutment. The service spillway consists of a drop inlet control weir, a rectangular channel, and a rock-lined jump-type stilling basin; all located within the trapezoidal shaped emergency spillway.

The outlet works consists of a 24-inch diameter concrete pipe. This line is valved at the intake and is located to the right of the dam center. The pipe carries flow approximately 360 feet before it is discharged into a riprap-lined channel at the toe of the dam (see Figure 3).

Another appurtenance of note is the piezometer building located about 20 feet beyond the base of the toe in a flat, grassy area immediately downstream of the embankment. Contained within the structure are the gauges and miscellaneous equipment.

b. Location. Gravel Lick Dam is located on Gravel Lick Run in Sandy Township of Clearfield County, Pennsylvania. The structure is located less than 1/2 mile north of the Penfield Interchange of Interstate 80 and approximately

2 miles northeast of the city of DuBois (see Regional Vicinity Map, Appendix G). The dam, reservoir, and watershed are located within the Sabula U.S.G.S. 7.5 minute quadrangle and the coordinates of the dam are N41° 08' and W78° 42' 45".

c. Size Classification. Intermediate (75 feet high, 5,500 acre-feet storage capacity).

d. Hazard Classification. High (see Section 3.1.c.6).

e. Ownership. Treasure Lake of Pennsylvania, Inc.
3300 University Drive
Coral Springs, Florida 15801

f. Purpose. Gravel Lick Dam was constructed as part of the Treasure Lake Real Estate Development. The reservoir serves as a recreational facility for property owners within the resort community.

g. Historical Data. Gravel Lick Dam was designed for Treasure Lake, Inc., by R. M. Keddal and Associates, Inc., of Bethel Park, Pennsylvania. Construction began in July 1971 and was completed in June 1974. The only modification to the embankment since its completion, has been the installation of a sanitary sewer line along the bench which crosses the downstream face of the embankment approximately at elevation 1470. Seepage around the left abutment required some drainage modification which were implemented in 1977.

1.3 Pertinent Data.

a. Drainage Area. 1.32 square miles.

b. Discharge at Dam Site. Discharge records are not available for this facility. The owner's representative could not recall the maximum discharge with any certainty. It was pointed out, however, that the emergency spillway has never discharged.

Outlet Works Conduit at Operating Pool - A computer analysis included in the design calculations indicate the discharge to be approximately 90 cfs.

Emergency Spillway Capacity at Maximum Pool Elevation ≈ 8,600 cfs.

c. Elevation (feet above mean sea level).

Top of Dam - 1505.

Maximum Pool Design Surcharge - 1501.6.

Service Spillway Crest - 1495.0.

Emergency Spillway Crest - 1497.5.

Maximum Pool of Record - Not known.

Normal Pool - 1495.

Upstream Portal Invert Outlet - 1449.

Downstream Portal Invert Outlet Conduit - 1433.

Streambed at Centerline ≃ 1427.

Maximum Tailwater - Not known.

d. Reservoir Length (miles).

Maximum Pool ≃ 1.2 (elevation 1505).

Normal Pool ≃ 1.1 (elevation 1495).

e. Storage (acre-feet).

Service Spillway Crest ≃ 5,500 (elevation 1495.0).

Emergency Spillway ≃ 5,970 (elevation 1497.5).

Top of Dam ≃ 7,800 (elevation 1505).

Design Surcharge ≃ 1,830.

f. Reservoir Surface (acres).

Service Spillway Crest ≃ 193 (elevation 1495).

Emergency Spillway ≃ 203 (elevation 1497.5).

Top of Dam ≃ 226 (elevation 1505).

Maximum Design Pool ≃ 226 (elevation 1505).

g. Dam.

Type - Zoned earthfill.

Length - 1,800 feet.

Height - 75 feet.

Top Width - 40 feet.

Side Slopes - upstream 3H:1V
upper downstream 2.5H:1V
lower downstream 3H:1V

Zoning - Drawings indicate the embankment is constructed of an impervious clay core protected on both sides by 10 feet of filter material. The upstream and downstream slopes are composed of semi-pervious materials. Two feet of dumped riprap placed on 8 inches of gravel protect a portion of upstream face against wave action.

Impervious Core - Drawings indicate a central core with a top width of 20 feet at five feet below the crest and increasing to a maximum width of about 70 feet at its base.

Cutoff - The impervious clay core was apparently extended to the bedrock surface and serves as a cutoff trench of varying width.

Grout Curtain - None indicated.

h. Outlet Conduit.

Type - 24-inch diameter concrete pipe supported on a concrete cradle.

Length - 357 feet.

Closure - 24-inch slide gate mounted on the upstream end of the pipe.

Access - The intake is submerged and is not accessible.

Regulating Facilities - Flow is regulated by the gate on the intake. Operation of the gate is provided from the top of the dam.

i. Spillway.

Type (service) - Concrete rectangular channel with an uncontrolled drop inlet weir. At approximately 400 feet downstream, the concrete terminates and a rock-lined, trapezoidal channel continues.

Weir Length - 8 feet.

Channel Length ≈ 1,300 feet.

Crest Elevation - 1495.

Type (emergency) - Uncontrolled natural channel with a trapezoidal cross-section.

Channel Width - 150 feet.

Channel Length ≈ 1,300 feet.

Crest Elevation - 1497.5

Upstream Channel - Riprap-lined channel.

Downstream Channel - Flow passes down a moderate to steep sloped, heavily wooded valley immediately beyond the dam. At approximately 1/2 mile downstream, Gravel Lick Run passes beneath Interstate 80. The stream enters Sandy Lick Creek about another 1/2 mile downstream.

j. Regulating Outlets. 24-inch diameter reinforced concrete pressure pipe supported by a concrete cradle. A sliding gate is located at the intake and is controlled manually from atop the dam crest. The outlet works are intended to also serve as the emergency drawdown facilities.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources.

1. Hydrology and Hydraulics. A complete hydrology and hydraulic analysis by Systems Planning Associates of Pittsburgh, Pennsylvania, is available from PennDER files. Also obtainable from these files is a report prepared by PennDER in May 1971 on the application of Treasure Lake, Inc., for construction of Lake Bimini Dam (Gravel Lick Dam). The report summarizes available hydrologic and hydraulic design data. Included are references to basic design parameters and pertinent features of the project.

2. Embankment. The embankment design was based on data presented in the report prepared by Engineering Mechanics, Inc., of Pittsburgh, Pennsylvania, titled "Subsurface Investigation and Earthwork Design". The report includes a summary of the subsurface investigation, along with results of seepage and stability analyses.

3. Appurtenant Structures. Structural design data and computations are included in the report prepared by Systems Planning Associates available from PennDER files.

b. Design Features.

1. Embankment. The contract drawings indicate the dam embankment is a zoned earthfill structure. An impervious core and cutoff trench to rock are provided along the embankment centerline. Ten-foot wide filters are provided on each side of the impervious core material (see Figure 2).

The outer zones are comprised of semi-pervious material. The embankment is provided with side slopes of 3H:1V upstream and 2-1/2H:1V downstream above elevation 1470. There is a 15-foot wide berm at elevation 1470 on the downstream face. The slope below this elevation is 3H:1V. The dam crest was measured to be 40 feet wide and contains an asphalt roadway surface. A 2-foot thick zone of riprap covers an 8-inch filter blanket on the upstream face between elevation 1485 and the top of the dam. A 30-foot wide drain is located at the downstream toe to control the phreatic surface within the embankment (see Figure 2).

2. Appurtenant Structures.

a) Service Spillway. The service spillway is a rectangular, 8-foot wide reinforced concrete channel located within the emergency spillway at the right abutment (see Figure 3 and Photograph 6). A "drop inlet" type concrete weir controls flow at the entrance. An 8-inch thick by 2-foot deep reinforced concrete key is constructed at the entrance just downstream of the weir. The wingwalls are backfilled with 1.5 feet of gravel to facilitate proper drainage.

b) Emergency Spillway. The emergency spillway is a trapezoidal channel, 150 feet wide at the base, cut into rock at the right abutment. The side slopes are 2H :1V. The depth of the spillway at the control section is 7.5 feet below the crest of the dam (see Figures 3 and 8).

c) Outlet Works. The outlet works serving Gravel Lick Dam are located to the right of the dam center. The system includes a submerged intake structure, a sliding trash screen and sluice gate, a 24-inch pipe passing through the dam, and a riprap-lined plunge pool (see Figures 3, 4, 5, and 6).

d) Piezometric Monitoring System. A system of piezometers was installed in the embankment during construction. The subsurface investigation and earthwork design report recommended the system in order to monitor pore pressure development throughout the construction phase. The gages and operating mechanisms are housed in a small masonry building located at the base of the toe (see Figure 7 and Photograph 12).

c. Design Data and Procedures.

1. Hydrology and Hydraulics. The design report prepared by Systems Planning Corporation details the hydrologic/hydraulics utilized.

In essence the following design criteria were adopted: 1) the principal spillway should pass the flow associated with a 100-year 24-hour storm (4.6 inches of rainfall); 2) the emergency spillway should pass inflow associated with the maximum probable flood (as per Bureau of Reclamation Procedures); 3) half of the discharge from Lake Rene will flow through the Galion Bay spillway into Gravel Lick from coincident storms of similar intensities.

It was also noted in the design report that the rainfall intensities utilized to determine the maximum probable flood varied from 20 inches for a 4-hour storm to 35 inches in 48 hours which are of the same order of magnitude of the record July 1942 Smethport part area rainfall of greater than 30 inches in 4-1/2 hours.

2. Embankment. Two geotechnical reports were prepared for this project. The geology of the area was studied and reported by personnel of R. M. Keddal and Associates, Inc., of Bethel Park, Pennsylvania, and the subsurface investigation and earthwork design were presented by Engineering Mechanics, Inc., of Pittsburgh, Pennsylvania.

Pertinent recommendations from the above studies include removal of the alluvial soils in the embankment area, installation of a cutoff extending through the coal outcrop to the underlying sandstone and sealing of exposed carbonaceous shale and coal seams to prevent leakage.

Review of the embankment design report indicates that soils parameters for the design were estimated (conservatively) from triaxial tests on undisturbed colluvial soil samples recovered during the drilling program. The reported design parameters are as follows:

Material Location	Shear Strength C′ (psf)	Shear Strength Ø′ (deg.)	Permeability k(cm/sec)
Base	0	31	10^{-5}
Core	0	26	10^{-5}
Shell (with confining pressure < 4,000 psf)	200	24	10^{-3}
Shell (with confining pressures > 4,000 psf)	0	26	10^{-3}

Factors of safety (presumably for steady state conditions only) were reported as:

Station	Factor of Safety Upstream	Factor of Safety Downstream
7+50	2.2	1.6
11+50	2.0	1.5

Seepage analyses were performed based on the assumed permeability parameters which indicated that a 30-foot wide toe drain was required to "reduce seepage along the front (downstream) face of the dam".

As the parameters were assumed, further triaxial testing was recommended during construction for verification. In addition, it was recommended that soils in the earth embankment be compacted to at least 110 percent of the maximum dry density obtainable by ASTM Test Designation D698-70 (Standard Proctor).

3. Appurtenant Structures. Detailed design calculations (hydraulic and structural) were presented for the outlet system by Systems Planning Corporation. Design details include analysis for impact, vibration, etc. A drawdown curve for the outlet system is also presented.

2.2 Construction Records.

R. M. Keddal and Associates, Inc., acted as project supervisors during construction. During this period, they compiled a series of memoranda and status reports which are now available in PennDER files. In addition, photographs taken by both Keddal and PennDER personnel are also available in PennDER files.

2.3 Operating Records.

No operational records are available.

2.4 Other Investigations.

Two studies have been undertaken by GAI Consultants relative to Gravel Lick Dam since its completion. The first study in May 1976, assessed the seepage through the left abutment and presented a remedial system of sub-drains which were installed. The second study consisted of a Phase I inspection of all Treasure Lake Dams in October 1977. Recommendations contained therein are under current consideration by the owner.

2.5 Evaluation.

Engineering data available were provided by the PennDER and Treasure Lake, Inc. The information obtained is considered sufficient for a Phase I evaluation.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the structure and its appurtenances suggests that the facility is adequately maintained; however, its overall condition is fair.

b. Embankment. Based on the visual inspection, the condition of the embankment is considered fair. The slopes are adequately maintained with no signs of undesirable vegetation. The downstream slope is covered with crown vetch while the upstream slope is protected with a layer of durable sandstone riprap. No signs of cracking or slope distress were evident. The crest is covered with an asphalt road surface with guard rails lining both sides.

Erosion gullies are evident across a large portion of the downstream face between the bench and the toe. These gullies are the apparent result of unchecked surface runoff prior to growth of the thick crown vetch cover.

A broad seepage area was located approximately 200 to 350 feet from the left abutment and surfacing about 9 to 12 feet below the bench level. The area is characterized by a change of vegetation and in particular a lack of dense crown vetch. No positive determination could be made as to the origin of the seepage. The amount of seepage appeared to be minimal; however, its relative height on the downstream slope is of concern.

Discharge ends of the toe drain pipes as shown on the contract drawings were located approximately 25 feet downstream and to the left of the outlet conduit. Only the left abutment drain was discharging at the time of the inspection with a flow estimated not to exceed 25 gpm.

c. Appurtenant Structures.

1. Service Spillway. The primary spillway appears to be in excellent condition. No indications of concrete deterioration were visible; however, much of the wingwalls are concealed by overgrowth of vetch from adjoining slopes (see Photograph 7). At the time of inspection, the weir was discharging under a head of 0.2 feet. The natural channel section of the primary spillway located downstream also appeared to be in good condition.

2. Emergency Spillway. According to the owner's representative, the emergency spillway has never discharged. Its condition at the time of inspection was excellent (see Photographs 7 and 8).

3. Outlet Conduit. The intake end of the outlet conduit is submerged and cannot be inspected under normal conditions. The manually operated valve control, located flush against the upstream slope near the crest, is approximately ten feet above normal pool and in apparent good condition (see Photograph 9). The valve is reportedly in proper operating order but was not operated in the presence of the inspection team. The box casing which serves to protect the valve stem was firmly in place but displayed minor corrosion throughout its visible length.

The discharge end on the outlet conduit appears to be in good condition. No signs of concrete weathering are evident. The plunge pool and downstream channel immediately beyond the conduit also appear to be in good condition.

4. Piezometric Monitoring System. The masonry building housing the instruments is in excellent condition. The instruments are operable but were not read during the inspection.

The gauges were read and recorded by R. M. Keddal and Associates, Inc., until 1975. Their readings are contained in the owner's and PennDER files. Piezometer readings were last taken in the fall of 1977 by GAI Consultants, Inc.

5. Reservoir Area. The reservoir area is bounded by moderate, heavily wooded slopes. No signs of slope distress were in evidence at the time of inspection.

6. Downstream Channel. The downstream channel immediately beyond the embankment is fairly narrow and heavily wooded. At approximately 0.5 miles south of the embankment, Gravel Lick Run passes beneath Interstate 80. Further downstream, approximately 1 mile from the embankment, Gravel Lick Run passes beneath PA Route 255 and merges with Sandy Lick Creek. Sandy Lick Creek, at this point, is a meandering stream in a broad floodplain. The only damage likely to be incurred as a result of an embankment breach up to this point (one mile) would be associated with the two highways. Nevertheless, located adjacent to the stream about 2.5 miles from the embankment are a major shopping complex and a power substation. Both are likely to be affected by a breach of the Gravel Lick embankment. Consequently, the hazard rating for this facility is high.

3.2 Evaluation.

The visual inspection revealed the facility to be adequately maintained. The appurtenant structures are generally in good condition and appear to be functioning properly. The presence of an extensive saturated area coupled with noticeable erosion of the downstream indicates the overall condition of this facility is "fair". The volume of seepage was small and not measurable (see Section 3.1.b).

Downstream conditions indicate that many lives would be affected and much property damage incurred in the event of an embankment breach. Thus, the hazard rating of this facility is considered high.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

According to the owner's representatives, there are no formal operational procedures at the facility. Excess reservoir inflow is passed through the service spillway and into the stream channel below the embankment. The outlet conduit is opened at least once a year to ensure its operability. The emergency spillway is designed to handle storms of PMF intensity but reportedly has never discharged.

