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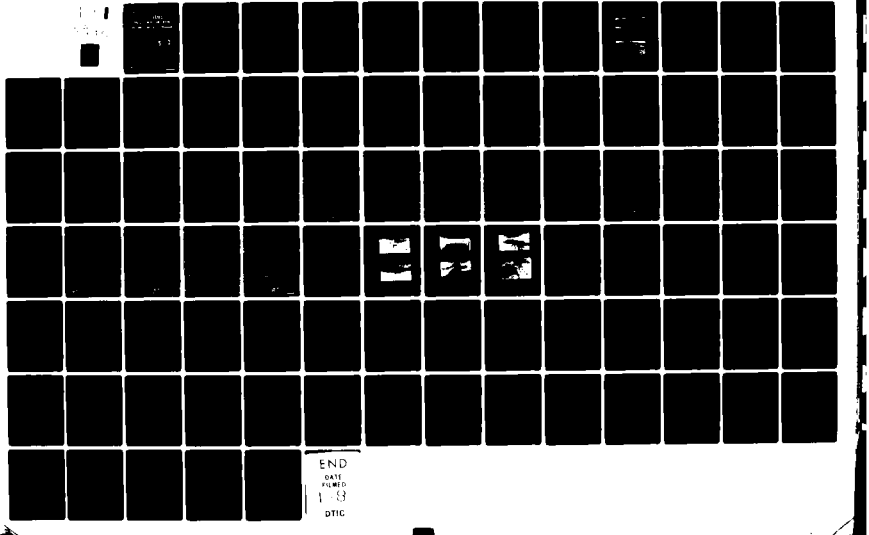

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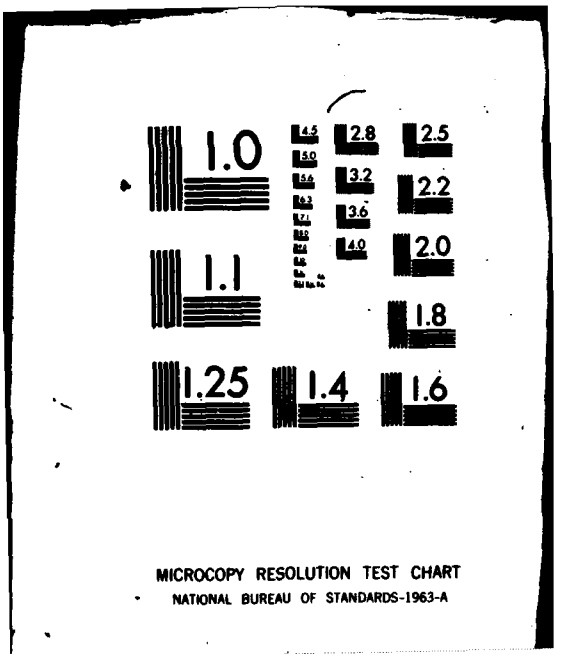
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JAMES RIVER BASIN

(6) National Dam Safety Program.

Name Of Dam: UPPER OCCOQUAN REGIONAL WATER RECLAMATION PLANT DAM

Location:

Inventory Number: VA [redacted] 05924

(1) (B.S.)

James River Basin,
Fairfax County, Virginia.

LEVEL II

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

(9) Final rept.,

(10) Ray E. Martin

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U.S. ARMY CORPS OF ENGINEERS · NORFOLK DISTRICT ·

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(15) DACW65-79-D-0004

PREPARED FOR

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BY

SCHNABEL ENGINEERING ASSOCIATES, P.C./
J. K. TIMMINS AND ASSOCIATES, INC.

September, 1980 (13)

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by 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 conditions 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.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of 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 Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide 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.

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

BRIEF ASSESSMENT OF DAM

Name of Dam:	Upper Occoquan Regional Water Reclamation Plant Dam
State:	Virginia
County:	Fairfax
USGS Quad Sheet:	Manassas
Coordinates:	Lat 38^0 48.3' Long 77^o 27.4'
Stream:	Branch of Bull Run
Date of Inspection:	1 May, 1980

Upper Occoquan Regional Water Reclamation Plant Dam is a zoned earthfill structure about 1680 ft long and 41 ft high. The principal spillway consists of a 250 ft long concrete weir, which discharges into a 20 ft wide by 10 ft deep concrete discharge channel. Additional outlet works include a valved 36 inch diameter iron pipe extending through the embankment at the bottom of the reservoir. The dam is an intermediate size structure and is assigned a "significant" hazard classification. The dam is located on a branch of Bull Run approximately two miles north of Manassas Park, Virginia. The lake is used for the dilution and storage of the wastewater treatment plant effluent and is owned and maintained by the Upper Occoquan Sewage Authority.

Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the appropriate Spillway Design Flood (SDF) is the ½ PMF or 200 percent of the SDF. The spillway is judged adequate.

The visual inspection revealed no apparent problems. It is recommended that a warning system be developed for the downstream area. A staff gage should also be installed to monitor water levels. These remedial measures should be accomplished within the next 12 months.

Prepared by:

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Chief, Engineering Division

Date: SEP 19 1980

RESERVOIR AND TREATMENT PLANT

OVERVIEW OF DAM (UPSTREAM SLOPE)

1 MAY, 1980

SECTION I - PROJECT INFORMATION

1.1 General:

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army through the Corps of Engineers, to initiate a national program of safety inspection of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (see Reference 1, Appendix VI). The main responsiblity is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances: Upper Occoquan Regional Water Reclamation Plant Dam is a zoned earthfill structure approximately 1680 ft long and 41 ft high.* The top of the dam is 20 ft wide, and side slopes are approximately 4 horizontal to 1 vertical (4:1) on the upstream and downstream sides of the dam. The top of the dam is at elevation 195 msl.

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* Height is measured from the top of the dam to the downstream stream toe at the centerline of the stream.

The dam is keyed into the foundation and there is an internal drainage system with drain outlets. Existing vegetation on the downstream slope and riprap on the upstream slope provide embankment protection.

The principal spillway consists of a 250 ft long by 6 ft high reinforced concrete weir located at the right abutment. The weir discharges into a 10 ft deep by 20 ft wide reinforced concrete outlet channel, 480 ft in length. The weir crest is at elevation 188 msl. For low flow purposes the center 50 ft of the weir is at elevation 187.5 msl (0.5 ft lower than the remainder of the weir). A 24 inch diameter concrete pipe (invert elevation 179.0 msl) located under the outlet channel, conveys water from the low flow weir to the plunge pool during low flow conditions.

For purposes of drawing off water from the reservoir at different elevations in the event of thermal, nutrient or dissolved oxygen stratification there is a separate outlet. The outlet works consist of a 36 inch diameter hydraulically controlled intake structure with an invert at elevation 161 msl, and 355 ft of 36 inch diameter ductile iron outlet pipe discharging at an invert elevation of 155.5 msl. There are two hydraulically activated circular pipe intakes and hydraulically operated gates located adjacent to the intake structure. A 10 inch diameter inlet is at centerline elevation 167.5 msl and an 8 inch inlet is located at centerline elevation 177.5 msl, (see Plates No. 3, 5 through 7, Appendix I).

1.2.2 Location: Upper Occoquan Regional Water Reclamation Plant Dam is located on a branch of Bull Run approximately two miles north of Manassas Park, Virginia, (see Plate No. 1, Appendix I).

1.2.3 Size Classification: The dam is classified as an "intermediate" size structure because of its height and the maximum lake storage potential.

1.2.4 Hazard Classification: The dam is located in a suburban area, and based upon the proximity of several commercial structures, located several miles downstream, the dam is assigned a "significant" hazard classification. The hazard classification used to categorize a dam is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The dam is owned by the Upper Occoquan Sewage Authority (UOSA).

1.2.6 Purpose: Storage and dilution of wastewater treatment plant effluent.

1.2.7 Design and Construction History: The dam was designed and constructed under the supervision of CH_2M-Hill, Consulting Engineers, of Reston, Virginia. The structure was constructed by Richard F. Kline, Inc. and completed in 1976.

1.2.8 Normal Operational Procedures: The principal spillway is ungated, therefore, water rising above the crest of the weir automatically is discharged downstream. Normal pool is maintained

slightly above the crest of the low 50 foot center portion of the spillway (elevation 187.5). Above normal flows rise above elevation 188 and utilize the entire spillway in discharging water from the reservoir.

1.3 Pertinent Data:

1.3.1 Drainage Area: The drainage area is 0.89 square miles.

1.3.2 Discharge at Dam Site: According to Mr. Ed Wozniak (UOSA) the maximum flood at the dam site has not been observed.

Principal Spillway Discharge:

Pool Elevation at Crest of Dam (elev 195 msl) 9821 CFS

1.3.3 Dam and Reservoir Data: See Table 1.1, below:

Table 1.1 - DAM AND RESERVOIR DATA

	Reservoir				
		Storage			
Item	Elevation feet msl	Area Acres	Volume Acre Feet	Watershed Inches	Length Miles
Crest of Dam	195	75	1130	23.8	0.7
Principal Spillway Crest	188	56	552	11.6	0.6
50 Ft Center Section	187.5	54	515	10.85	0.6
Streambed at Downstream Toe of Dam	154	-	-	-	-

SECTION 2 - ENGINEERING DATA

2.1 Design: The dam was designed and constructed under the direction of CH_2M-Hill for the Upper Occoquan Sewage Authority. Design data and operations records are available at the site.

A subsurface investigation was conducted at the site by CH_2M-Hill during the initial design phase. The investigation consisted of drilling test borings and excavating test pits at the locations shown on Plate No. 2, Appendix I. Test boring and test pit logs are given on Plate No. 8, Appendix I. Foundation recommendations were prepared based upon the subsurface investigation and laboratory test data, however, this information was not made available.