4.2 Maintenance of Dam.

The dam is reportedly maintained on an as-needed basis. Part of the regular maintenance includes clearing debris from the service spillway, and operating the gate valve on the outlet conduit. The embankment slopes are essentially self maintaining and require little attention. The dam and spillways are readily accessible from the roadway system of the development.

4.3 Maintenance of Operating Facilities.

Other than occasionally operating the gate valve, no regular maintenance is performed on the operating mechanism. The hand operator is readily accessible from the embankment crest at a break in the guardrails (see Photograph 9).

4.4 Warning Systems.

There are no formal warning systems in effect.

4.5 Evaluation.

The facility is designed to require little maintenance and its overall appearance is good. No formal operations and maintenance manuals are available. There is no formal warning system for downstream residents who could be affected by a failure of the dam.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

The hydrologic and hydraulic analyses available from PennDER are very extensive. Included are discussions supported by calculations pertaining to stage-volume relationships, primary and emergency spillway analysis, outlet works, etc. Structural and foundation analyses relative to these appurtenances are also included.

Gravel Lick Dam has a watershed equal to 1.32 square miles. Consideration, however, was also given to Lake Rene located just north of the facility. Lake Rene was in the process of being altered during the Gravel Lick Dam design with the addition of a saddle dam across Wolf Creek located at the northwest corner of the present reservoir (see Appendix G). The resulting watershed for Lake Rene was determined to be approximately 4.7 square miles. It was assumed one-half of the discharge from Lake Rene would pass into Gravel Lick Reservoir (via discharge facilities through Galion Bay). Consequently, the total watershed contributing to Gravel Lick Reservoir was assumed to be 3.67 square miles.

Three separate hydraulic systems have been implemented at this facility. The outlet system was designed to carry flows during the construction period and to draw down the reservoir when necessary thereafter. The service spillway is designed to maintain a pool elevation of 1,495 feet and to accommodate a flood with a 100-year recurrence interval (Design Discharge ≈ 159 cfs). The emergency spillway system was designed to prevent overtopping of the dam during the maximum probable flood (not the PMF as defined herein) as developed by Bureau of Reclamation procedures (Design Discharge ≈ 3,200 cfs with 2.6 feet of freeboard).

5.2 Experience Data.

Discharge records are not kept for this facility. As a result, no data pertinent to spillway evaluation based on past performance are available.

5.3 Visual Observations.

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event.

5.4 Overtopping Potential.

The "PMF Peak Flow" was determined from an empirical curve supplied by the Corps of Engineers, Baltimore District. The curve used was one prepared for the Ohio River Basin. Based on this curve and a drainage area of 1.32 square miles, Peak PMF Q = 2574 cfs. The size category is "intermediate" and the hazard rating "high". Consequently, the SDF is the PMF.

Calculations were performed to determine the overtopping potential at this facility. The maximum discharge of the emergency spillway was found to approximately equal 8600 cfs. A comparison of peak inflow (2570 cfs) with maximum discharge indicates the facility is capable of passing and/or containing the inflow resulting from a storm of PMF intensity.

Additional calculations consider the effects of inflow from Lake Rene on Gravel Lick Dam. An attempt was made to verify the design criteria of Systems Planning Associates as stated in Section 5.1 using the procedure recommended by the Corps of Engineers, Baltimore District. Based on the recommended procedure and an equivalent drainage area of 3.67 square miles, Peak PMF Q = 6006 cfs. A comparison of peak inflow with maximum discharge (8600 cfs) indicates the spillway is also capable of passing the PMF for the equivalent drainage area stated above.

Further calculations were performed in accordance with the procedures recommended by the Corps of Engineers, Baltimore District, which indicate the facilities associated with Lake Rene are capable of passing and/or storing the probable maximum flood (PMF) without overtopping. Discharge from Lake Rene normally enters Gravel Lick Reservoir via Galion Bay. The combined maximum discharge capacity of the emergency spillway and outlet works at Galion Bay Dam is approximately 1200 cfs. Adding 1200 cfs to the already computed Peak Inflow Q = 2570 cfs for the Gravel Lick watershed yields a value of 3970 cfs. A comparison of peak inflow (3970 cfs) with maximum discharge at Gravel Lick Dam (8600 cfs) indicates that Gravel Lick Dam is capable of handling additional flow from Lake Rene during the PMF event.

5.5 Spillway Adequacy.

The facility will pass and/or contain inflow associated with the PMF; as a result, the spillway is deemed adequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Two problem areas of concern were noted relative to the embankment. One involves the erosion gullies visible across the downstream face which were apparently formed by surface runoff during and immediately after construction. These have since been seeded and the majority are protected by a vegetative cover. The condition is presently considered a minor problem which can be remedied by backfilling and reseeding and does not pose an immediate threat to the stability of the structure.

The second problem involves the broad saturated area located along the downstream slope (see Section 3.1.b). The location of the seepage, about 9 to 12 feet below the bench level suggests that its source may be the sanitary sewer system that underlies the bench. Regardless of the origin of the seeps the area influenced by the additional pore pressure is likely to reduce the overall stability of the embankment.

b. Appurtenant Structures. Based on the visual inspection, the appurtenant structures appear to be stable and in good condition.

6.2 Design and Construction Techniques.

a. Embankment. A subsurface investigation and embankment design report were prepared by a geotechnical consultant prior to construction (see details in Section 2.1.c.2). As previously noted, assumed strength and permeability parameters for embankment materials were utilized based on triaxial testing of colluvial samples obtained during the drilling program. It was recommended that the parameters be verified by testing of actual embankment materials during construction.

Pore pressure development was recognized as a potential problem during construction, thus an extensive monitoring system containing 29 piezometers was recommended. This system was installed during the embankment construction; however, there is no evidence (in available files) that the soil parameters were verified. In fact, the only gradation test of record in PennDER files indicates that the shell materials does not meet the design permeability requirement.

Correspondence dated August 3, 1971, also indicate that additional drilling with hydraulic pressure testing of the bedrock was performed after construction was initiated. Based on this testing, seepage was anticipated through the embankment upon reservoir filling. It was recommended that an evaluation of the seepage be made after reservoir filling and remedial grouting be conducted if found necessary.

This design philosophy appears inconsistent in that only a nominal drainage system was recommended to provide seepage control. It is also noted that a filter system adjacent to both the upstream and downstream face of the impervious core material is shown on the design drawings; however, there are no indications that the filter has a drainage outlet and consequently would be inoperable in lowering the phreatic surface within the downstream portion of the dam.

Construction photographs and generalized reports are available in PennDER files indicating adequate construction procedures were utilized. The project duration was unusually lengthy, commencing in July 1971 and not being completed until June 1974.

b. Appurtenant Structures. Detailed analysis were utilized in the design of the appurtenant structures. The design philosophy resulted in an adequately sized spillway. Based on observed field conditions, construction techniques were also adequate.

6.3 Past Performance.

No formal records are available; however, based on field observations, the facility has functioned adequately. Seepage through the left abutment developed as anticipated, and has been subsequently controlled by a collector system.

Review of recent piezometer data shows high pore pressure development near the toe possibly indicating plugging of the toe drain or flow in excess of the drain capacity.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and is thus subject to minor earthquake induced forces. Since the embankment is broad-based and constructed of residual soils, it is believed that under well-drained conditions the static stability would be sufficient to withstand minor earthquake

induced forces. However, as seepage and high pore pressures are apparent near the downstream toe, small dynamic forces may be significant and should be considered in future evaluations of the embankment stability.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. Based upon the visual inspection and available engineering data, Gravel Lick Dam is considered to be in fair condition. Seepage was noted on the downstream slope approximately 9 to 12 feet below the bench level and between 200 to 350 feet from the left abutment. Noticeable erosion has also occurred below the bench level. Review of recent piezometer readings also indicate that a steady increase of pore pressures has occurred near the downstream toe drain. Hydraulic and hydrologic calculations used as part of our investigation indicate that the spillway is capable of passing and/or storing the flow resulting from a storm of PMF magnitude and, therefore, is adequate.

b. Adequacy of Information. The available data are considered sufficient to make an accurate Phase I assessment of the facility.

c. Urgency. It is suggested that the recommendations and studies listed below be implemented immediately.

d. Necessity for Additional Investigations. An additional investigation is deemed necessary to determine the origin of the seepage along the downstream face of the embankment and to assess the apparent increase in pore pressure near the downstream toe.

7.2 Recommendations/Remedial Measures.

It is recommended that:

a. The owner should engage the services of a qualified registered professional engineer to investigate the seepage through the downstream face and evaluate the increasing pore pressure condition at the toe. Remedial measures should then be implemented as required.

b. The erosion gullies of the downstream face be backfilled and reseeded.

c. A formal warning system and plans for round-the-clock surveillance during periods of unusually heavy rainfall be implemented to protect downstream residents who may ultimately be affected by an embankment breach.

d. The facility be inspected periodically by qualified personnel to check for hazardous conditions which might develop.

APPENDIX A

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Gravel Lick Dam
NDI# 807
ID # PennDER# 17-109

ITEM	REMARKS	SHEET 1

AS-BUILT DRAWINGS

Set of design drawings including a piezometer installation chart available from PennDER files. Drawings are not marked "as-built".

REGIONAL VICINITY MAP

U.S.G.S. 7.5 minute quadrangle Sabula.

CONSTRUCTION HISTORY

Construction photographs, memoranda and progress reports are available from PennDER files.

TYPICAL SECTIONS OF DAM

See Appendix F.

OUTLETS - PLAN See Appendix F.

- DETAILS

- DISCHARGE RATINGS

RAINFALL/RESERVOIR RECORDS

No staff gage at reservoir. Reservoir levels are not recorded. 3 years of daily rainfall records are available at the local sewage treatment plant.

DESIGN REPORTS

Hydraulic design by Systems Planning Associates, Pittsburgh, PA, available from PennDER. Also included are the subsurface investigation and foundation design by Engineering Mechanics, Inc., of Pittsburgh, PA, and construction reports by R. M. Keddal and Associates, Inc., of Bethel Park, PA.

GEOLOGY REPORTS

Geology summary included in report by Engineering Mechanics, Inc.

DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES

Report by Systems Planning Associates includes computations for hydrology and hydraulics, along with filter and riprap design.

MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY
FIELD

Included in report by Engineering Mechanics, Inc.

POST-CONSTRUCTION SURVEYS OF DAM

None.

BORROW SOURCES

See Appendix F.

MONITORING SYSTEMS

Piezometer system designed by Engineering Mechanics, Inc. See Appendix F.

MODIFICATIONS

Modifications to the original plans are as follows: 1) the outlet pipe and appurtenances were moved horizontally, approximately 140 feet east of the design location. The invert elevations were not changed; 2) a 15-inch concrete encased sanitary sewer was constructed across the 15-foot bench on the downstream slope; 3) subsurface drains were constructed in 1977 to control seepage around left abutment.

HIGH POOL RECORDS

Not available. Emergency spillway has reportedly never discharged.

POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS

Report entitled, "Inspection of Dams - Phase I" for Treasure Lake of Pennsylvania by GAI Consultants, Inc., October 1977. Available from the owner.

PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS

None.

MAINTENANCE OPERATION RECORDS

None available.

ITEM	REMARKS	ID # PA-807	SHEET 4

SPILLWAY PLAN — See Appendix F.

SECTIONS

DETAILS

OPERATING EQUIPMENT
PLANS & DETAILS — See Appendix F.

NDI# PA-807

CHECK LIST ID # PennDER 17-109

HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.32 square miles.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1495 (5,550 acre-feet).

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1497.5 (5,970 acre-feet).

ELEVATION MAXIMUM DESIGN POOL: 1505 (7,800 acre-feet).

ELEVATION TOP DAM: 1505.

SPILLWAY DATA:

a. Crest Elevation (service) 1495; (emergency) 1497.5.

b. Type (service) drop inlet, concrete channel; (emergency) uncontrolled natural channel.

c. Weir Length (service) 8 feet.

d. Channel Length (service) ≈1,300 feet, (emergency) ≈1,300 feet.

e. Location Spillover Both spillway at right abutment.

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type 24-inch diameter low level conduit.

b. Location Left of spillways and right of dam center.

c. Entrance Inverts 1449.

d. Exit Inverts 1433.

e. Emergency Draindown Facilities Manually operated gate at entrance.

HYDROMETEOROLOGICAL GAGES:

a. Type Rain.

b. Location Sewage treatment plant.

c. Records Records compiled since 1975.

MAXIMUM NON-DAMAGING DISCHARGE: Not available.

APPENDIX B

CHECK LIST - VISUAL INSPECTION

CHECK LIST
VISUAL INSPECTION
PHASE 1

NDI# PA-807

DAM NAME Gravel Lick Dam COUNTY Clearfield STATE PA ID # PennDER 17-109

TYPE OF DAM Earth HAZARD CATEGORY High

DATE(S) INSPECTION 27 June 78 WEATHER Hot-humid overcast TEMPERATURE 80°±

POOL ELEVATION AT TIME OF INSPECTION 1495.2 M.S.L. TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL:

B. M. Mihalcin (GAI)	Chandu Patell (PennDER)	
J. P. Nairn (GAI)		
D. L. Bonk (GAI)		

B. M. Mihalcin RECORDER

EMBANKMENT ID# PA-807 Sheet 1

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	Erosion gullies visible across most of the toe. A few of these extend up to and beyond the berm located at elevation 1470.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Excellent condition.	
RIPRAP FAILURES	None observed.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM

Good condition. Left abutment hillside has had extensive work performed on it that included the installation of a drainage system to divert runoff away from the embankment. At the time of inspection, the area had not been reseeded and some erosion was evident.

ANY NOTICEABLE SEEPAGE

Broad saturated area measured to be approximately 150 feet across is located approximately 200 to 350 feet from the left abutment and 9 to 12 feet below the elevation of the berm area is characterized by a lack of healthy vegetation.

STAFF GAGE AND RECORDER

None observed.

DRAINS

The discharge points of the toe drains are located approximately 25 feet downstream and to the left of the outlet conduit. Only the left abutment drain was partially discharging during inspection with a flow estimated to be not in excess of 25 GPM. These drains were concealed and partially obstructed. Nevertheless, with the aid of the owner's maintenance superintendent, they were located and the flow path cleared.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Concrete surfaces appear to be in good condition.	
INTAKE STRUCTURE	Submerged and could not be inspected.	
OUTLET STRUCTURE	Discharging a small amount of flow at the time of inspection. Concrete and plunge pool appear to be in good condition. Outlet end was slightly obstructed with rocks and debris but was cleared by the inspection team.	
OUTLET CHANNEL	Natural riprap lined channel appears to be in good condition.	
EMERGENCY GATE	Submerged at the intake. Manual control located directly above intake and near the crest in good condition. Control is operable according to the owner's representatives. However, it was not operated in the presence of the inspection team.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

CONCRETE WEIR

Concrete surfaces appear to be in good condition. Wingwalls are partially covered by overgrown vegetation from the adjoining slopes. During the inspection, the weir was discharging under a head of approximately 0.2 feet. Some debris in the form of small boulders and driftwood could be seen scattered along the channel.

APPROACH CHANNEL

Riprap lined channel in apparent good condition.

DISCHARGE CHANNEL

The service spillway consists of a rectangular shaped, concrete channel approximately 400 feet in length. Beyond the concrete channel is a trapezoidal shaped, riprap lined channel. Together they form the service spillway channel and are located within the emergency spillway channel. Both the service and emergency spillways appear to be well kept and maintained and in good condition.

BRIDGE AND PIERS

Located less than 100 feet downstream of the weir is a bridge which spans the service channel. The bridge carries vehicular traffic as a part of Carribean Road. It appears to be in excellent condition.

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		

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

MONUMENTATION/SURVEYS

None observed.

OBSERVATION WELLS

None observed.

WEIRS

Located at entrance of service spillway only.

PIEZOMETERS

Piezometer hut located just beyond the downstream toe near the dam center houses a series of piezometers that were installed during construction. These piezometers are not the continuous read-out type and were not prepared to be read during inspection.

OTHERS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate - heavy wooded - no slumps.	
SEDIMENTATION	None observed.	

DOWNSTREAM CHANNEL ID # PA-807 SHEET 8

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Unobstructed gentle sloping natural channel passes underneath Interstate 80 approximately 1/2 mile south of the embankment and beneath Route 255 approximately 1 mile south of the embankment.	
SLOPES	Intermittent grassy and wooded sections characterized by moderate side slopes.	
APPROXIMATE NO. OF HOMES AND POPULATION	A major shopping complex and a power substation are likely to be adversely affected by high water resulting from an embankment breach.	