The dam is a zoned, compacted earthfill embankment (Plate No. 3, Appendix I). Construction specifications required that the "impervious core" be constructed with "mixtures of silt, clayey silt and decomposed shale" with a maximum particle size of 2 inches. The outer shell or "random embankment" consists of "silt, clayey silt, decomposed shale, and shale". "Cobbles or boulders" included in this zone were not to exceed 6 inches in size. Fill within both zones was to be compacted to a "minimum of 98 percent relative compaction" as defined in the construction specifications. Lift thicknesses were not to exceed 6 inches following compaction.

A review of design data indicates that most of the dam is founded on decomposed shale and includes a cutoff trench which extends into the decomposed shale. The only portion of the dam founded on overburden soils is the downstream slope beyond the strip drain. No field permeability test data was included in the

design data reviewed. Details of the cutoff trench are provided on Plate No. 3, Appendix I.

An internal drainage system was constructed immediately downstream of the impervious core in order to collect seepage, reduce uplift pressures beneath the dam, and control the phreatic surface within the embankment. This system consists of a sand and gravel strip drain approximately 925 ft long, 12 to 25 ft wide, and 3.5 ft thick. Water is collected in 20 ft of 6 inch perforated concrete pipe and exits through two 6 inch nonperforated concrete pipes into an outlet channel. The 6 inch pipes are enclosed in an envelope of coarse drain fill. Thirteen (13) 6 inch diameter relief wells, spaced on 50 ft centers, were also constructed in conjunction with this system. They extend 30 ft below the strip drain and have been backfilled with filter material. Details of the drainage system are provided on Plates No. 3 and 4 of Appendix I. Sixteen (16) piezometers were also installed at 8 locations along the downstream slope in order to monitor piezometric levels within the downstream embankment. Locations and construction design are provided on Plates No. 3 and 4, respectively of Appendix I.

The principal spillway consists of a 250 ft long and 6 ft high reinforced concrete weir located at the right abutment. The weir discharges into a 10 ft deep and 20 ft wide reinforced concrete channel. Design details are presented on Plate No. 5, Appendix I.

The outlet works consist of a 36 inch diameter hydraulically controlled intake structure and 355 ft of 36 inch ductile iron pipe,

which discharges into a riprap lined outlet channel. Five (5) antiseep collars spaced on 30 ft centers were included to prevent piping of embankment materials along the outlet pipes (see Plates No. 6 and 7, Appendix I).

A stability analysis was reportedly performed for this structure, however, this information was not provided.

2.2 Construction: The construction records were not furnished but are available from the CH_2M-Hill office in Reston, Virginia.

2.3 Evaluation: Engineering calculations are adequate and the design drawings are representative of the dam. The operational procedure is consistant with the purpose of the dam, and employs satisfactory methods of operation. There is sufficient information to evaluate foundation conditions but not the embankment stability.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: At the time of inspection, the dam was in good condition. Field observations are outlined in Appendix III.

3.1.1 General: An inspection was made 1 May 1980 and the weather was sunny with a temperature of 70° F. The pool and tailwater levels at the time of inspection were 182.5 and 154 msl, respectively. This corresponds to a below normal pool elevation and normal tailwater elevation. Ground conditions were damp at the time of inspection. A record of piezometer readings and a recently completed report on siltation buildup in the reservoir were available during the inspection.

3.1.2 Dam and Spillway: Two 6-inch concrete pipes from the outlet for the foundation toe drain. No flow was observed from the right pipe with less than 1 gpm exiting from the left. The downstream embankment slope was grassed and the upstream slope was blanketed with riprap with maximum dimensions of about 2 ft± (Photo No. 2, Appendix II and Overview Photo of Dam, Page 3). The crest of the dam consists of a gravel road (Overview Photo of Dam, Page 3). Field measurements indicate both the upstream and downstream slopes are approximately 4H:1V. The dam appears to be constructed with various combinations of sand and silt which visually range from SM to ML in accordance with the Unified Soils Classification System. No surface erosion was noted on the embankment slopes and no seepage was observed along the downstream toe.

Both abutments were well vegetated and the abutment-embankment contacts were in good condition. Surface soils in the surrounding area include clayey silt (ML) and silty sand (SM) materials, which are derived from the in-place weathering of underlying bedrock. Nearly flat-lying red micaceous shales with sandstone interbeds

were exposed along the right side of the spillway discharge channel or chute. Rectangular jointing was noted in the rock. No faults were observed in the field during this inspection and geologic maps of the area do not show the presence of faults in the immediate vicinity.

The weir structure and outlet pipe showed no signs of deterioration and were functioning properly at the time of inspection, (Photos No. 3 and 4, Appendix II). The 36 inch outlet facility was reportedly in good operating condition according to Mr. Ed Wozniak. The plunge pool riprap was intact indicating no signs of movement or erosion.

3.1.3 Reservoir Area: The reservoir area was free of debris and the perimeter was grassed except for the upper reaches. The reservoir is located in a valley with side slopes at approximately 10H:1V, (see Overview Photos, Page 3). No sediment buildup was observed. A staff gage does not exist for this structure.

3.1.4 Downstream Area: The downstream channel consists of a 5 ft wide channel located in a valley with side slopes of 5H:1V. This valley is lightly wooded. Approximately two miles downstream at the intersection of Bull Run and Route 29 there are two commercial facilities at stream bank level.

3.1.5 Instrumentation: Four (4) 1-inch diameter iron pipe monuments exist on the crest of the dam, which are used for horizontal and vertical control. Their locations are provided on Sheet 15 of Appendix IV. Sixteen (16) piezometers have been installed along the downstream slope. Previous readings and locations are included in Appendix V.

3.2 Evaluation: Overall, the dam was in good condition at the time of the inspection. The vegetative cover appears to be well maintained and no trees were growing on the embankment. A routine maintenance program exists for this structure. Riprap present along the upstream slope, in the plunge pool, and along the downstream outlet channel is in good condition and appears to be functioning properly. No surface erosion was observed on the embankment or in the abutment areas. The internal drainage system is apparently functioning properly, as no seepage was observed along the downstream toe and piezometer readings taken during the inspection are consistent with previous readings.

The outlet pipe and principal spillway are in good structural condition. All operating appurtenances are functionally good. A staff gage should be installed to usually monitor pool levels. Water levels are monitored when piezometer readings are made using a surveyor's level.

3.2.2 Downstream Area: A breach in the Upper Occoquan Regional Water Reclamation Plant Dam during extreme flooding conditions could potentially damage the downstream dwellings.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: Upper Occoquan Regional Water Reclamation Plant Dam is used for dilution of wastewater discharges. The normal pool elevation (187.9 msl) is maintained by a weir acting as the principal spillway. Water automatically flows over the low weir when pool levels exceed elevation 187.5 msl, and over the entire weir when pool levels exceed elevation 188 msl. An intake structure with inlets at various elevations below normal pool is used to decant water from the reservoir at different levels within the reservoir. The water quality at the various levels dictate at which level water is decanted.

4.2 Maintenance of Dam and Appurtenances: Maintenance is the responsibility of the Owner. Maintenance consists of inspection, debris removal, mowing of vegetative cover, and repair.

4.3 Warning System: The emergency action plan does not include a downstream warning system or evacuation plan for the dam. (See Appendix IV.p.3

4.4 Evaluation: The dam and appurtenances are in good operating condition. Maintenance of the dam is good. Records should be maintained of all maintenance and operational procedures for future reference. An emergency action and warning plan for the downstream area should be developed. It is recommended that a formal emergency procedure be prepared and furnished to all operating personnel. This should include:

a. How to operate the dam during an emergency.

b. Who to notify, including public officials, in case evacuation from the downstream area is necessary.

SECTION 5 - HYDRAULICS/HYDROLOGIC DATA

5.1 Design: The dam was designed by CH_2M-Hill as a multi-purpose dam and a portion of the hydrologic and hydraulic data is available. Data used included the stage-discharge and stage-storage area curves made available.

5.2 Hydrologic Records: There are no records available.

5.3 Flood Experience: Is not known.

5.4 Flood Potentials: In accordance with the established guidelines, the Spillway Design Flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region), or fractions thereof. The Probable Maximum Flood (PMF), hydrograph was developed by the SCS method (Reference 5, Appendix VI). Precipitation amounts for the flood hydrograph of the PMF are taken from the U. S. Weather Bureau Information (Refernce 6, Appendix VI). Appropriate adjustments for basin size and shape were accounted for. These hydrographs were routed through the reservoir to determine maximum pool elevations.

5.5 Reservoir Regulation: For routing purposes, the pool at the beginning of flood was assumed to be at elevation 188 msl. Reservoir stage-storage data and stage-discharge data were determined from the design report and plans. Floods were routed through the reservoir using the principal spillway discharge. The 36 inch outlet pipe was assumed to be closed.

5.6 Overtopping Potential: The predicted rise of the reservoir pool and other pertinent data were determined by routing the flood hydrographs through the reservoir as previously described. The results for the flood conditions (100 year flood, ½ PMF and PMF) are shown in the following Table 5.1.

Table 5.1 - RESERVOIR PERFORMANCE

		Hydrograph	
	Normal Flow	½ PMF	PMF
Peak Flow, CFS			
Inflow	50*	3553	7106
Outflow	50	2192	4475
Maximum Pool Elevation			
ft, msl	188	189.93	191.66
Non-Overflow Section (elev 195 msl)			
Depth of Flow, ft	-	-	-
Duration, Hours	-	-	-
Velocity, fps	-	-	-
Principal Spillway (elev 188 msl)			
Depth of Flow, ft	-	1.93	3.66
Duration, Hours	-	9.0	9.0
Velocity, fps*	-	6.4	8.2
Tailwater Elevation			
ft, msl	157	168	171

* Critical velocity at control section

* Flow is from plant discharge at maximum hydraulic loading

5.7 Reservoir Emptying Potential: A 36-inch diameter outlet at invert elevation 161 msl is capable of draining the reservoir to elevation 161 msl. Assuming that the lake is at normal pool elevation (188 msl) and there is 50 cfs inflow, it would take approximately two days (13.5 ft per day) to lower the reservoir to elevation 161 msl.