APPENDIX C

HYDROLOGY AND HYDRAULICS

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLB DATE 7-21-78 PROJ. NO. 78-501-807

CHKD. BY JTS DATE 8-4-78 SHEET NO. 1 OF 9

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DAM STATISTICS

MAXIMUM HEIGHT OF DAM = 75 FEET (REF 1, Pg1)

DRAINAGE AREA = 1.32 SQ. MI. "

STORAGE CAPACITY = 5500 ACRE-FEET (REF: "ELEVATION VS. CAPACITY CURVE" ON FIGURE 1, APPENDIX F)

SIZE CLASSIFICATION

DAM SIZE = INTERMEDIATE (REF 2, TABLE 1)

HAZARD RATING = HIGH (POSSIBLE LOSS OF LIFE IS GREATER THAN 3)

REQUIRED SDF = PMF (REF 2, TABLE 3)

REFERENCES

1: "REPORT UPON THE APPLICATION OF TREASURE LAKE, INC." PENNA. DEPT. OF ENVIROMENTAL RESOURCES, DIV. OF DAMS & ENCROACHMENTS, MAY 27, 1971

2: "RECOMMEND GUIDELINES FOR SAFETY INSPECTION OF DAMS" DEPT. OF THE ARMY - OFFICE OF CHEIF ENGINNEER, APPENDIX D

3: "STANDARD HANDBOOK FOR CIVIL ENGINEERS" F. S. MERRITT, MCGRAW-HILL 1976

4: "HYDRAULICS ON BROAD-CRESTED SPILLWAYS" U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, TECHNICAL RELEASE NO. 39, DESIGN UNIT, MAY 1968

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLB DATE 7-21-78 PROJ. NO. 78-501-807

CHKD. BY JTS DATE 8-4-78 SHEET NO. 2 OF 9

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PMF (PEAK FLOW)/AREA = 1950 CFS/SQ. MI. (REF: C OF E CURVE OHIO RIVER BASIN)

PEAK INFLOW Q = 1950 CFS/SQ. MI. (1.32 SQ. MI.) = 2574 CFS

TOTAL TIME OF FLOW = 31 HRS (REF: C OF E CURVE OHIO RIVER BASIN)

VOLUME OF INFLOW HYDROGRAPH

$V = \frac{1}{2}(Q_{IMAX})(TIME)$

$= \frac{1}{2}(2574\ CFS)(31\ HRS)(3600\ SEC/HRS)(1\ ACRE/43,560\ SQ.\ FT.)$

$= 3297$ ACRE FEET

DETERMINE AVERAGE RUNOFF REQUIRED TO PRODUCE THE ABOVE VOLUME OF INFLOW.

$(3297\ AC\text{-}FT)(1\ SQ.\ MI./640\ ACRES)(12\ IN/FT)/(1.32\ SQ.\ MI.) = 46.8$ INCHES

VOLUMES PRODUCED BY RUNOFF IN EXCESS OF 26 INCHES ARE TO BE RECALCULATED USING 26 INCHES AS AN UPPER BOUND

$(26\ INCHES)(1.32\ SQ.\ MI.)(640\ ACRES/SQ.\ MI.)(1\ FT/12\ IN) = 1830\ AC\text{-}FT$

VOLUME OF INFLOW (RECALCULATED) = 1830 AC-FT

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLB DATE 7-21-78 PROJ. NO. 78-501-807

CHKD. BY JTS DATE 8-4-78 SHEET NO. 3 OF 9

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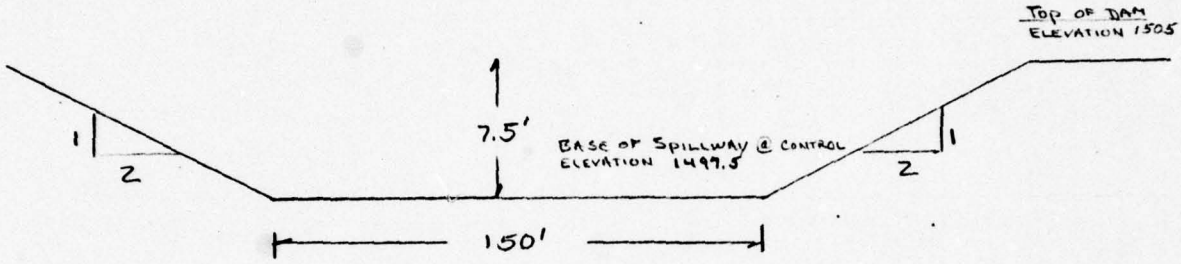
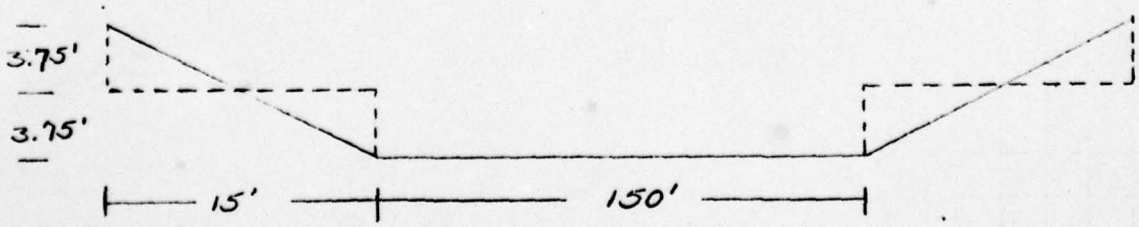
SPILLWAY CAPACITY



NOTE: ALL ELEVATIONS ARE TAKEN FROM DRAWING 2 OF 15 ENTITLED "GENERAL PLAN". THE SLOPES ARE ASSUMED TO 2H ON 1V AT THE CONTROL SECTION ALTHOUGH IN REALITY THEY ARE LESS THAN THIS DUE TO THE ROADWAY WHICH CROSSES THE SPILLWAY AT THE CONTROL. NEVERTHELESS, 2H ON 1V IS TYPICAL FOR THE REMAINING PARTS OF THE CHANNEL. THUS THIS ASSUMPTION IS CONSIDERED TO BE CONSERVATIVE

CONSIDER THE SPILLWAY CONTROL SECTION AS A BROAD CRESTED WEIR



——— ACTUAL SPILLWAY SECTION

- - - ASSUMED SPILLWAY SECTION

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLB DATE 8-3-78 PROJ. NO. 78-501-807

CHKD. BY JTS DATE 8-4-78 SHEET NO. 4 OF 9

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BREADTH OF CREST = 40FT (REF: DRWG 2 OF 15, "GENERAL PLAN")

C = DISCHARGE COEFFICIENT = 2.63 (REF 3: TABLE 21-15)

NOTE: THE ABOVE COEFFICIENT IS APPLICABLE TO BOTH THE 150FT SECTION UNDER 7.5FT OF HEAD AS WELL AS THE TWO 15FT SECTIONS UNDE 3.75' OF HEAD.

$Q_1 = C L_1 H_1^{3/2}$ = FLOW ACROSS CENTER (150FT) SECTION

$L_1 = 150FT$
$H_1 = 7.5FT$

$Q_2 = C L_2 H_2^{3/2}$ = FLOW ACROSS END (15FT) SECTION

$L_2 = 15FT$
$H_2 = 3.75FT$

$Q_{TOTAL} = Q_1 + 2Q_2$

$Q_{TOTAL} = (2.63)(150FT)(7.5FT)^{3/2} + 2(2.63)(15FT)(3.75FT)^{3/2}$

$Q_{TOTAL} = 8676$ CFS

PEAK OUTFLOW (8676 CFS) > PEAK INFLOW (2574 CFS)

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLR DATE 8-3-78 PROJ. NO. 78-501-807

CHKD. BY JTS DATE 8-4-78 SHEET NO. 5 OF 9

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AS NOTED IN REF 1, PG 2, THE EFFECTS OF LAKE RENE WERE CONSIDERED IN THE DESIGN OF GRAVEL LICK DAM BY COMPUTING AN EQUIVALENT WATERSHED. THE SIZE OF THIS WATERSHED IS GIVEN AS 3.67 SQ. MI.

DRAINAGE AREA = 3.67 SQ. MI

PMF (PEAK FLOW)/AREA = 1800 CFS/SQ. MI (REF: COE CURVE OHIO RIVER BASIN)

PMF = 1800 CFS/SQ. MI (3.67 SQ. MI.) = 6606 CFS

PEAK OUTFLOW (8676 CFS) > PEAK INFLOW (6006 CFS)

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLB DATE 8-4-78 PROJ. NO. 78-501-807

CHKD. BY JPN DATE 8-5-78 SHEET NO. 6 OF 9

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CONSIDER THE CAPABILITY OF LAKE RENE TO PASS AND/OR STORE THE PMF.

REFERENCE 5: REPORT ENTITLED "INSPECTION OF DAMS - PHASE I" FOR TREASURE LAKE OF PENNSYLVANIA, DUBOIS, PENNSYLVANIA. BY GAI CONSULTANTS, INC. OCTOBER 1977

LAKE RENE DRAINAGE AREA = 4.32 SQ.MI. (REF 5: SHEET 1 OF 1, APPENDIX E)

ASSUME SDF = PMF

PMF (PEAK FLOW)/AREA = 1780 CFS/SQ.MI

PMF = (1780 CFS/SQ. MI.)(4.32 SQ.MI.) = 7690 CFS

COMBINED EMERGENCY AND PRIMARY SPILLWAY CAPACITY OF WOLF CREEK AND GALION BAY DAMS IS AS FOLLOWS:

WOLF CREEK DAM

PRIMARY SPILLWAY DISCHARGE = 172.9 CFS
EMERGENCY SPILLWAY DISCHARGE = 3600 CFS

GALION BAY DAM

PRIMARY SPILLWAY DISCHARGE = 193.5 CFS
EMERGENCY SPILLWAY DISCHARGE = 1006.2 CFS

(REF 5: SHEET 1 OF 1, APPENDIX E)

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLB DATE 8-4-78 PROJ. NO. 78-501-807

CHKD. BY JPN DATE 8-5-78 SHEET NO. 7 OF 9

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TOTAL COMBINED DISCHARGE = (3600 + 172.9 + 1006.2 + 193.5) CFS

= 4973 CFS

PEAK INFLOW (7690 CFS) > PEAK OUTFLOW (4973 CFS)

CONSIDER INFLOW RELATIVE TO BOTH OUTFLOW AND STORAGE USING METHOD RECOMMENDED BY NAD

$$P = \frac{\text{MAXIMUM SPILLWAY DISCHARGE}}{\text{PMF PEAK INFLOW}} = \frac{4973 \text{ CFS}}{7690 \text{ CFS}} = 0.65$$

$$(1-P) = \frac{\text{REQUIRED RESERVOIR STORAGE}}{\text{VOLUME OF INFLOW HYDROGRAPH}} = (1-0.65) = 0.35$$

DETERMINE VOLUME OF INFLOW

MAXIMUM INFLOW = 7690 CFS

TOTAL TIME OF FLOW = 38 HRS

$V = \frac{1}{2}(Q_{INFLOW})(TIME)$

$V = \frac{1}{2}(7690 \text{ CFS})(38 \text{ HRS})(3600 \text{ SEC/HR})(1 \text{ ACRE}/43{,}560 \text{ SQ. FT.})$

V = 12075 AC-FT

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLB DATE 8-4-78 PROJ. NO. 78-501-807

CHKD. BY JPN DATE 8-5-78 SHEET NO. 8 OF 9

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DETERMINE THE AVERAGE RUNOFF REQUIRED TO PRODUCE THE A VOLUME OF INFLOW EQUIVALENT TO 12,075 AC-FT.

$$\frac{\text{VOLUME OF INFLOW}}{\text{DRAINAGE AREA}} = \frac{(12{,}075 \text{ AC-FT})(1 \text{ SQ. MI.}/640 \text{ ACRES})(12 \text{ IN/FT})}{(4.32 \text{ SQ. MI.})} = 52.4 \text{ INCHES}$$

VOLUMES PRODUCED BY RUNOFFS IN EXCESS OF 26 INCHES ARE TO BE REDUCED USING 26 INCHES AS AN UPPER BOUND.

$$(26 \text{ INCHES})(640 \text{ ACRE/SQ. MI})(4.32 \text{ SQ. MI.})(1 \text{ FT.}/12 \text{ IN.}) = 5990 \text{ AC-FT}$$

VOLUME OF INFLOW (RECALCULATED) = 5990 AC-FT

NOTE: Q_{INFLOW} REMAINS CONSTANT
TOTAL TIME OF FLOW IS TO DECREASE IN ACCORDANCE WITH THE DECREASE IN INFLOW VOLUME.

$$\text{EQUIVALENT FLOW TIME} = (5990 \text{ AC-FT})(2)(43{,}560 \text{ SQ. FT/ACRE})/(7690 \text{ CFS})(3600 \text{ SEC/HR})$$

$$= 18.8 \text{ HRS}$$

FROM SHEET 7:

$$\text{REQUIRED STORAGE} = 0.35 \text{ (VOLUME OF INFLOW)}$$

$$= 0.35 (5990 \text{ AC-FT}) = 2097 \text{ AC-FT}$$

SUBJECT DAM SAFETY INSPECTION
GRAVEL LICK DAM

BY DLB DATE 8-5-78 PROJ. NO. 78-501-807

CHKD. BY JRN DATE 8-5-78 SHEET NO. 9 OF 9

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CALCULATE STORAGE AVAILABLE

AVAILABLE FREEBOARD AT GALION BAY DAM = 7FT (REF 5, Pg 3)

TOP OF DAM ELEVATION - 1669.5 "
NORMAL POOL ELEVATION - 1662.5 "

STORAGE AVAILABLE = 90×10^6 CU. FT. OR 2066 AC-FT
(REF 5; APPENDIX E, STORAGE VS. ELEVATION CURVE)

STORAGE AVAILABLE (2066 AC-FT) ≃ STORAGE REQUIRED (2097 AC-FT)

APPENDIX D

PHOTOGRAPHS

PHOTOGRAPH 1 View of Gravel Lick Dam taken from the left abutment.

PHOTOGRAPH 2 View of the downstream slope of Gravel Lick Dam taken from the area of the right abutment.

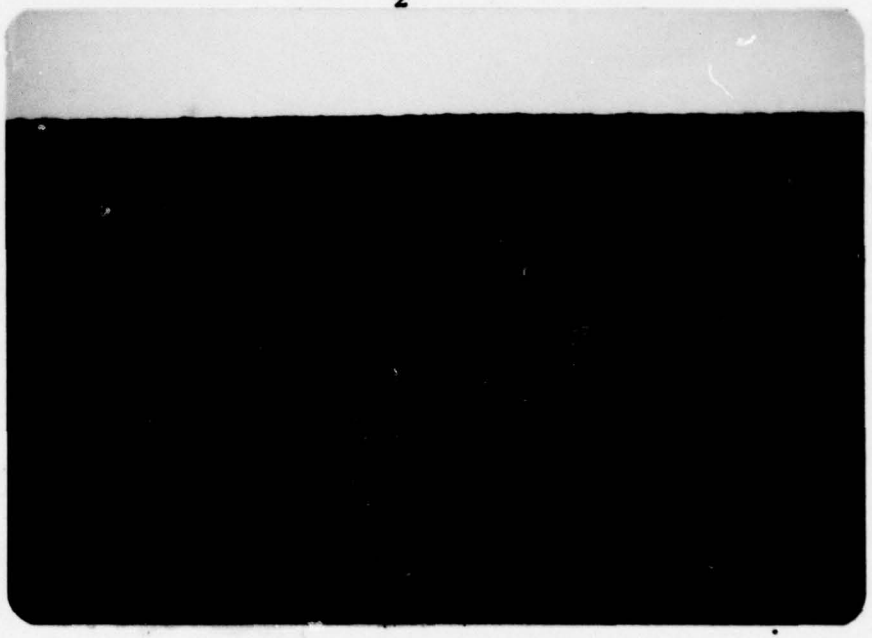
PHOTOGRAPH 3 View of erosion channels below the berm on the downstream slope of Gravel Lick Dam.

PHOTOGRAPH 4 Same as Photograph 3.

1

2

3



4

PHOTOGRAPH 5 View of a large area of seepage approximately 200 feet from the intersection of the berm and the left abutment. Crown vetch would not grow in the wet areas making it rather easy to locate the seepage.