5.8 Evaluation: The U. S. Army, Corps of Engineers, guidelines indicate the appropriate Spillway Design Flood (SDF) for an intermediate size, significant hazard dam is the ½ PMF to PMF. Because of the risk involved, the ½ PMF has been selected as the SDF. The spillway will pass in excess of 100 percent of the PMF (200 percent of the SDF).

Hydrologic data used in the evaluation pertains to present day conditions with no consideration given to future development.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: The dam is located in the Piedmont physiographic province of Virginia. Red micaceous shale with thin sandstone interbeds are exposed along the right side of the spillway outlet channel. These rocks belong to the Newark Formation of Triassic Age. The dam and reservoir are underlain by similar rocks and it is likely that diabase dikes traverse the site intermittently. Available geologic maps of the area do not indicate the presence of any faults in the site vicinity.

Test boring and test pit data (Plate No. 8, Appendix I) indicate the embankment and abutments are underlain basically by a thin veneer of residual soils (probably SM to ML materials) resting upon decomposed to slightly weathered shale and "siltstone". Although no field permeability data was provided, natural permeabilities in Triassic shales are typically low except in the presence of fracturing or jointing, which result in higher natural permeabilities. Jointing was noted on the exposed rock on the right side of the discharge channel.

Based upon the materials encountered in the test pits and test borings, a stable foundation is assumed. Gradual consolidation of the underlying soils would be expected during application of fill materials. The underlying soils probably has essentially fully consolidated under the applied load not long after completion of construction. A 1 ft camber was recommended in design, however no readings on the monuments were available for comparing the actual amount of settlement.

6.2 Embankment:

6.2.1 Materials: Design drawings show the dam as a zoned structure. The "impervious core" and cutoff were constructed with mixtures of clayey silt, silt and decomposed shale up to 2 inches in maximum size. The outer shell or "random embankment" was constructed with more permeable mixtures of clayey silt, silt, decomposed shale and shale up to 6 inches in maximum size. Materials in both zones were to be compacted to a "minimum of 98 percent relative compaction" as defined in the construction specifications. Lift thicknesses were not to exceed 6 inches in compacted thickness.

6.2.2 Subdrains and Seepage: In attempt to control seepage beneath the embankment, a cutoff was constructed into the decomposed shale as shown on Plate No. 3, Appendix I. An internal drainage system for collecting seepage and controlling the phreatic surface through the embankment was also provided. This system consists of 12 to 25 ft wide strip drain composed of graded sand and gravel located beneath the downstream slope, directly below the "impervious core". Thirteen (13) relief wells extend beneath the strip drain to reduce uplift pressures. Drainage pipes were provided for transmitting the collected water to an outlet channel. Design details are given on Plates No. 3 and 4 of Appendix I. In attempt to prevent piping around the 36 inch outlet pipe, five (5) anti-seep collars were included as shown on Plate No. 6, Appendix I. Sixteen (16) piezometers were installed to monitor the phreatic surface through the embankment.

6.2.3 Stability: A stability analysis was reportedly performed for this structure, but this information was not provided. The dam is 41 ft high and has a crest width of 20 ft. A graveled access road traverses the crest of the dam. The upstream slope is 4H:1V and includes riprap from elevation 183 msl to the crest of the dam (elevation 195 msl). The downstream slope is 4H:1V. The dam is subjected to sudden drawdown because the approximate reservoir drawdown rate of 13.5 ft per day exceeds the critical rate of 0.5 ft per day for earth dams. The existing pool during the inspection was approximately 5.5 ft below maximum control storage pool which is at the crest of the principal spillway weir. The dam normally experiences the maximum control storage pool with no apparent side effects.

Although design drawings show the dam as a zoned structure, both the "impervious core" and "random embankment" were constructed with essentially the same materials, (see Section 6.2.1). Therefore, the embankment stability is assessed assuming a homogeneous dam. According to the guidelines presented in Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation for small homogeneous dams, with stable foundation, subjected to a drawdown and composed of SM to ML materials, the recommended slopes are 3H:1V to 3.5H:1V upstream and 2H:1V to 2.5H:1V downstream. The recommended width is 18.2 ft. Based on these general guidelines, the embankment slopes and crest width are adequate.

6.2.4 Seismic Stability: The dam is located in Seismic Zone 2. Therefore, according to the Recommended Guidelines for Safety Inspection of Dams, the dam is considered to have no hazard from earthquakes pro-

vided static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: Based upon the visual inspection and the design drawings, the foundation is considered stable. According to general Bureau of Reclamation guidelines, the embankment slopes and crest width are adequate. Piezometer readings indicate that the internal drainage system is functioning properly. Overtopping of the dam is not a problem, as the spillway will pass 100 percent of the PMF (200 percent of the SDF). Since no undue settlement, cracking or sloughing was noted at the time of inspection, it appears that the embankment is adequate for maximum control storage with water at elevation 188 msl.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

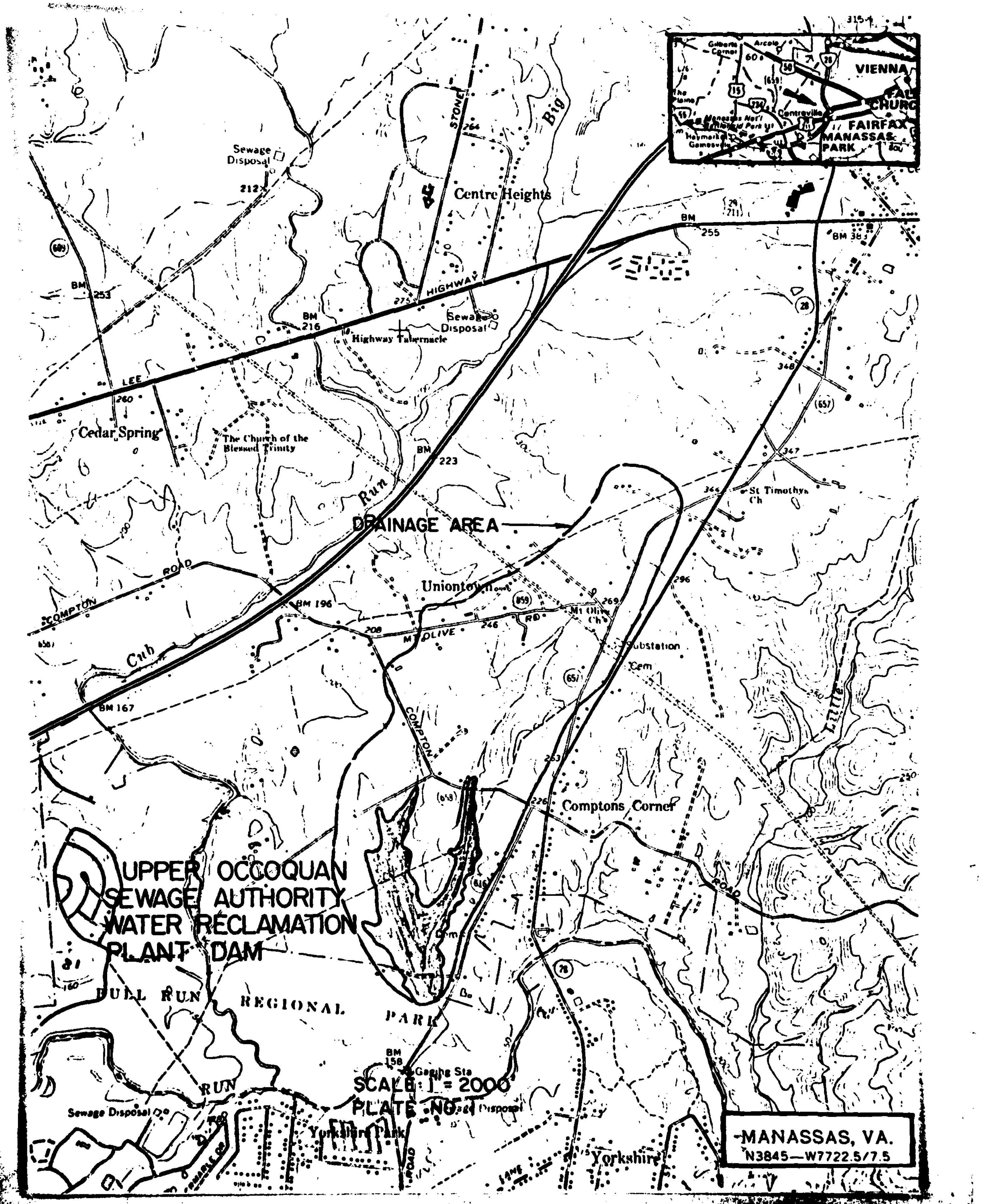
7.1 Dam Assessment: The available engineering data is adequate. The visual inspection revealed the dam is in good condition and there is no immediate need for remedial measures. There is a regular maintenance operations program and maintenance is good. There is an emergency action plan but no warning plan for the downstream area. Corps of Engineers guidelines indicate the appropriate Spillway Design Flood (SDF) for a small size and significant hazard dam is the ½ PMF. The spillway will pass in excess of 100 percent of the PMF (200 percent of the SDF). The spillway is judged adequate as it will pass the SDF without overtopping the dam. A stability check of the dam is not required as the embankment slopes and crest meet Bureau of Reclamation guidelines.