PHOTOGRAPH 6 Close-up view of the primary spillway outlet at Gravel Lick Dam. This concrete channel is simply a trench constructed within the larger emergency spillway.

PHOTOGRAPH 7 View of the primary spillway as it passes beneath the road which is located atop the crest of the dam.

PHOTOGRAPH 8 View of the emergency spillway looking downstream. At this point, water is discharged back into the natural drainage.

5

6

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8

PHOTOGRAPH 9 Close-up view of gate on outlet works of Gravel Lick Dam.

PHOTOGRAPH 10 View of the discharge end of the 24-inch RCP which passes beneath the Gravel Lick embankment.

PHOTOGRAPH 11 View of three 4-inch PVC pipes discharging in a small stream just downstream of the left abutment. The pipes were installed to collect and divert water which was apparently passing through coal in the left abutment.

PHOTOGRAPH 12 View of the wooded area just downstream of the dam as it is seen from the crest of the Gravel Lick embankment.

9

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11

12

APPENDIX E

GEOLOGY

GEOLOGY*

The Gravel Lick Dam site is underlain by sedimentary strata of the Pennsylvanian age Conemaugh Formation. These units are characterized as cyclic sequences of sandstone, siltstone, and shale with some thin coal and limestone seams.

The site is located near the axis of the Caledonia Syncline and the dip is reportedly 2 to 3° in the Gravel Lick Basin.

Alluvial soils are predominant within the reservoir reaching a maximum depth of 20 feet in the lower parts of the valley. Thin colluvial and residual soils are predominant on the hills surrounding the reservoir.

* This section is an abridged and edited version of a pre-construction report titled, "Volume 1" - Geologic Investigation prepared by J. A. Bellicini of R. M. Keddal and Associates, Inc.

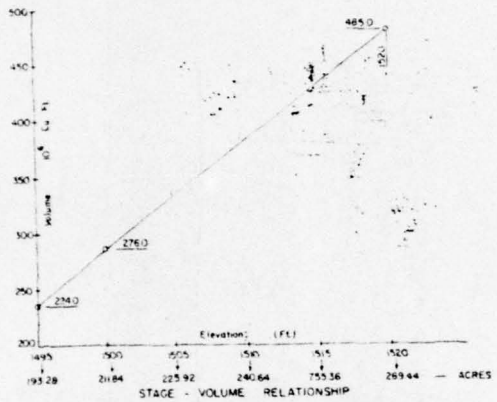
APPENDIX F

FIGURES

LIST OF FIGURES

Heavy Duty ——————— Light Duty ———————
Medium Duty — — — — — Unimproved Duty .....

ROAD CLASSIFICATION



STAGE - VOLUME RELATIONSHIP

① AREA CAPACITY CURVE

PROPOSED GRAVEL LICK DAM

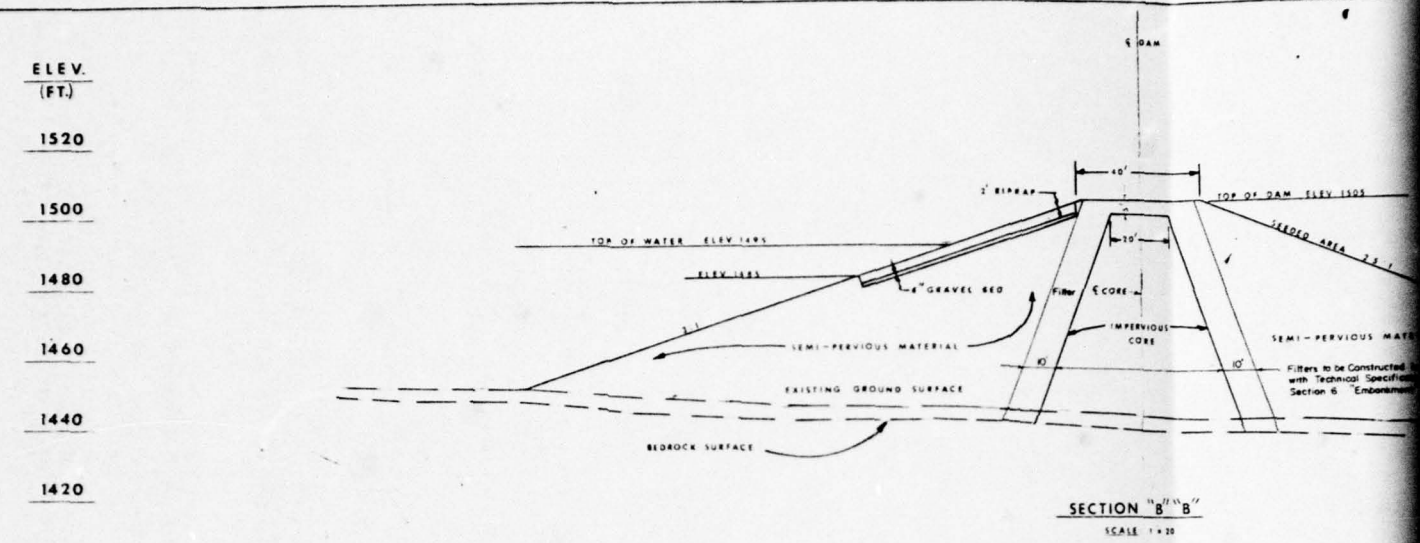
LOCATION PLAN
PROPOSED
GRAVEL LICK DAM
FOR
TREASURE LAKE INC.
BY

RM KEDDAL AND ASSOCIATES, INC
Engineers, Planners & Surveyors
1400 South Park Road
Wilkes-Barre, Pa

Revised 3/29/74 ①
Date - August, 1970
Scale - 1" = 2000'

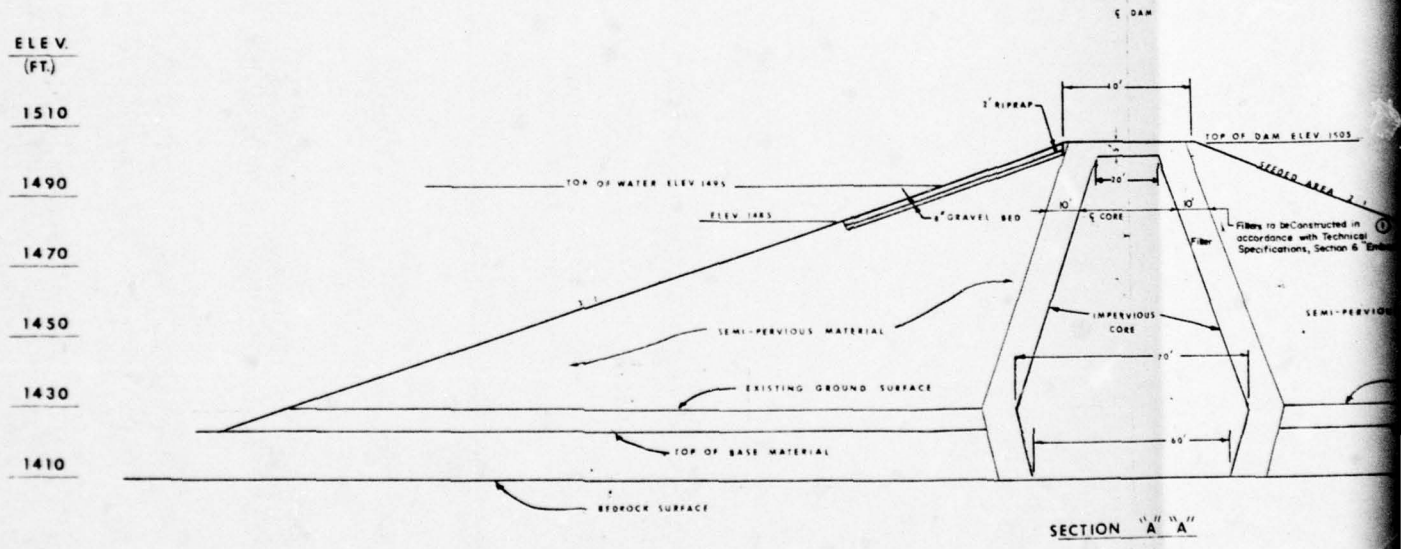
JOHN ROBERT SALES PE

FIGURE 1



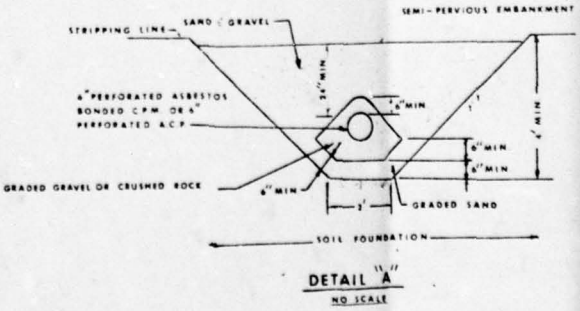
SECTION "B" "B"

SCALE 1" = 20'



SECTION "A" "A"

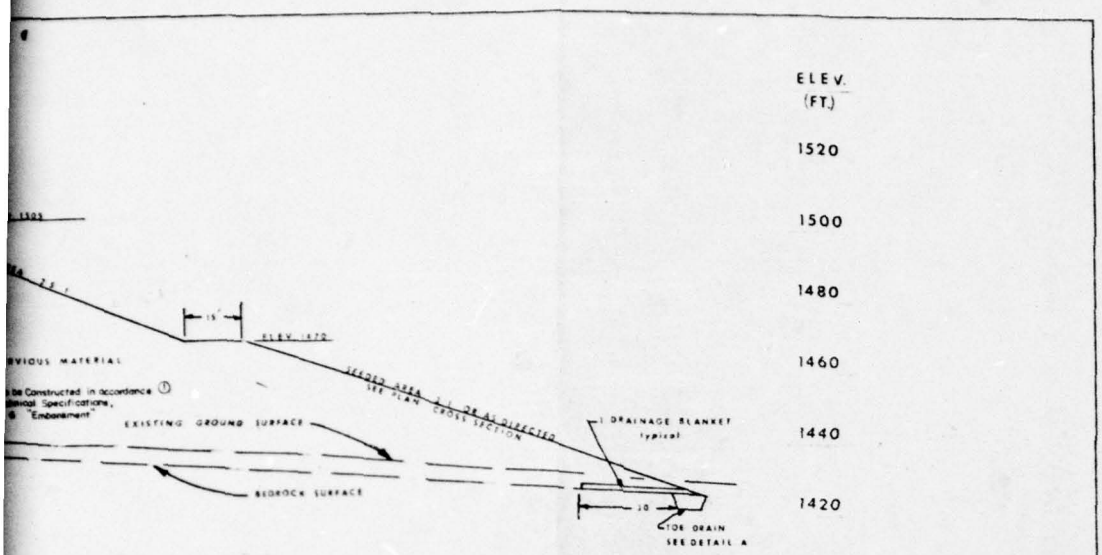
SCALE 1" = 20'

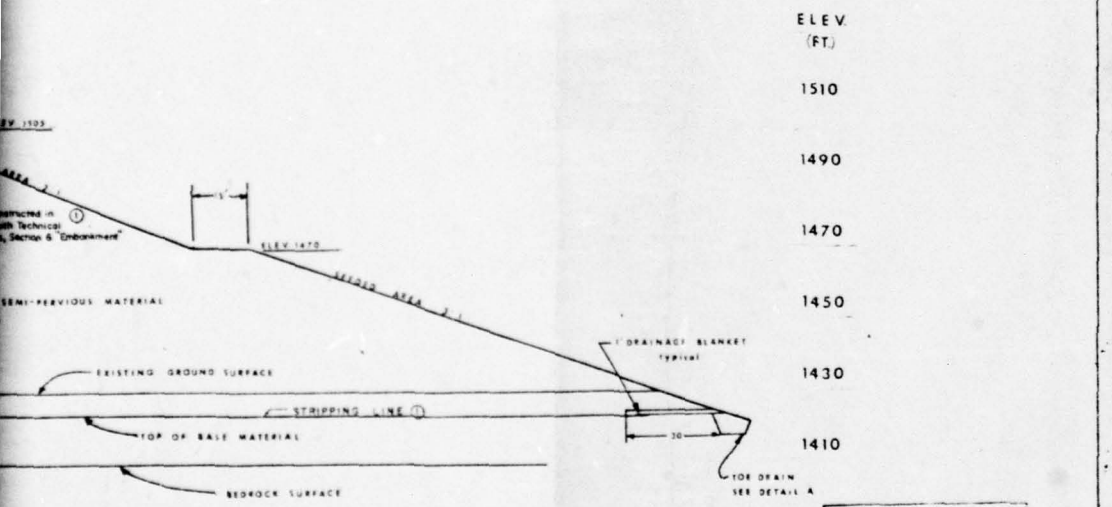


DETAIL "A"

NO SCALE

THIS DRAWING IS A PHOTOGRAPHIC REPRODUCTION OF R.M. KEDDAL AND ASSOCIATES, INC. DWG. 3 OF 15 JOB NO. 137, WITH SOME LINEWORK IMPROVED FOR DRAWING CLARITY.





TYPICAL SECTIONS & DETAILS

PROPOSED

GRAVEL LICK DAM

FOR

TREASURE LAKE INC.

BY

R.M. KEDDAL AND ASSOCIATES, INC.
Engineers, Planners & Surveyors
3400 South Park Road
Bethel Park, Pa.

Date - 3/29/71 (Revised) ①
Scale - As Noted

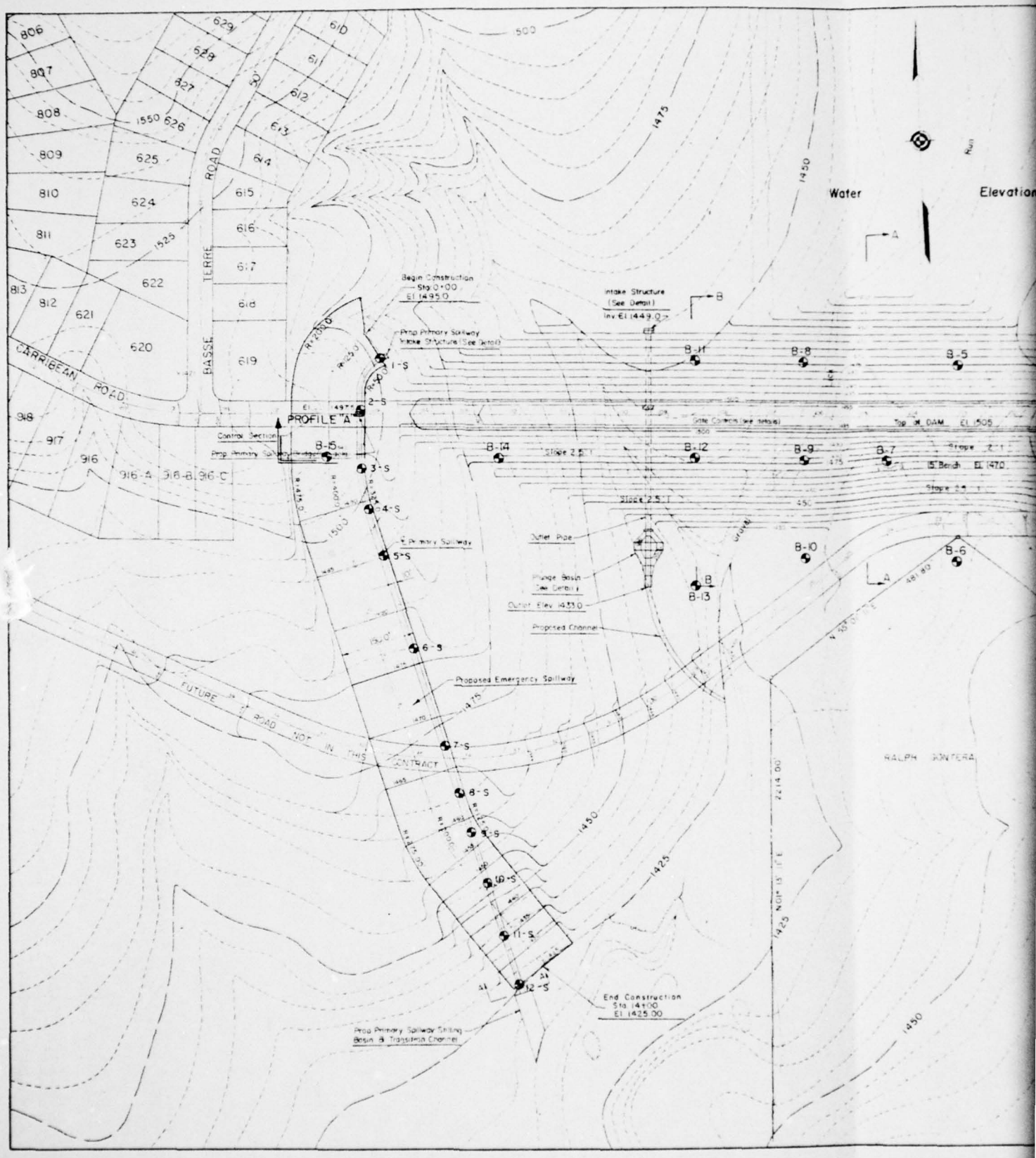
Job No. 137

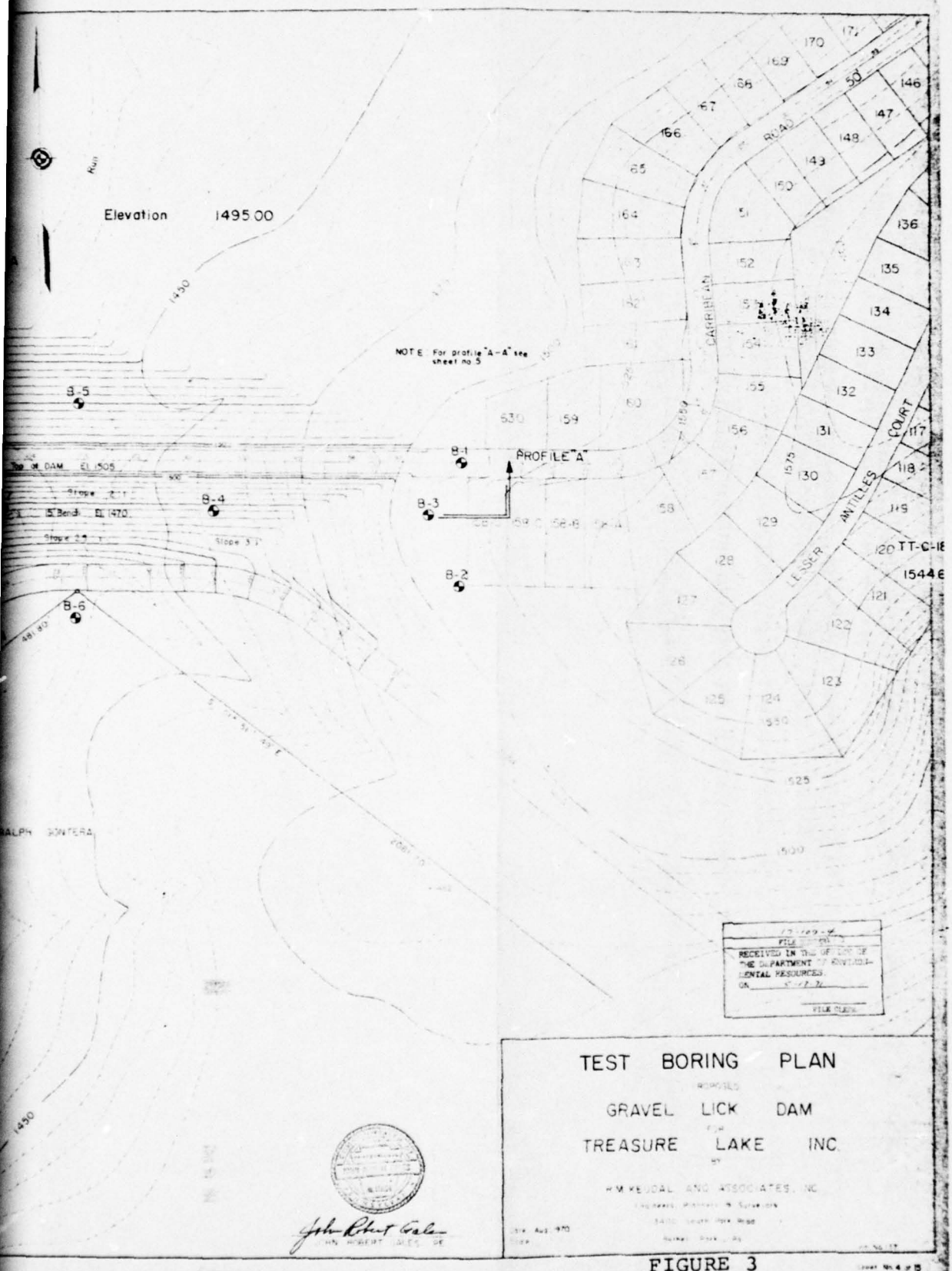
Sheet No. 1 of 8

John Robert Gales

JOHN ROBERT GALES PE.

FIGURE 2


Water
Elevation
CARRIBEAN ROAD
BASSE TERRE ROAD
PROFILE "A"
Begin Construction
Sta 0+00
El 1495.0
Intake Structure
(See Detail)
Inv El 1449.0
Prop Primary Spillway
Intake Structure (See Detail)
Control Section
Prop Primary Spillway
Top of DAM El 1505
Slope 2:1
15' Bench El 1470
Slope 2.5:1
Outlet Pipe
Plunge Basin
(See Detail)
Outlet Elev 1433.0
Proposed Channel
Proposed Emergency Spillway
FUTURE ROAD NOT IN THIS CONTRACT
RALPH ANTERA
End Construction
Sta 14+00
El 1425.00
Prop Primary Spillway Sitting
Basin & Transition Channel
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
B-10
B-11
B-12
B-13
B-14
1-S
2-S
3-S
4-S
5-S
6-S
7-S
8-S
9-S
10-S
11-S
12-S



TEST BORING PLAN

PROPOSED

GRAVEL LICK DAM

FOR

TREASURE LAKE INC.

BY

H.M. KEUDAL AND ASSOCIATES, INC.

Engineers, Planners & Surveyors

3400 South Park Road

Hollywood, Florida

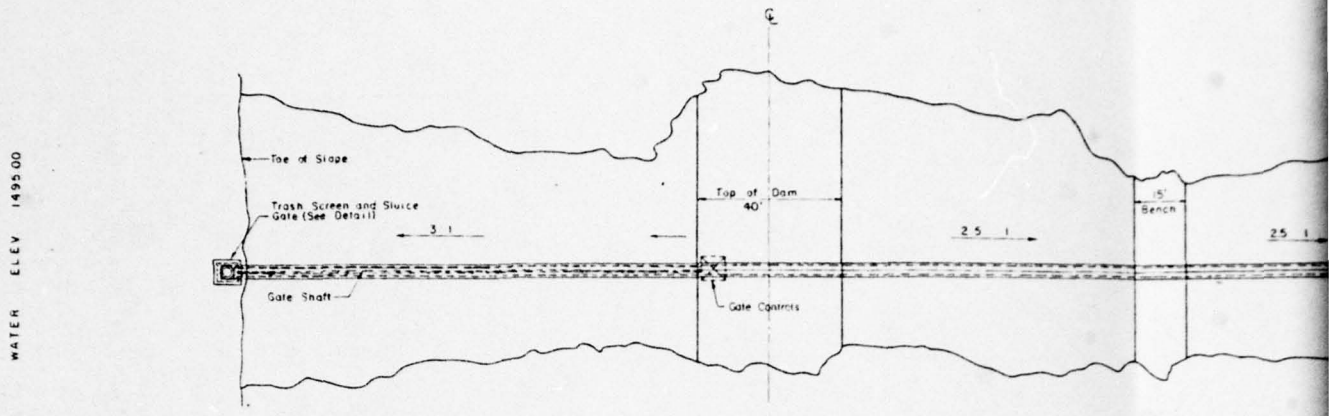
Date Aug 1970

Scale

John Robert Gales

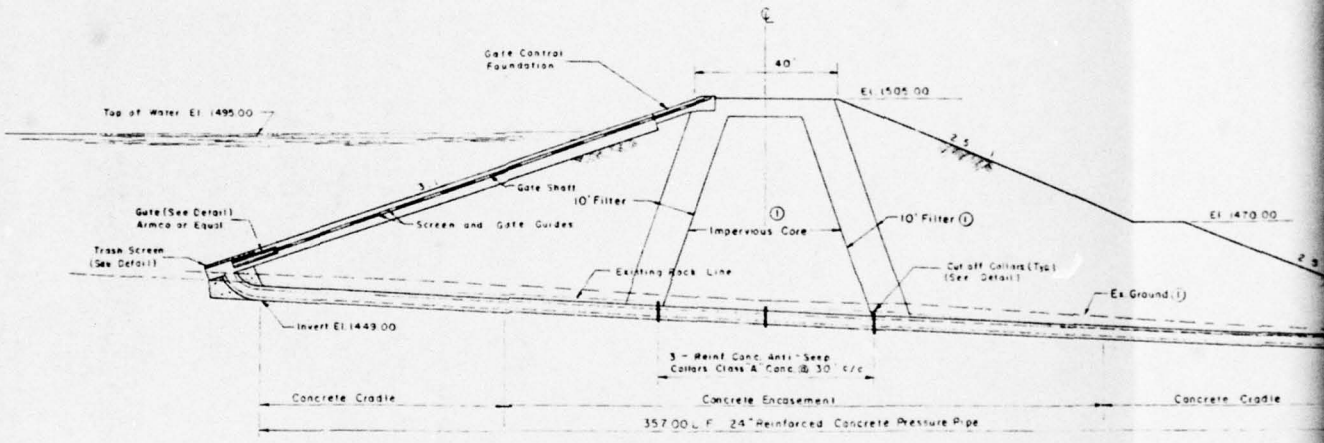
JOHN ROBERT GALES PE

FIGURE 3



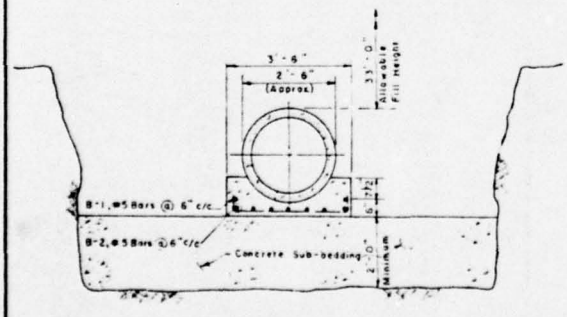
PLAN

Scale 1" = 20'



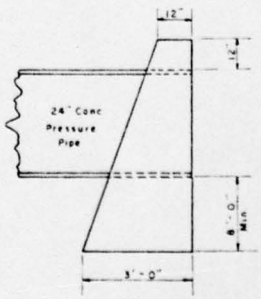
PROFILE OUTLET WORKS

SCALE 1" = 20' Horiz
1" = 20' Vert

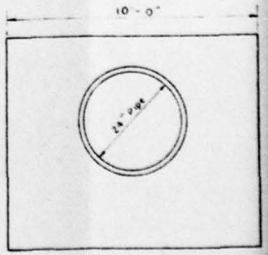


CONCRETE CRADLE CROSS SECTION

(To Be Used any where fill above pipe does Not Exceed 33 Feet)

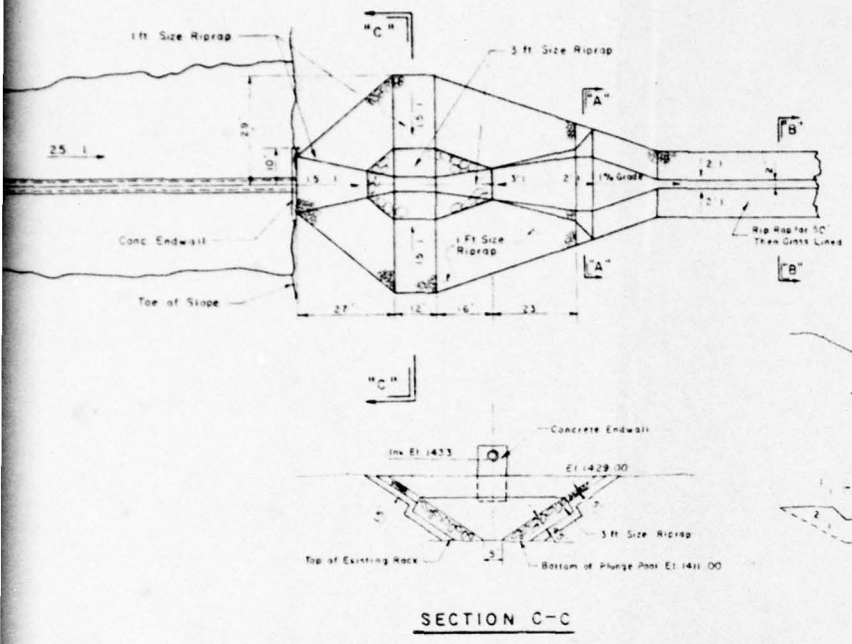


END VIEW

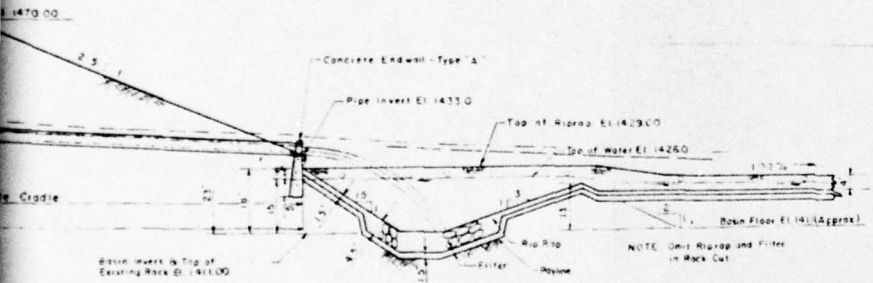


SIDE VIEW

ENDWALL TYPE "A"

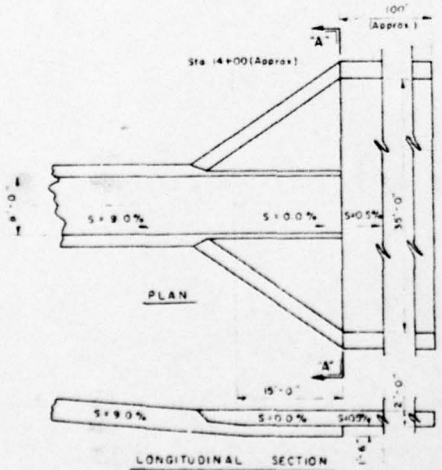


SECTION C-C



PLUNGE BASIN

NOTE
Elevations given are only approximate the Outlet Conduit must be laid to conform with section 12 - Quarry work of Specifications



PRIMARY SPILLWAY STILLING BASIN AND TRANSITION CHANNEL

JOHN ROBERT GALES PE

PROFILE OUTLET WORKS & DETAILS

PROPOSED

GRAVEL LICK DAM

FOR

TREASURE LAKE INC.

BY

RM KEDDAL AND ASSOCIATES, INC.