7.2 Recommended Remedial Measures: The following remedial measures are recommended:

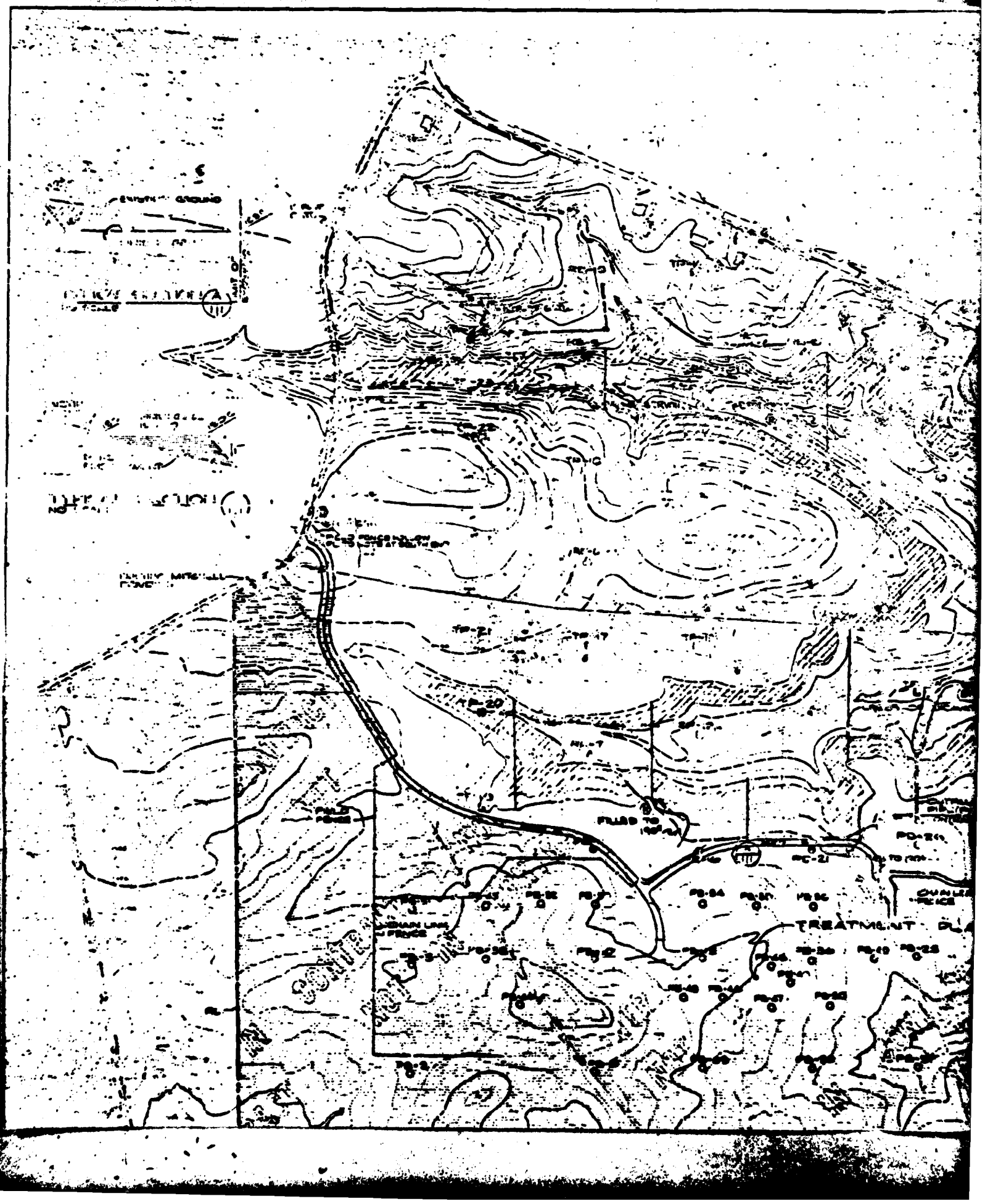
a) A warning system should be developed for the downstream area.

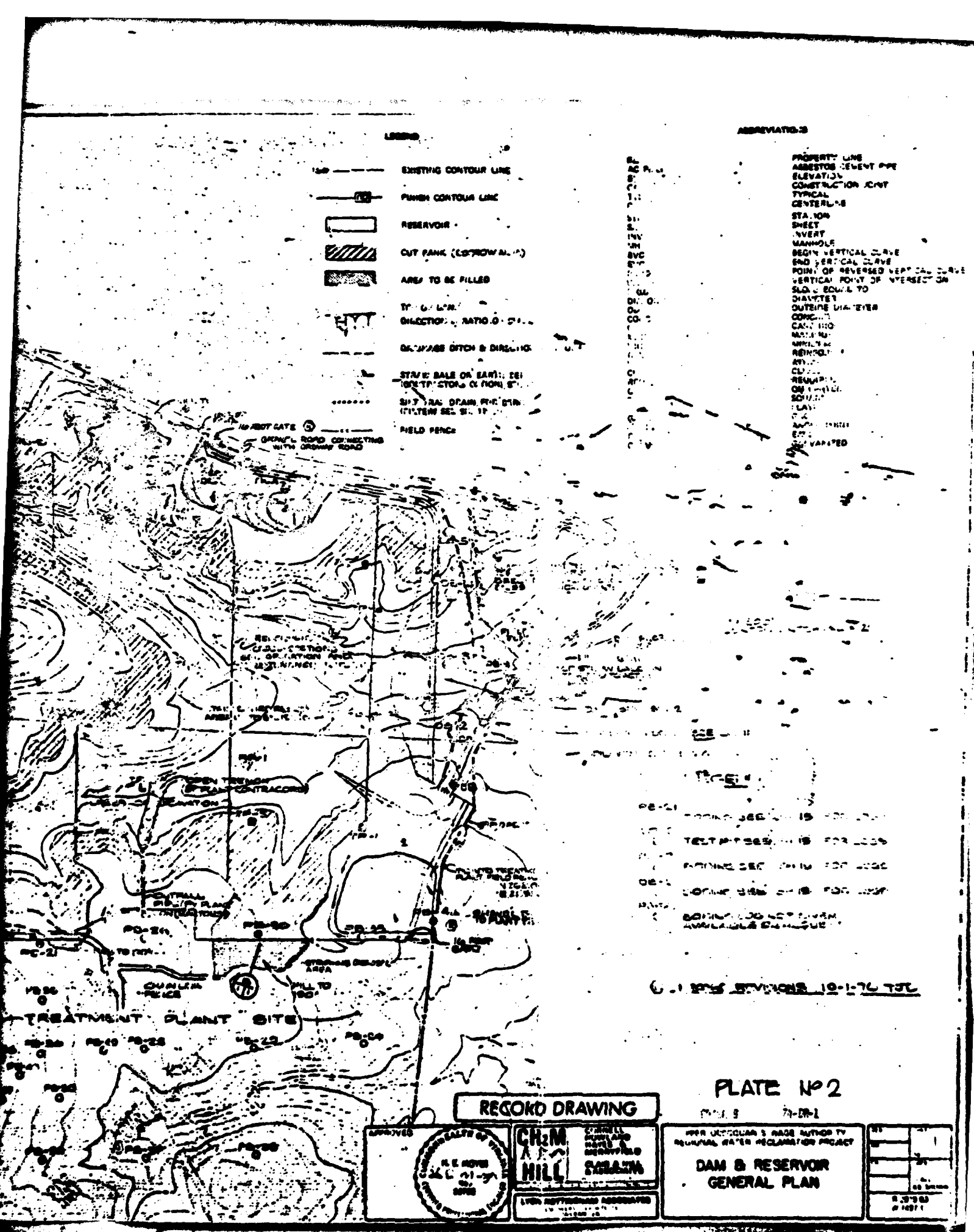
b) A staff gage should be installed to visually monitor water levels.