Engineers, Planners & Surveyors

1400 South Park Road

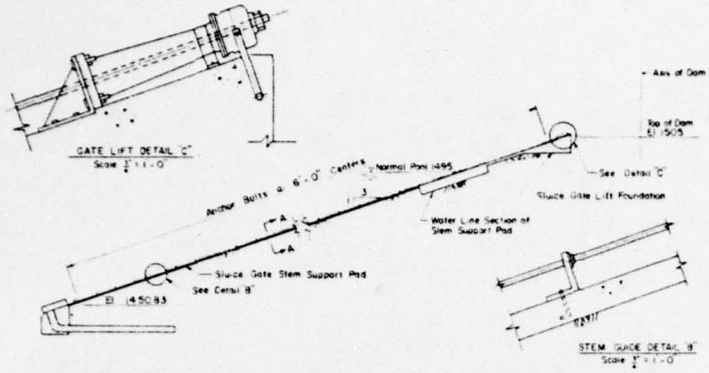
Bethel Park, Pa

Rev. 5/29/71
Date August, 1970
Scale As noted

Job No. 157

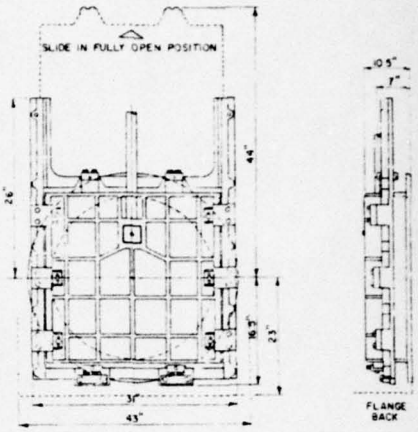
Sheet No. 7 of 13

FIGURE 4



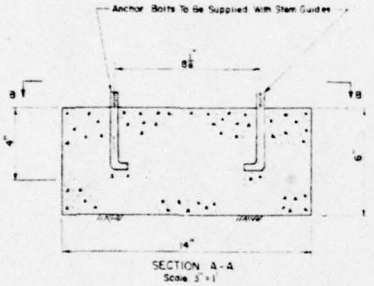
SUPPORT ELEMENTS FOR SLUICE GATE STEM GUIDES & SLUICE GATE LIFT

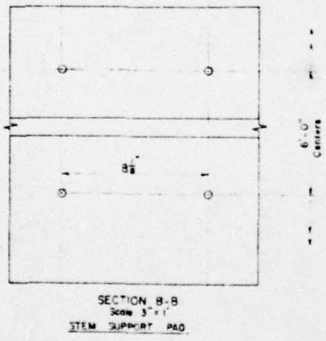
Scale 1"=20'

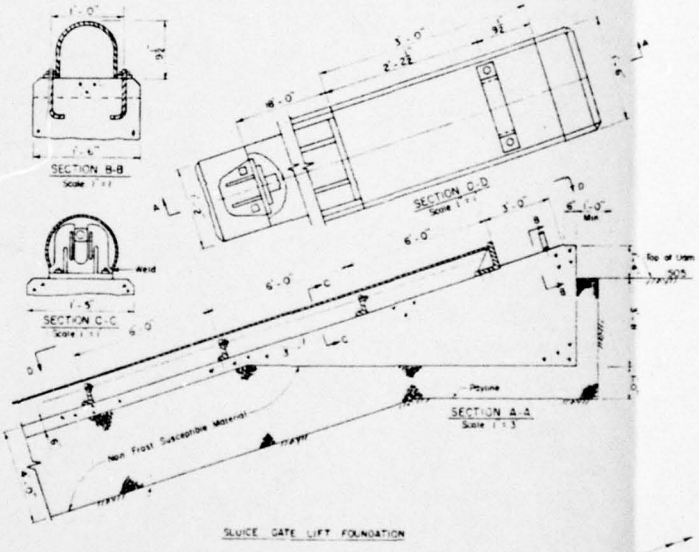


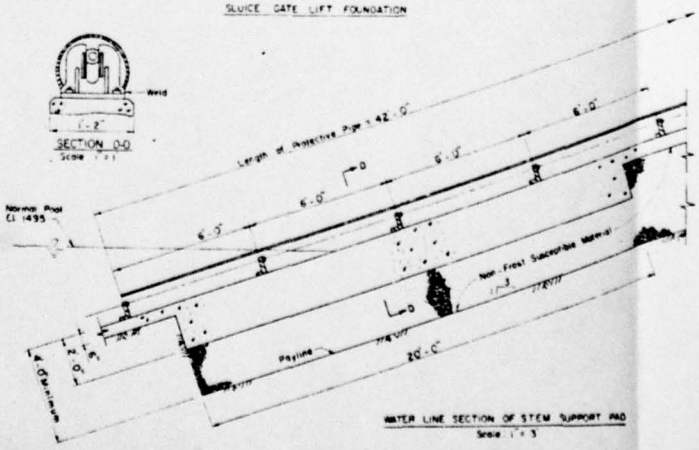
OUTLET WORKS SLUICE GATE

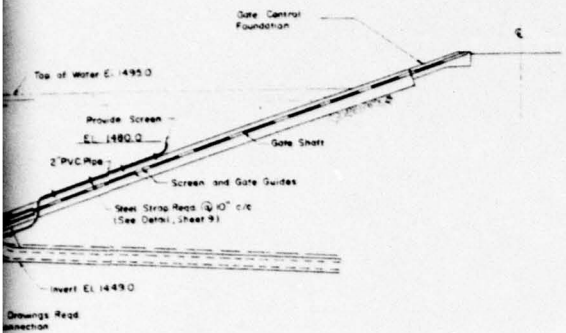
No Scale





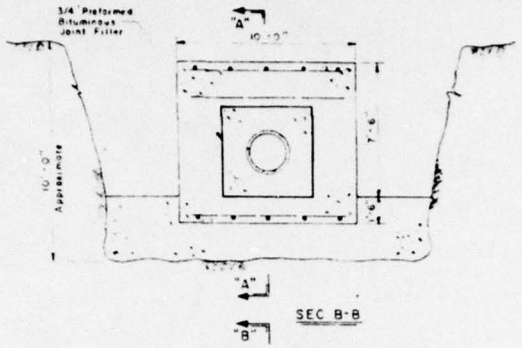




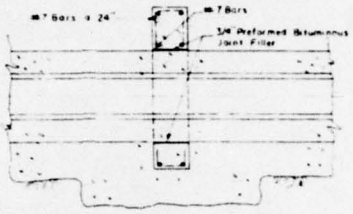


AIR - VENT RELEASE (1)

No Scale



SEC B-B

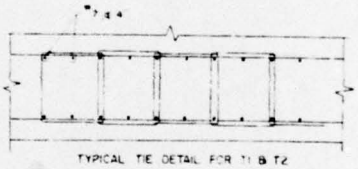


"B"

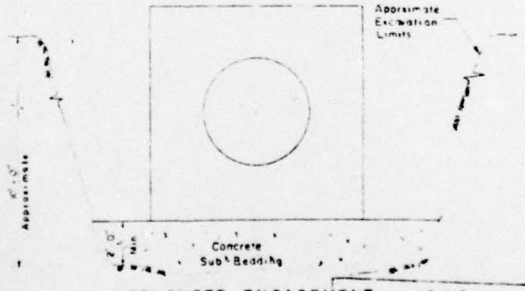
SEC A-A

CUTOFF COLLAR DETAILS

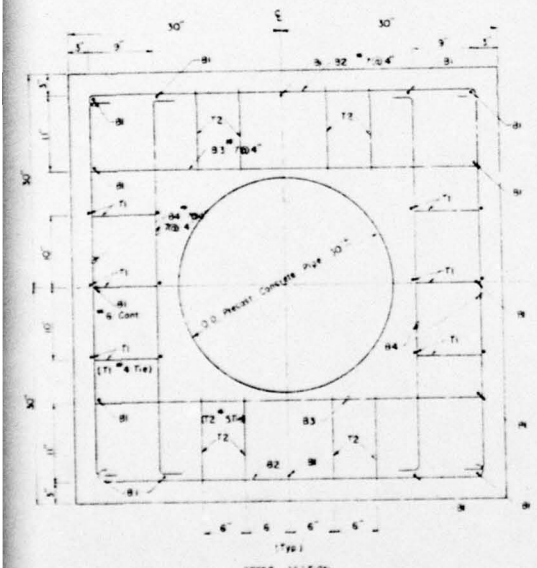
OUTLET CONDUIT DETAILS



TYPICAL TIE DETAIL FOR T1 & T2



CONCRETE ENCASEMENT
OUTLET CONDUIT DETAILS



CROSS SECTION

CONCRETE ENCASEMENT
OUTLET CONDUIT DETAILS

Scale 1" = 10'

To Be Used Where Fill Above Pipe Exceeds 33 Feet

JOHN ROBERT GAGES PE

DETAILS

PROPOSED

GRAVEL LICK DAM

FOR

TREASURE LAKE INC.

BY

R.M. KEDDAL AND ASSOCIATES, INC.

Engineers, Planners & Surveyors

3400 South Park Road

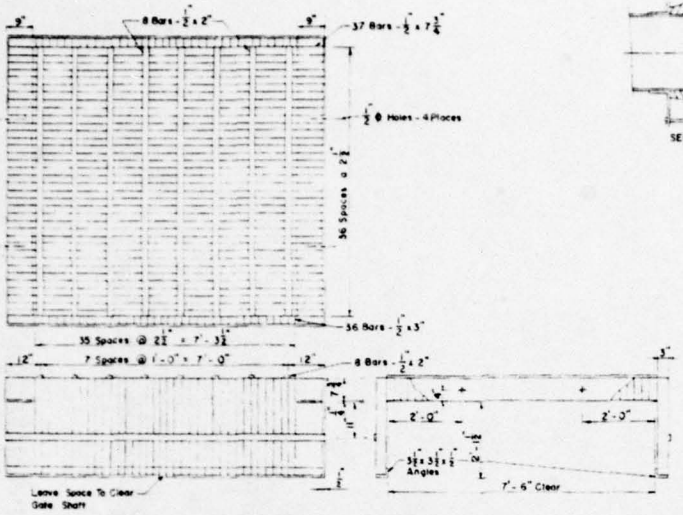
Bethel Park, Pa.

Rev. 3/29/71 (1)
Date: 1-1977
Scale: As Shown

Job No. 37

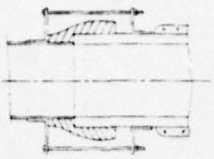
Sheet No. 8 of 9

FIGURE 5

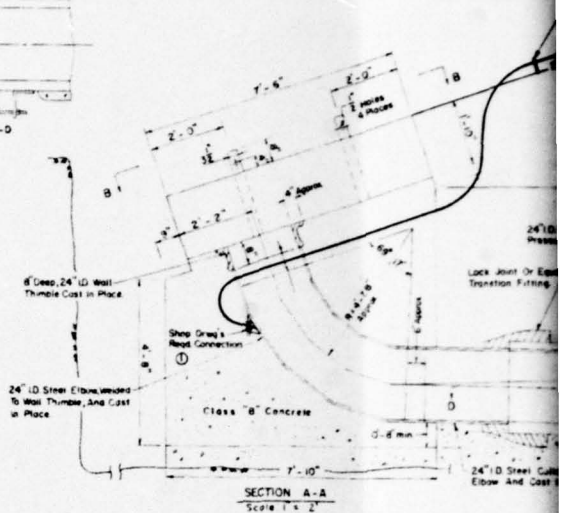


OUTLET WORKS TRASH RACK

Scale 1" = 2'

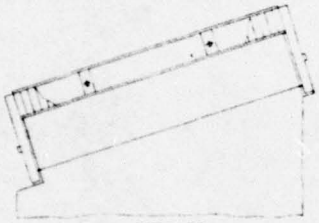


SECTION D-D

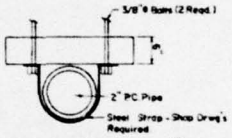


SECTION A-A

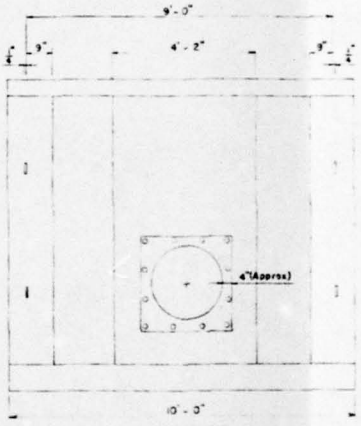
Scale 1" = 2'



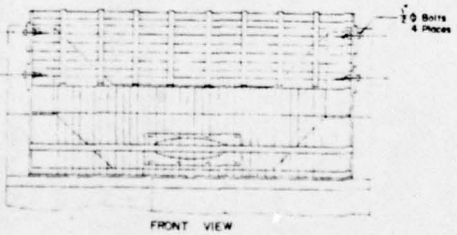
SIDE VIEW



PIPE STRAP DETAIL ①



SECTION B-B

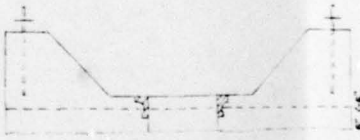


FRONT VIEW

OUTLET WORKS INTAKE STRUCTURE

TRASH RACK ASSEMBLY

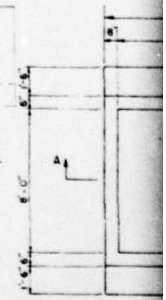
Scale 1" = 2'

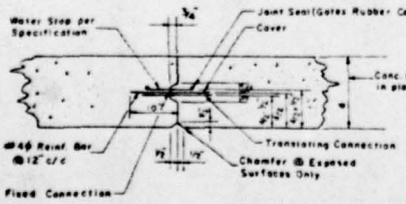


SECTION C-C

OUTLET WORKS INTAKE STRUCTURE

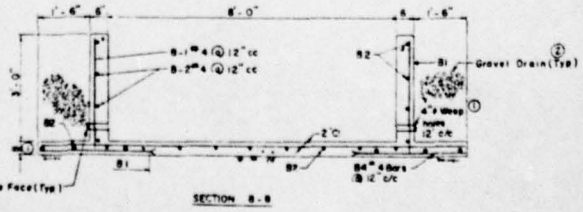
Scale 1" = 2'