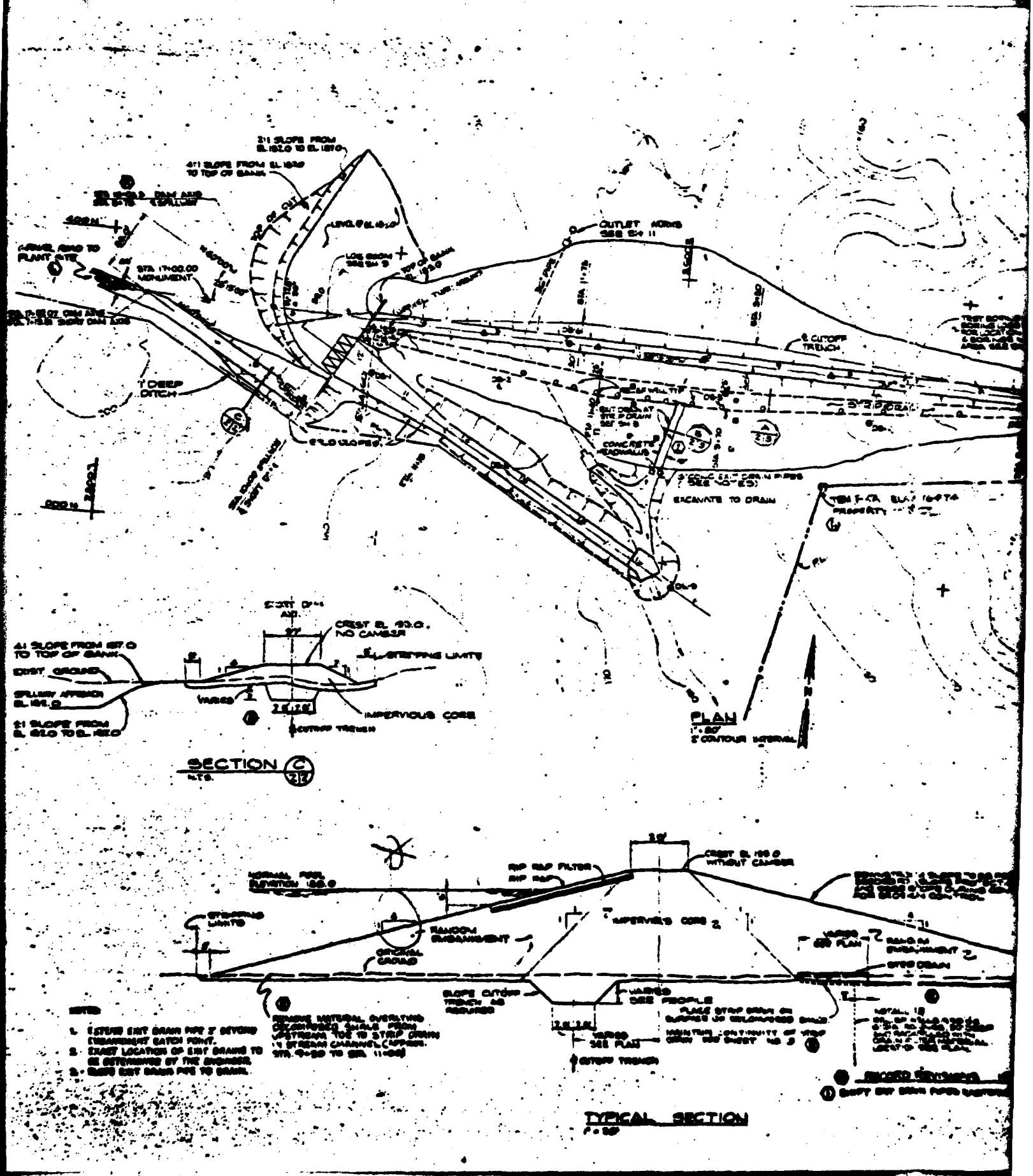
APPENDIX I
MAPS AND DRAWINGS

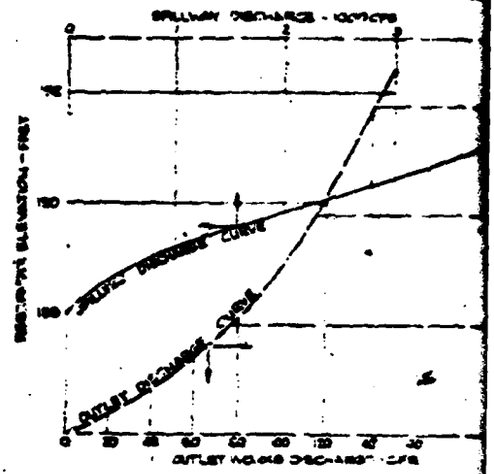


VIENNA
FAIRFAX
MANASSAS PARK
Sewage Disposal
Centre Heights
Big Run
LEE HIGHWAY
Highway Tabernacle
Cedar Spring
The Church of the Blessed Trinity
DRAINAGE AREA
Uniontown
COMPTON ROAD
Cub Run
MT OLIVE RD
Mt Olive Ch
Substation
St Timothys Ch
Comptons Corner
UPPER OCCOQUAN SEWAGE AUTHORITY WATER RECLAMATION PLANT DAM
BULL RUN REGIONAL PARK
SCALE 1" = 2000'
PLATE NO. 1
Yorkshire Park
Yorkshire
MANASSAS, VA.
N3845—W7722.5/7.5

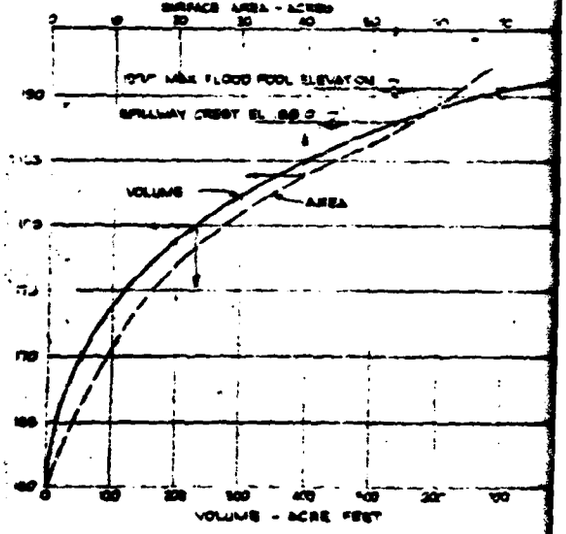

TREATMENT


LEGEND
EXISTING CONTOUR LINE
FINISH CONTOUR LINE
RESERVOIR
CUT BANK (CATCHBASIN)
AREA TO BE FILLED
DRAINAGE DITCH & DIRECTION
STRAW BALE OR EARTH DIKE
PIELD FENCE
ABBREVIATIONS
PROPERTY LINE
ASBESTOS CEMENT PIPE
ELEVATION
CONSTRUCTION JOINT
TYPICAL
CENTERLINE
STATION
SHEET
INVERT
MANHOLE
BEGIN VERTICAL CURVE
END VERTICAL CURVE
POINT OF REVERSED VERTICAL CURVE
VERTICAL POINT OF INTERSECTION
SLOPE EQUAL TO
DIAMETER
OUTSIDE DIAMETER
TREATMENT PLANT SITE
RECORD DRAWING
PLATE No 2
CH2M HILL
DAM & RESERVOIR
GENERAL PLAN


PLAN
SECTION
TYPICAL SECTION



SPILLWAY & OUTLET WORKS DISCHARGE



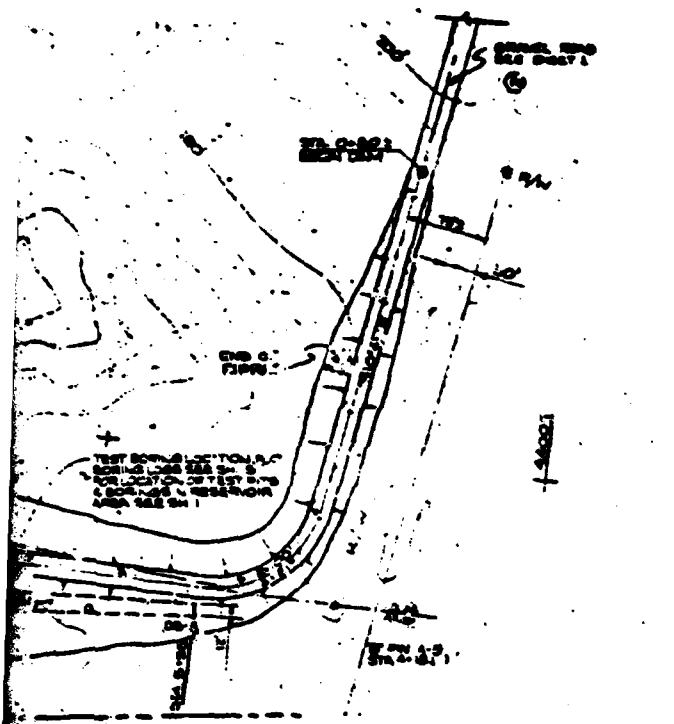
AREA & VOLUME vs ELEVATION

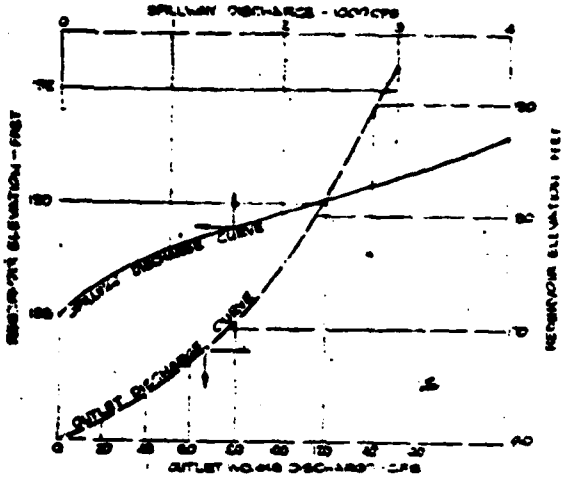
RECORD DRAWING

PLATE No 3

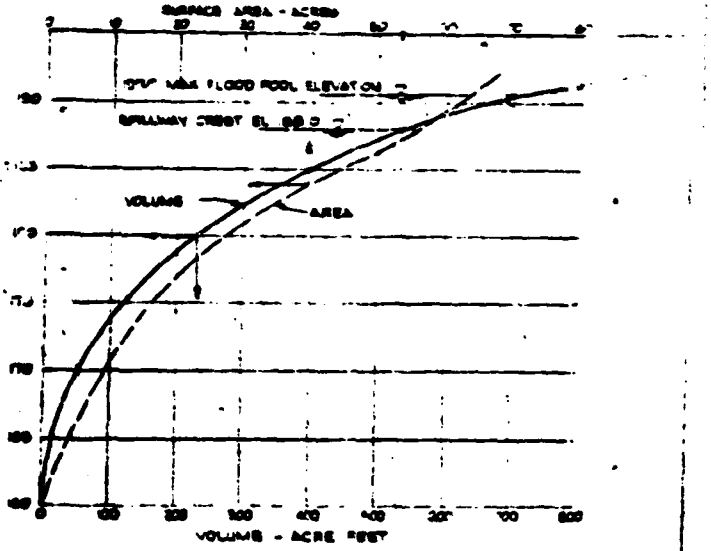
CH2M HILL

DAM SITE
GENERAL PLAN

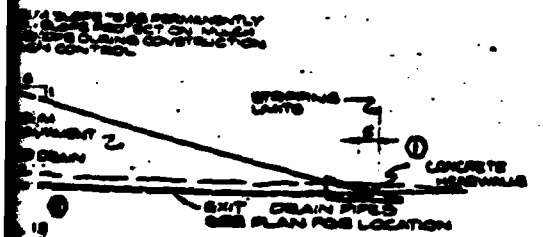




SPILLWAY & OUTLET WORKS DISCHARGE vs E. C.R.E.S



AREA & VOLUME vs ELEVATION



RECORD DRAWING

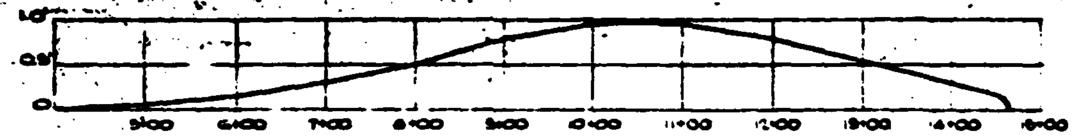
PLATE No 3

APPROVED

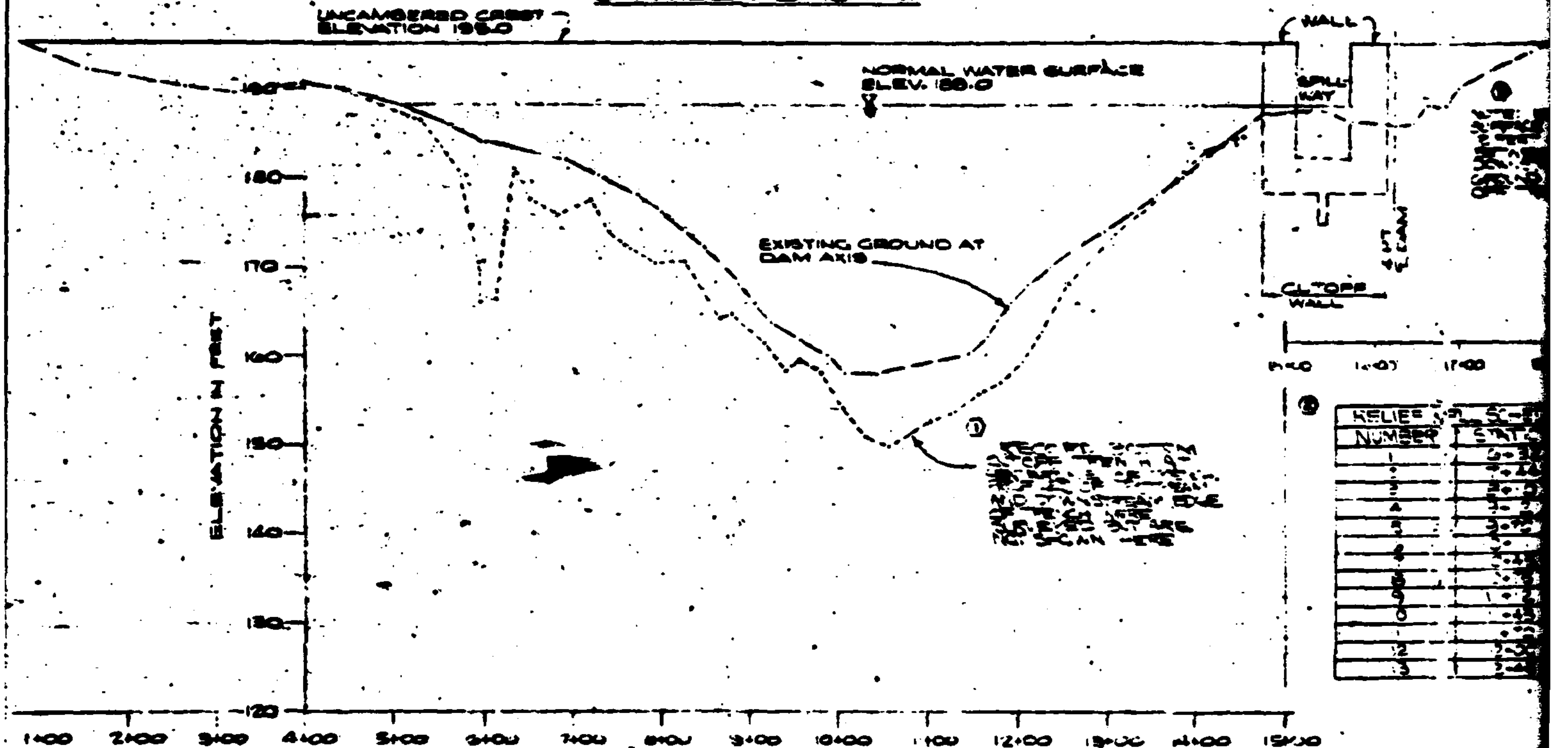
CH2M HILL

JOINT POWERS SEWAGE AUTHORITY
REGIONAL WATER RECLAMATION PROJECT

DAM SITE
GENERAL PLAN



CHAMBER DIAGRAM



DAM ℄ AXIS PROFILE

1"=100' HORIZ., 1"=10' VERT

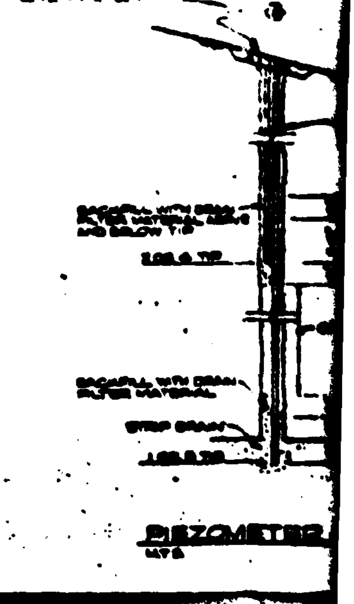
RECORD REVISIONS [illegible]

1. RECORD BOTTOM AT CENTERLINE OF TRENCH
2. ADD RELIEF WELL SCHEDULE.
3. ADD EXIT PIPE HEADWALL DETAIL
4. ADD [illegible] DETAIL FOR PIEZOMETERS 3 THRU 8
5. UPDATE PIEZOMETER SCHEDULE.
6. ADD METER COVER TO PIEZOMETER DETAIL, ELIMINATE 4x4 POST

PIEZOMETER SCHEDULE

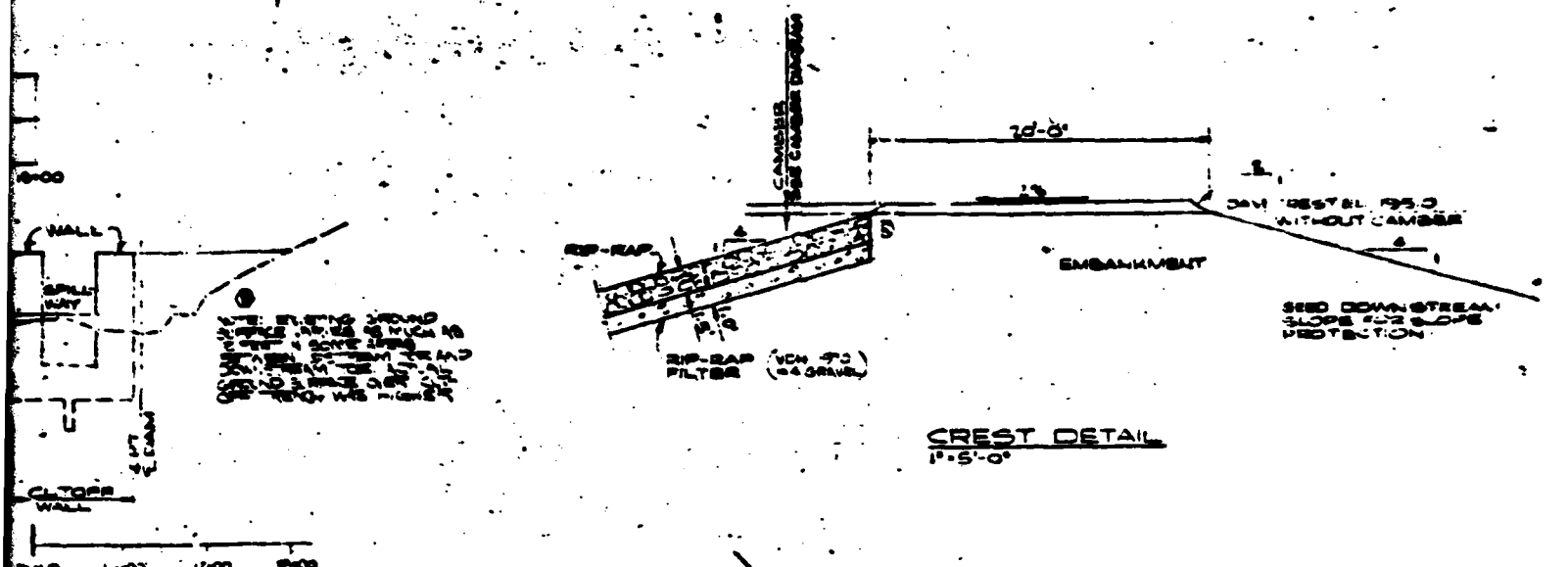
PIEZOMETER NO.	DAM AXIS STATION	DISTANCE LT OF ℄	TIP ELEVATION	MATERIAL AT TIP
1A	9+90	90	159.8	STRIP DRAIN
1B	9+90	90	161.0	EMBANKMENT
2A	11+00	90	158.8	STRIP DRAIN
2B	11+00	90	170.5	EMBANKMENT
3A	9+40	180	149.0	HARD SHALE
3B	9+40	180	154.8	WEATHERED SHALE
4A	10+90	180	137.6	HARD SHALE
4B	10+90	180	147.0	HARD SHALE
5A	10+90	180	146.4	HARD SHALE W/ SOFT LENSES
5B	10+90	180	156.6	OVERBURDEN SOIL
6A	11+20	180	145.1	HARD SHALE
6B	11+20	180	156.6	HARD SHALE
7A	9+40	80	150.3	HARD SHALE
7B	9+40	80	159.2	WEATHERED SHALE
8A	10+90	80	143.9	HARD SHALE
8B	10+90	80	159.4	WEATHERED & HARD SHALE