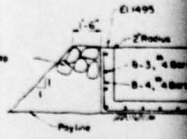


TYPICAL KEY JOINT DETAIL ③

No Scale



SECTION B-B



PRIMARY SPILLWAY CONCRETE LINED CHANNEL ①

STA. 0+00 TO STA. 4+00

No Scale

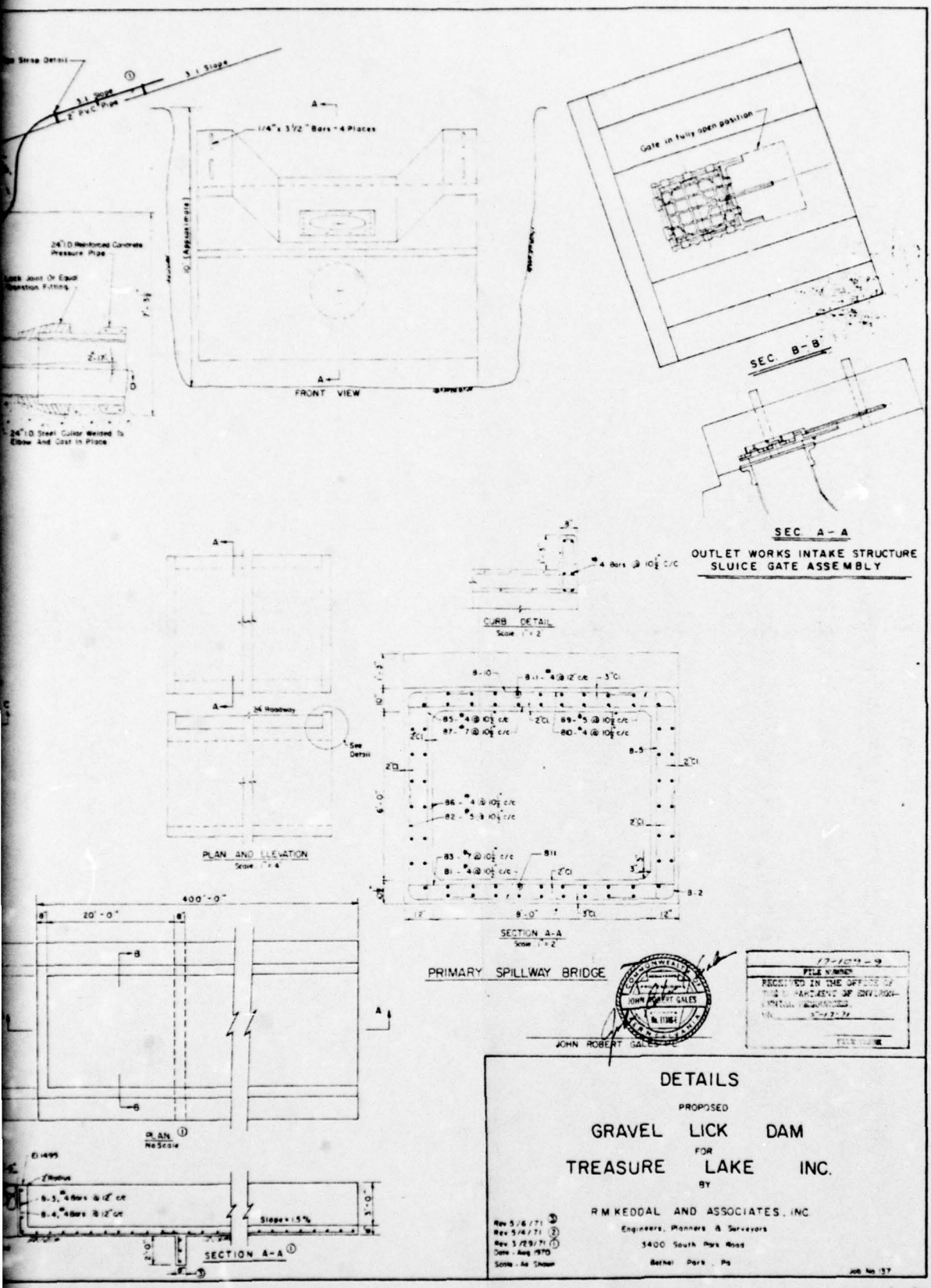
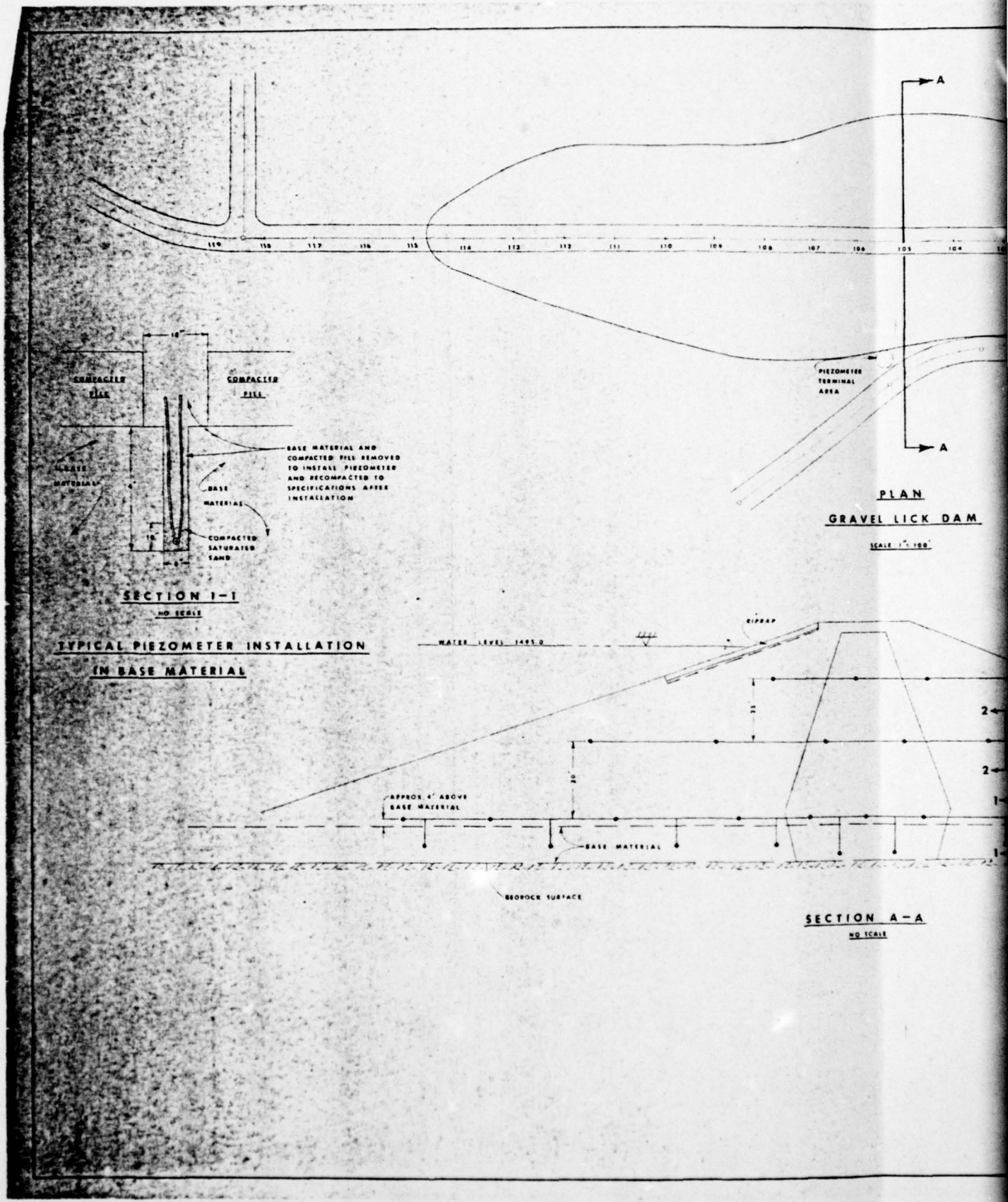

Gate in fully open position
SEC. B-B
FRONT VIEW
SEC A-A
OUTLET WORKS INTAKE STRUCTURE
SLUICE GATE ASSEMBLY
CURB DETAIL
Scale 1" = 2'
PLAN AND ELEVATION
Scale 1" = 4'
SECTION A-A
Scale 1" = 2'
PRIMARY SPILLWAY BRIDGE
400'-0"
20'-0"
PLAN ①
No Scale
SECTION A-A ①
Slope = 5%
JOHN ROBERT GALES
DETAILS
PROPOSED
GRAVEL LICK DAM
FOR
TREASURE LAKE INC.
BY
R.M. KEDDAL AND ASSOCIATES, INC.
Engineers, Planners & Surveyors
3400 South Park Road
Bethel Park, Pa
Rev 5/6/71 ③
Rev 5/4/71 ②
Rev 5/29/71 ①
Date - Aug 1970
Scale - As Shown
Job No. 37

FIGURE 6



PLAN

GRAVEL LICK DAM

SCALE 1" = 100'

SECTION 1-1

NO SCALE

TYPICAL PIEZOMETER INSTALLATION

IN BASE MATERIAL

SECTION A-A

NO SCALE

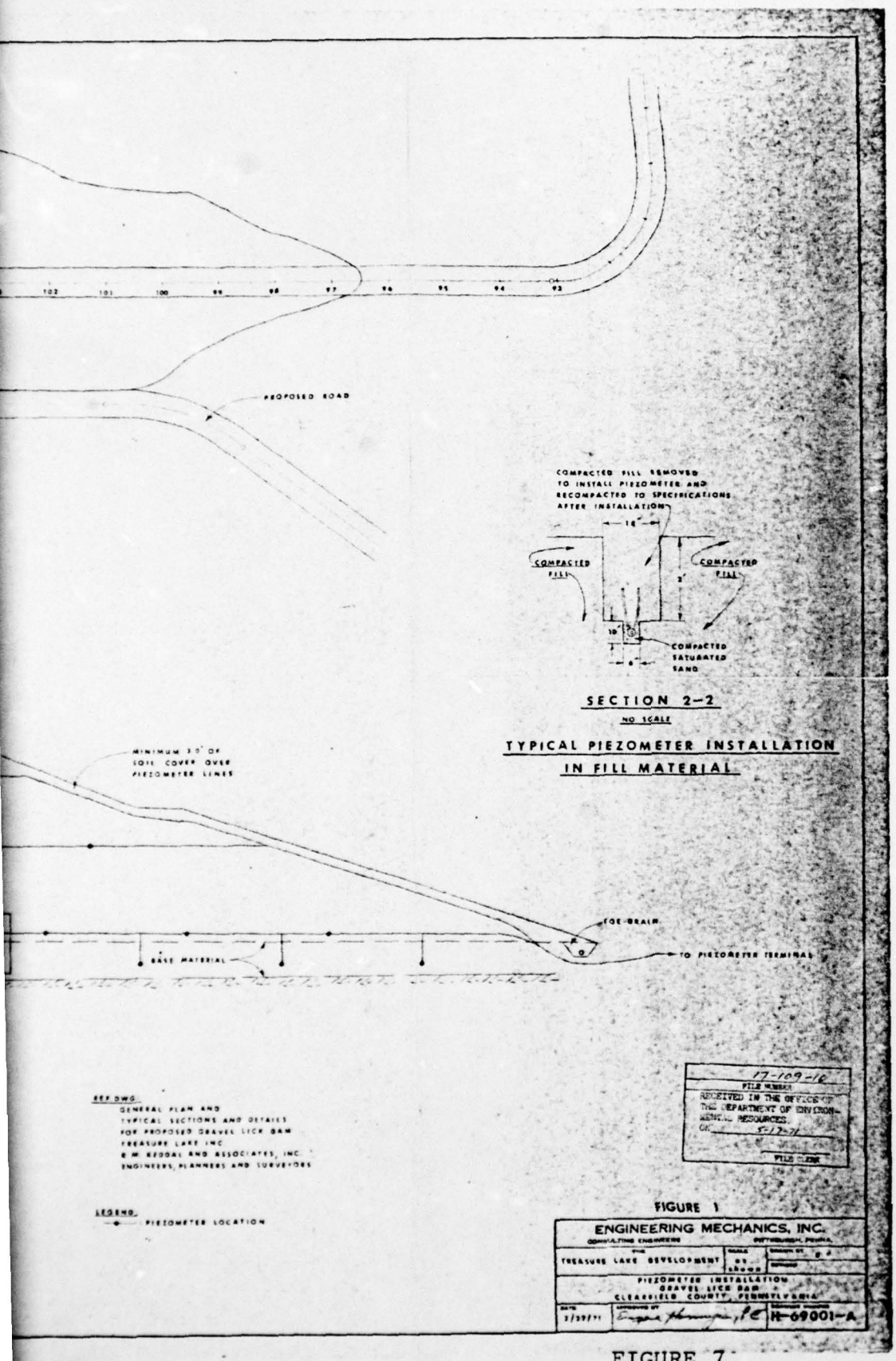
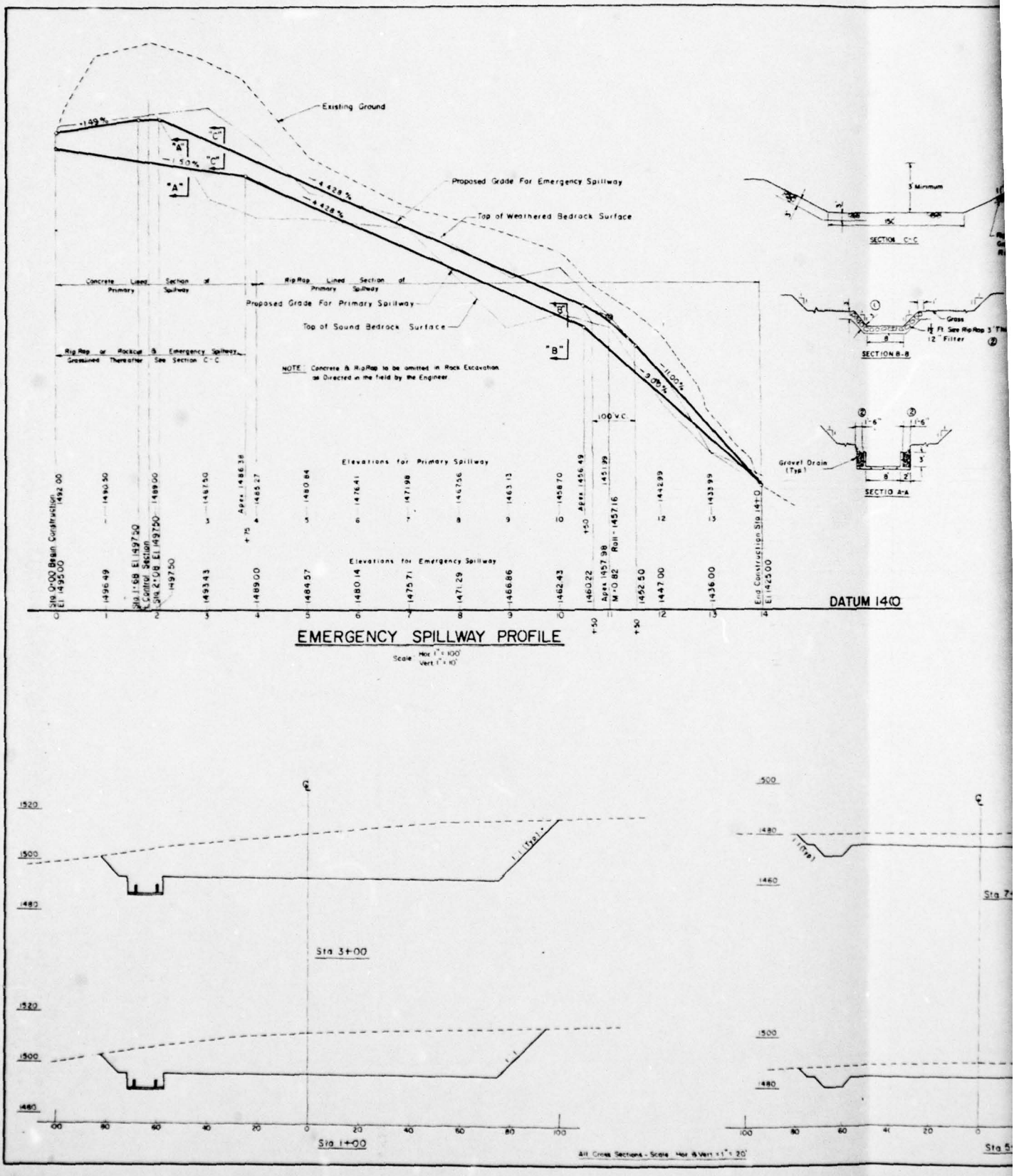
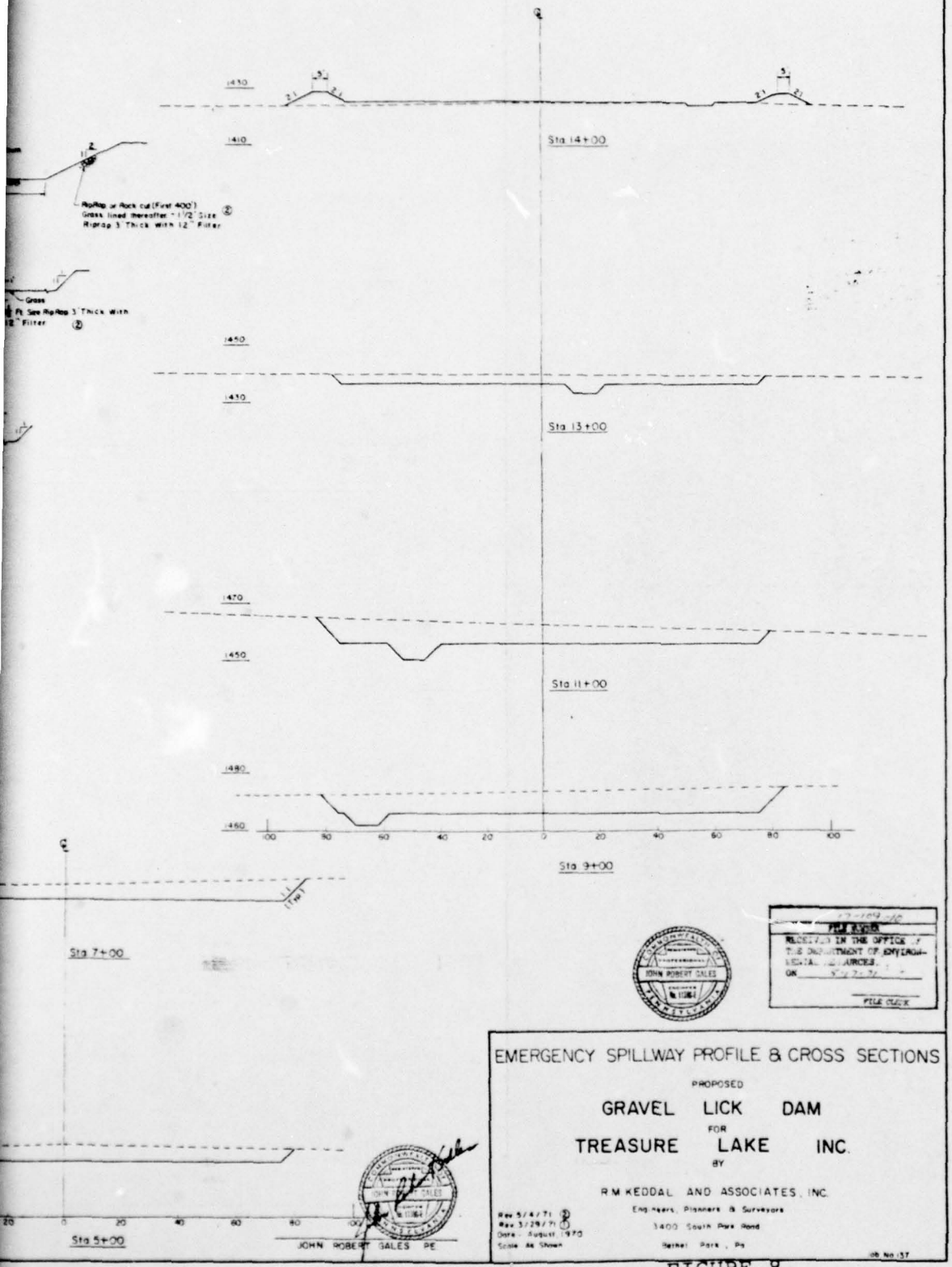