NOTE: PIEZOMETER NUMBERS IN SITE PLAN ACTUALLY CONTAIN TWO PIEZOMETER PIPES, A AND B



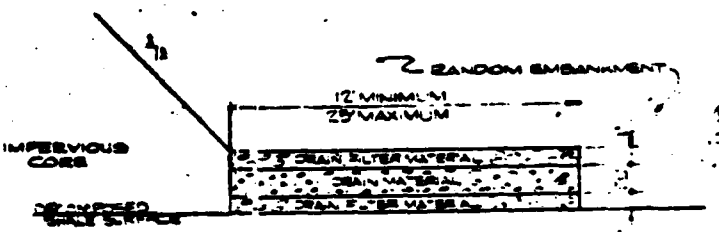
PIEZOMETER

NTS

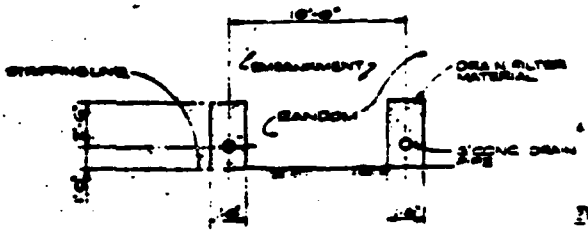


CREST DETAIL
1"=5'-0"

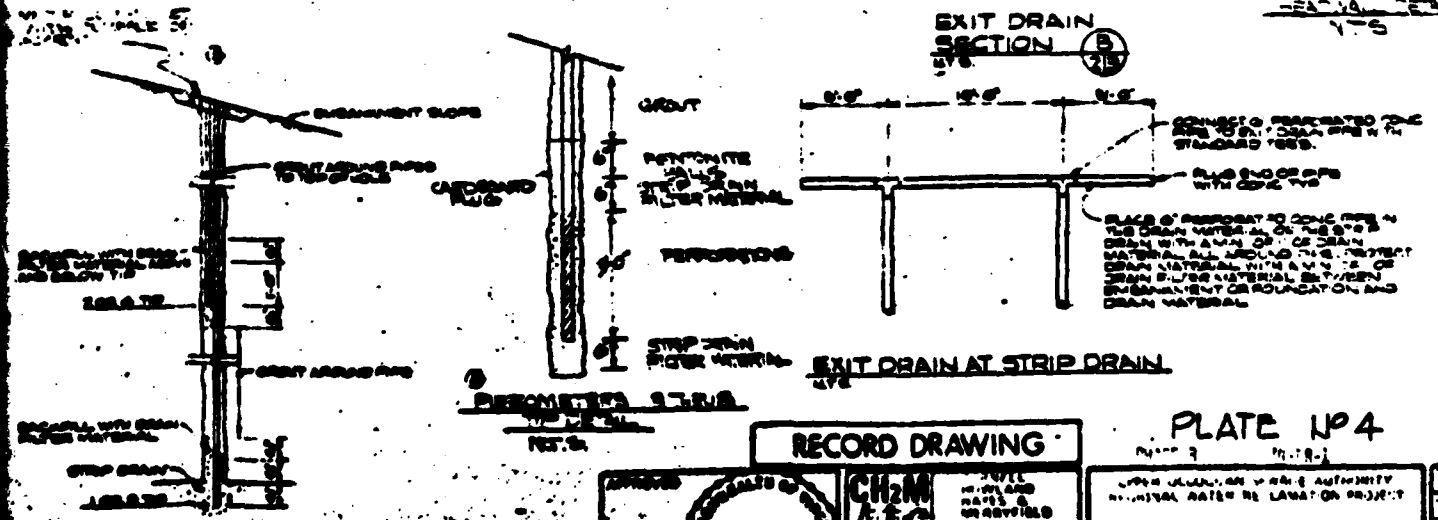
RELIEF WELL NUMBER	RELIEF WELL STATION
1	5+32
2	5+74
3	6+10
4	6+46
5	6+82
6	7+18
7	7+54
8	7+90
9	8+26
10	8+62
11	8+98
12	9+34
13	9+70