102
101
100
99
98
97
96
95
94
93
PROPOSED ROAD
COMPACTED FILL REMOVED TO INSTALL PIEZOMETER AND RECOMPACTED TO SPECIFICATIONS AFTER INSTALLATION
16"
COMPACTED FILL
COMPACTED FILL
2'
10"
6"
COMPACTED SATURATED SAND
SECTION 2-2
NO SCALE
TYPICAL PIEZOMETER INSTALLATION IN FILL MATERIAL
MINIMUM 3.0' OF SOIL COVER OVER PIEZOMETER LINES
TOE DRAIN
TO PIEZOMETER TERMINAL
BASE MATERIAL
REF DWG
GENERAL PLAN AND TYPICAL SECTIONS AND DETAILS FOR PROPOSED GRAVEL LICK DAM TREASURE LAKE INC. R.M. REDDAL AND ASSOCIATES, INC. ENGINEERS, PLANNERS AND SURVEYORS
LEGEND
PIEZOMETER LOCATION
17-109-16
FILE NUMBER
RECEIVED IN THE OFFICE OF THE DEPARTMENT OF ENVIRONMENTAL RESOURCES
ON 5-17-71
FILE CLERK
FIGURE 1
ENGINEERING MECHANICS, INC.
CONSULTING ENGINEERS
PITTSBURGH, PENNA.
TREASURE LAKE DEVELOPMENT
AS SHOWN
PIEZOMETER INSTALLATION
GRAVEL LICK DAM
CLEARFIELD COUNTY, PENNSYLVANIA
3/29/71
H-69001-A

FIGURE 7



EMERGENCY SPILLWAY PROFILE

Scale Hor 1" = 100'
Vert 1" = 10'



EMERGENCY SPILLWAY PROFILE & CROSS SECTIONS

PROPOSED

GRAVEL LICK DAM

FOR

TREASURE LAKE INC.

BY

R M KEDDAL AND ASSOCIATES, INC.

Engineers, Planners & Surveyors

3400 South Park Road

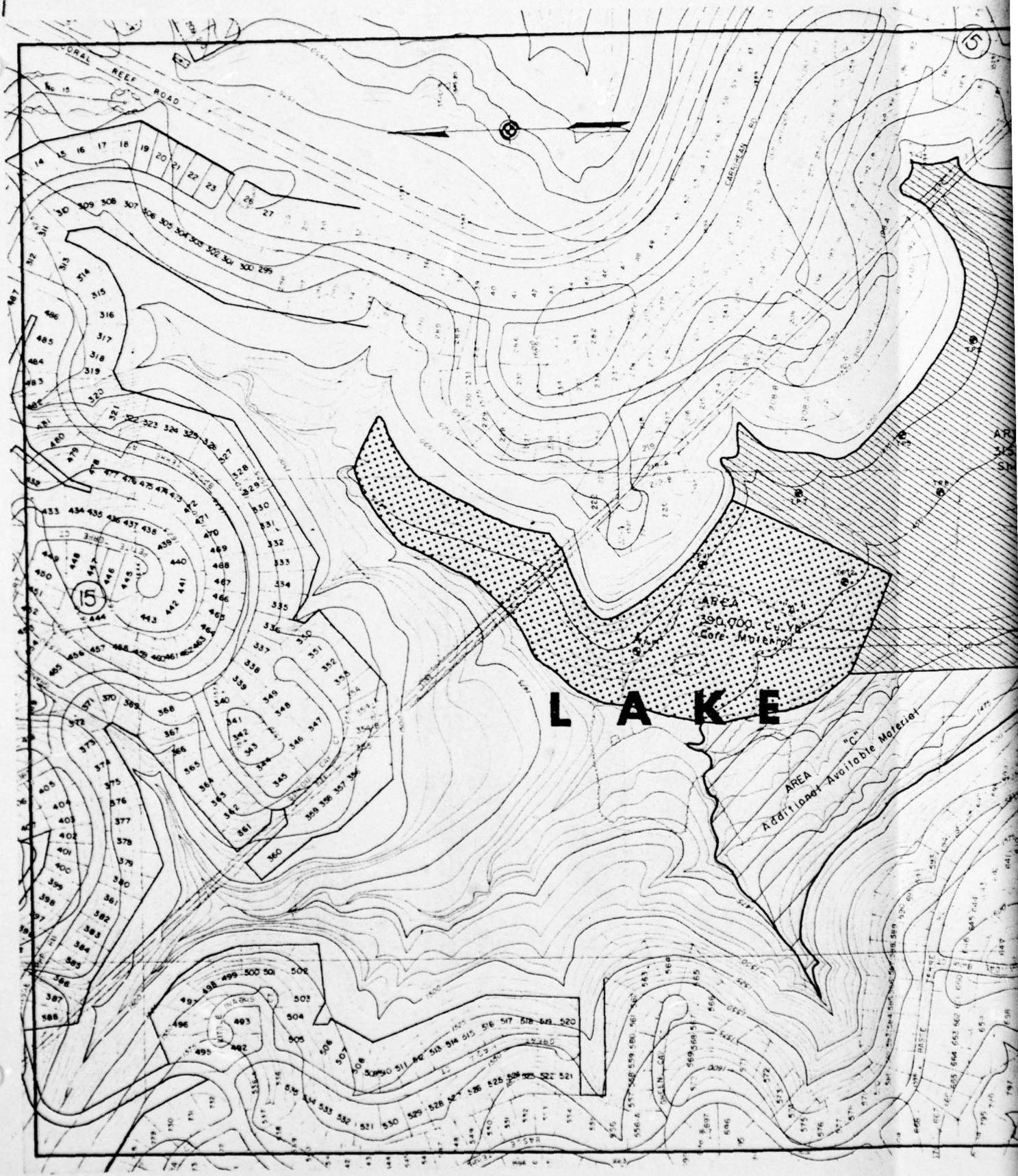
Bethel Park, Pa

Rev 5/6/71 ③
Rev 3/29/71 ①
Date August 1970
Scale As Shown

Job No 137

FILED
RECEIVED IN THE OFFICE OF
THE DEPARTMENT OF ENVIRONMENTAL RESOURCES.
ON 5/24/72
FILE CLERK

FIGURE 8


CORAL REEF ROAD
AREA
390,000 Cu. Yd.
Core Material
L A K E
AREA "C"
Additional Available Material

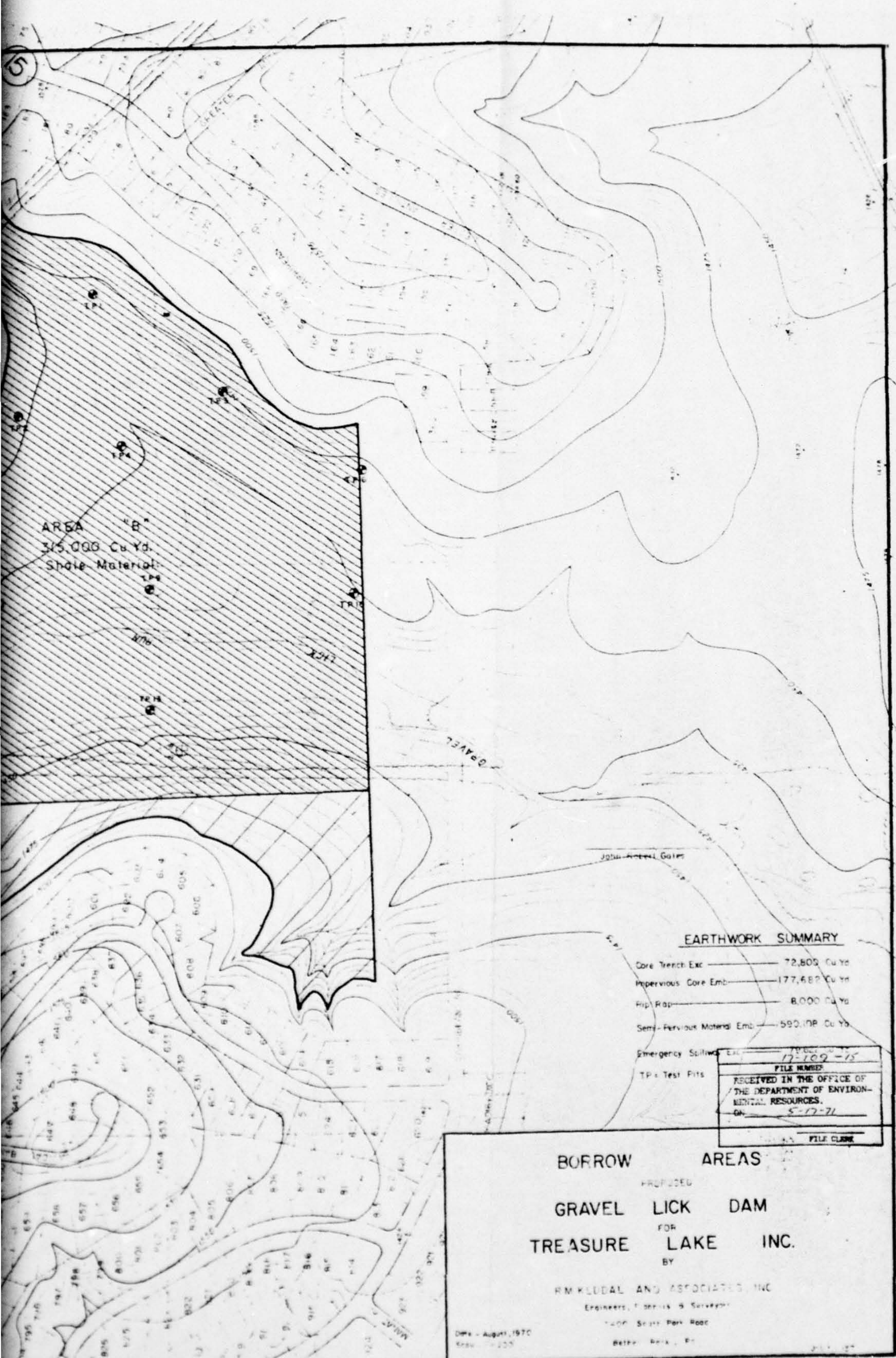
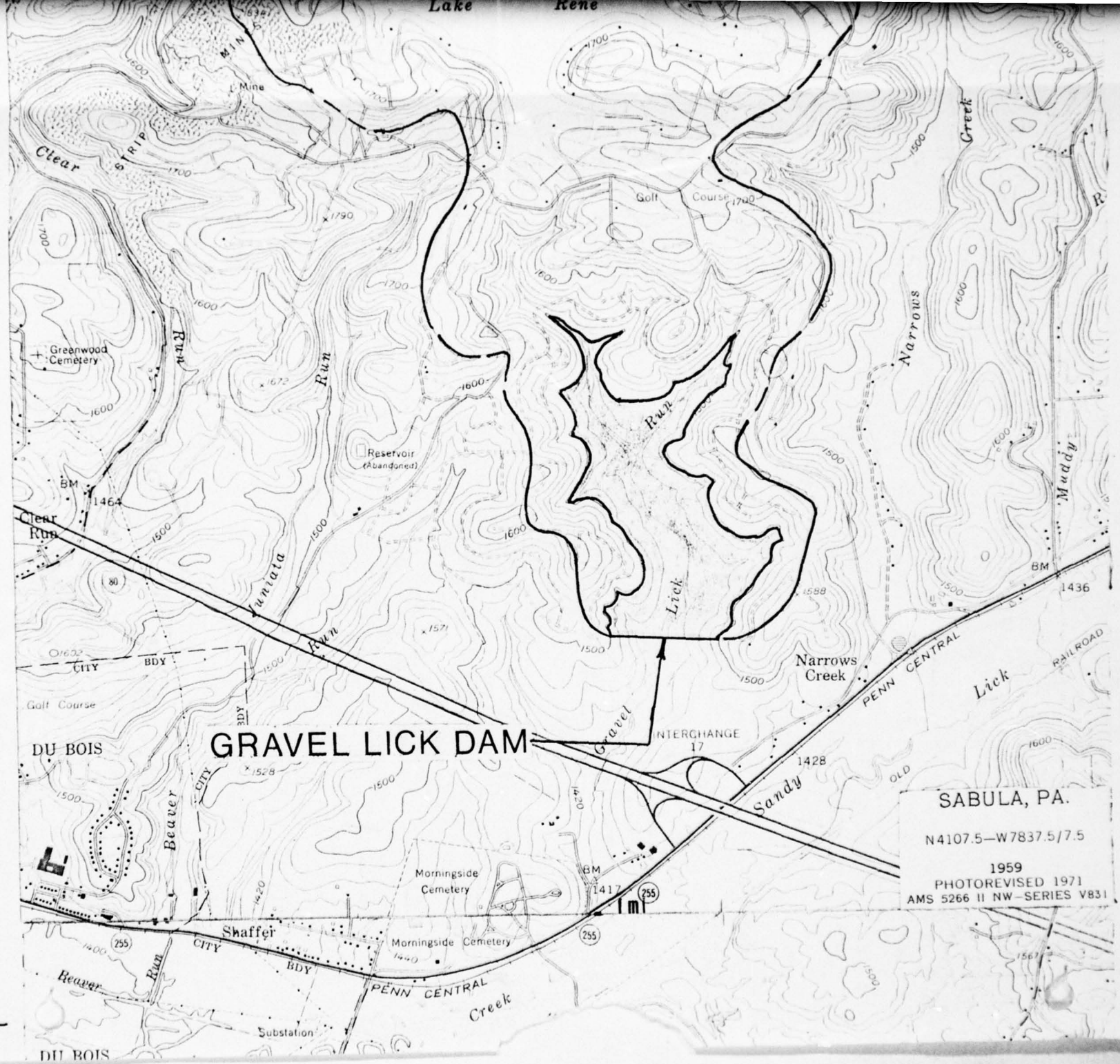

AREA "B"
315,000 Cu. Yd.
Shale Material
GRAVEL
LICK
EARTHWORK SUMMARY
Core Trench Exc — 72,809 Cu Yd
Impervious Core Emb — 177,682 Cu Yd
Rip Rap — 8,000 Cu Yd
Semi-Pervious Material Emb — 590,108 Cu Yd
Emergency Spillway Exc
TP = Test Pits
17-109-15
FILE NUMBER
RECEIVED IN THE OFFICE OF THE DEPARTMENT OF ENVIRONMENTAL RESOURCES.
ON 5-17-71
FILE CLERK
BORROW AREAS
PROPOSED
GRAVEL LICK DAM
FOR
TREASURE LAKE INC.
BY
Date - August, 1970

FIGURE 9

APPENDIX G

REGIONAL VICINITY MAP


GRAVEL LICK DAM
SABULA, PA.
N4107.5—W7837.5/7.5
1959
PHOTOREVISED 1971
AMS 5266 II NW—SERIES V831
Lake Rene
Clear Strip Mine
Golf Course
Greenwood Cemetery
Reservoir (Abandoned)
Clear Run
Juniata Run
Lick Run
Narrows
Muddy Creek
Narrows Creek
Gravel Lick
Sandy Lick
PENN CENTRAL RAILROAD
INTERCHANGE 17
OLD 80
DU BOIS
CITY BDY
Golf Course
Beaver Run
Morningside Cemetery
Shaffer
Beaver Run
Substation
DU BOIS
BM 1464
BM 1436
BM 1417
1428
1790
1672
1571
1528
1588
1620
1700
1600
1500
1400
255

STATE GAME LANDS
NO 11
RESERVATION BDY
Strip
PIPELINE
Mine
Wolf
Run
BM 1678
Narrows
Creek
BM 1776
Strip Mine
Strip Mines
JEFFERSON CO
CLEARFIELD CO
ELK CO
Gas Well
BM 1956
Bundy Cem
SANDY