STRIP DRAIN SECTION (A) 2/5



EXIT DRAIN SECTION (B) 2/5



EXIT DRAIN AT STRIP DRAIN

PIEZOMETER DETAIL

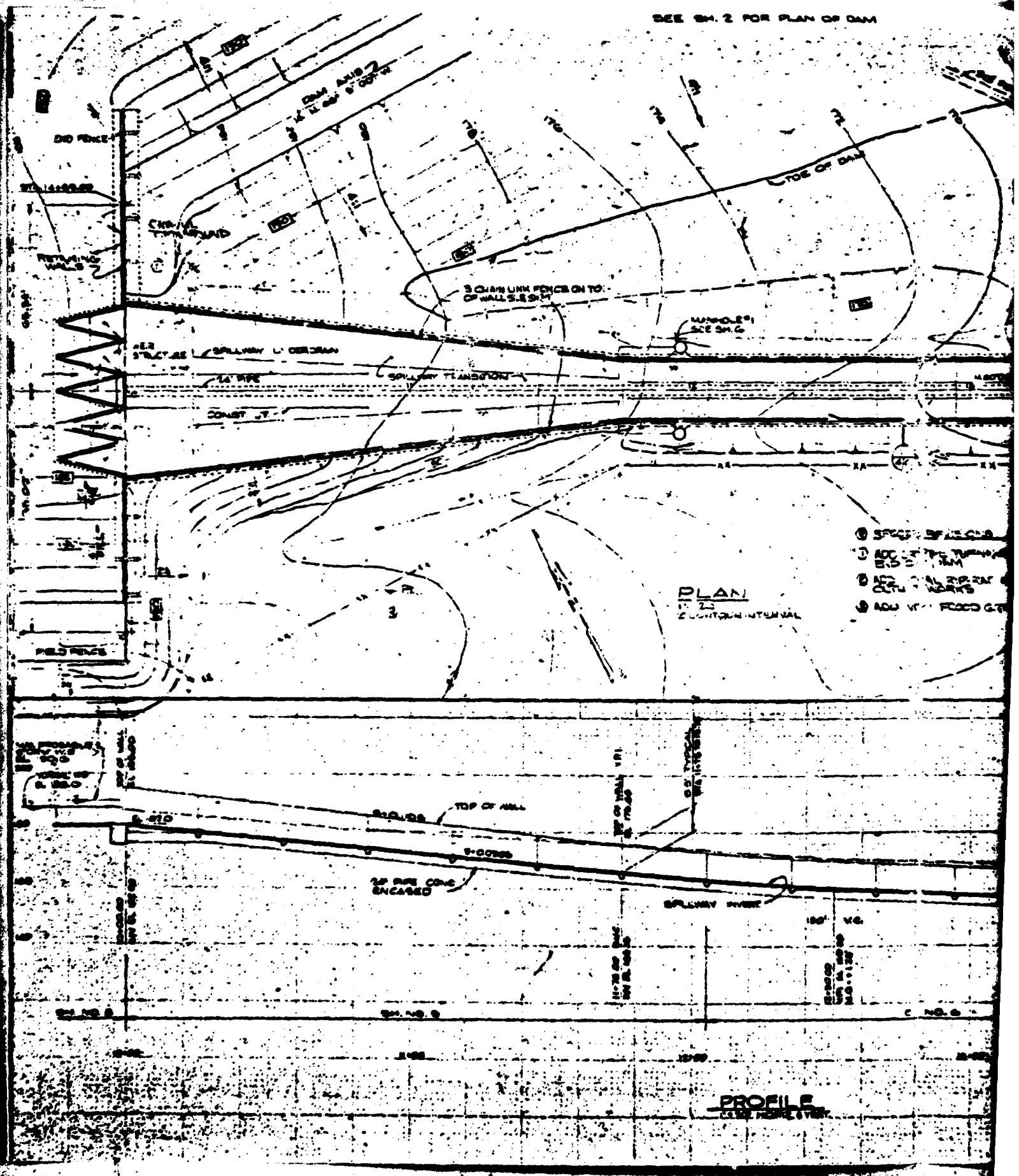
RECORD DRAWING

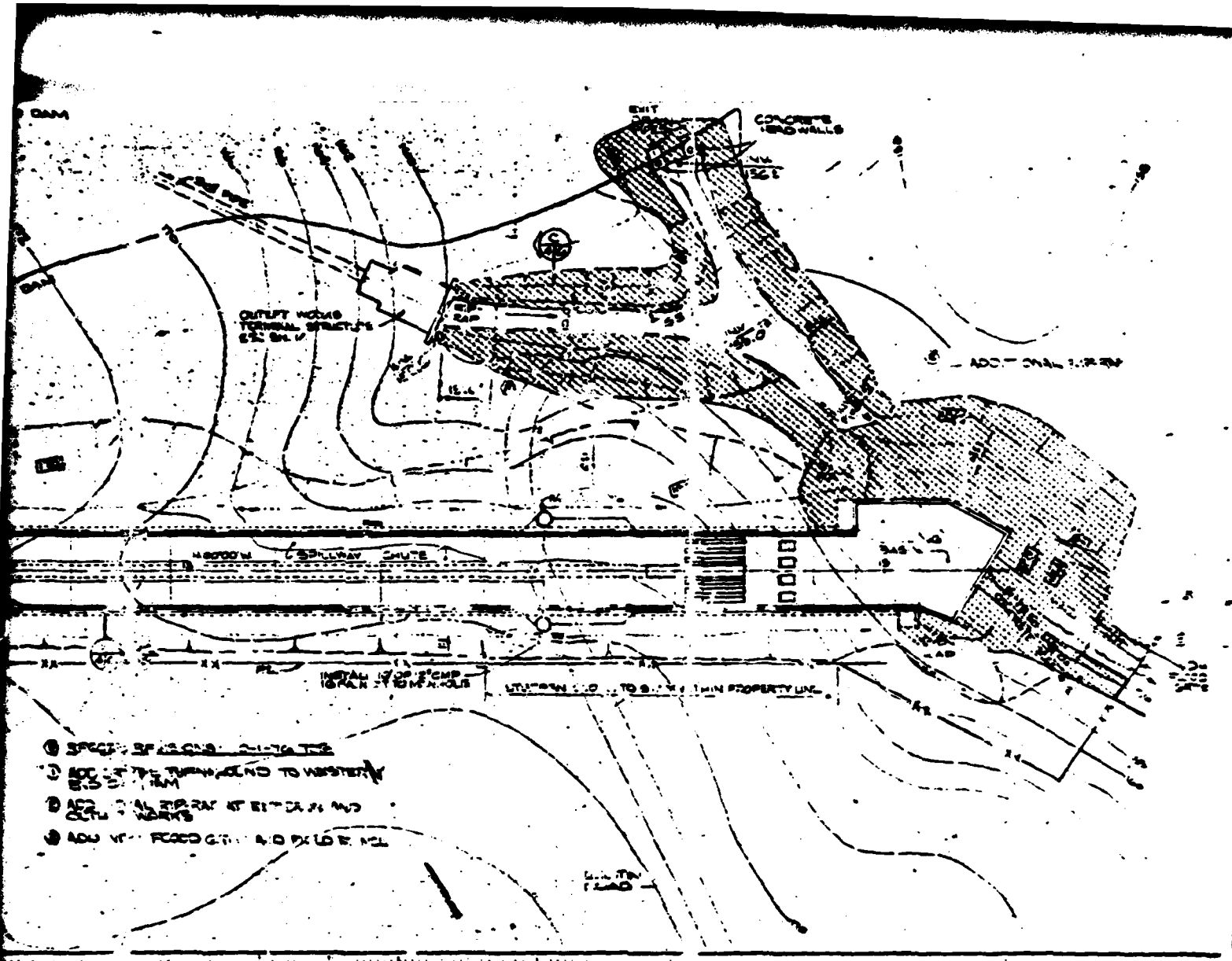
CH2M HILL

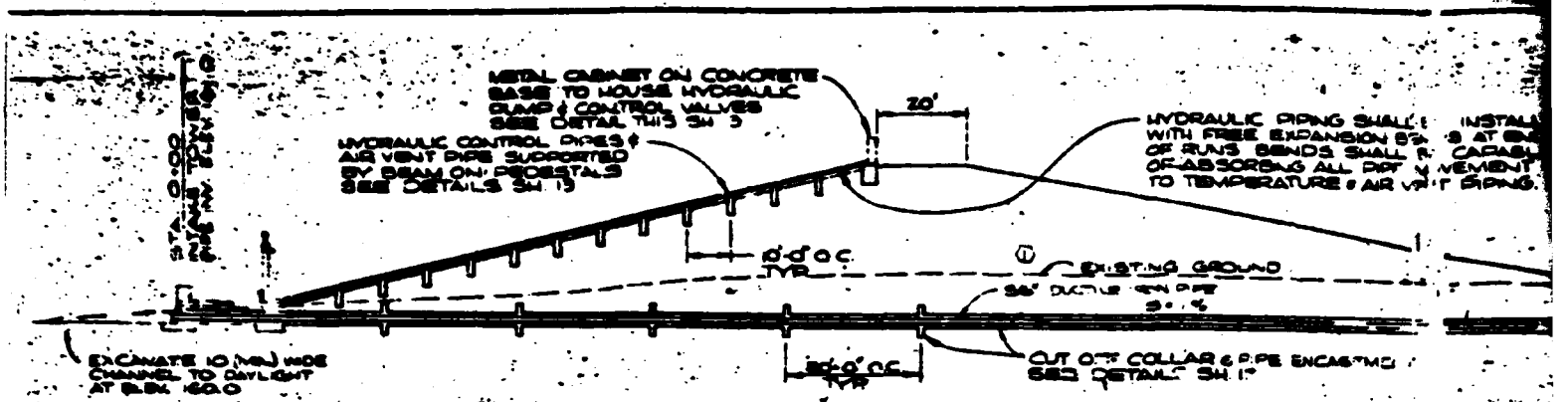
PLATE NO 4

DAM DETAILS

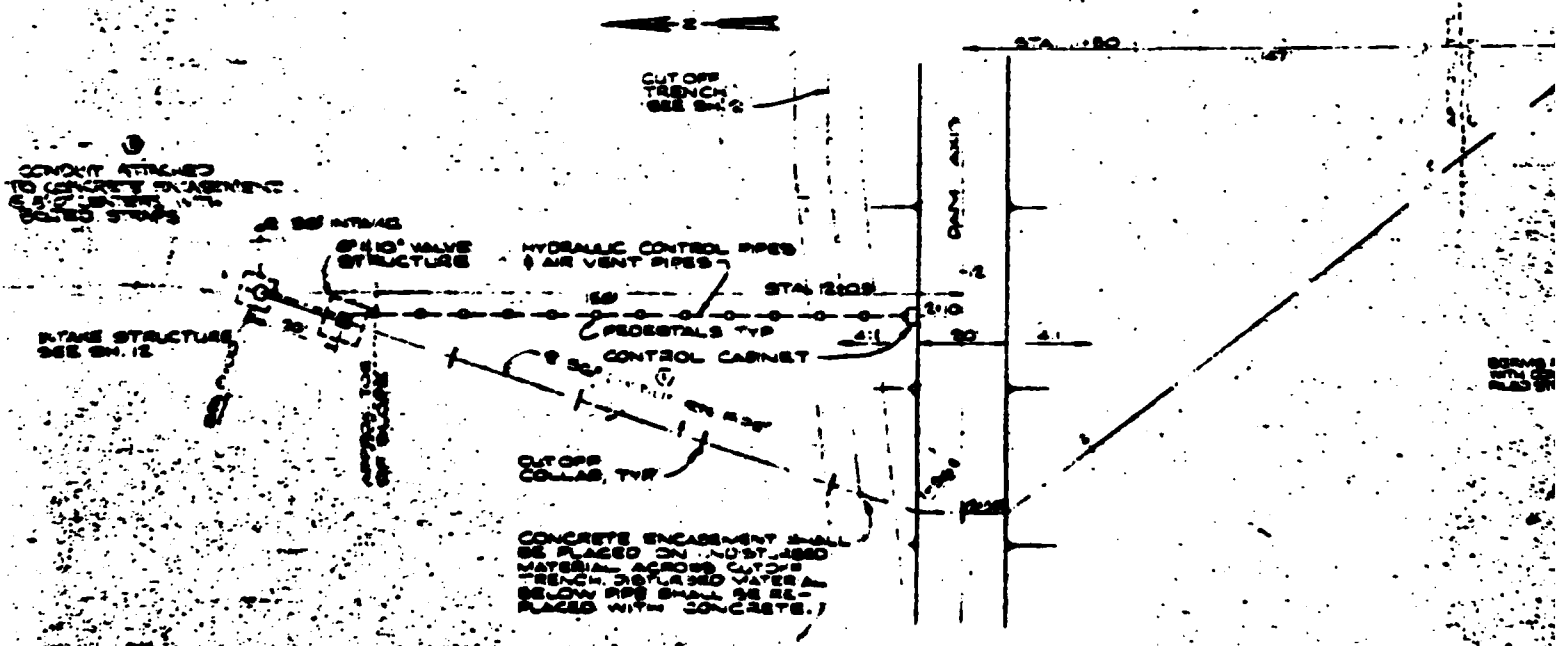
3


SEE SH. 2 FOR PLAN OF DAM
DAM AXIS
TOE OF DAM
3 CHAIN LINK FENCE ON TOP OF WALL S.E. SIDE
MANHOLE #1 SEE SH. 6
SPILLWAY TRANSITION
CONST. JT.
PLAN
TOP OF WALL
SPILLWAY INVERT
PROFILE

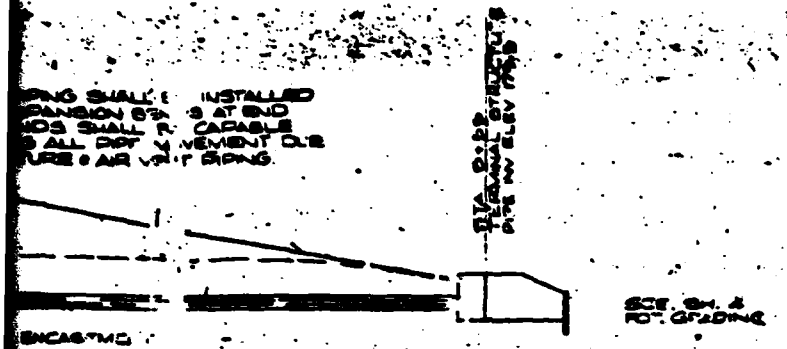

DAM
OUTLET WORKS TERMINAL STRUCTURE
SPILLWAY CHUTE
CONCRETE SIDE WALLS
EXIT
ADDITIONAL RIPRAP
INSTALL 12"Ø CMP
UTILITIES TO BE WITHIN PROPERTY LINE
EXISTING GROUND
RECORD DRAWING
PLATE NO5
CH2M HILL
SPILLWAY GENERAL PLAN
UPPER OCCOQUAN SEWAGE AUTHORITY
REGIONAL WATER RECLAMATION PROJECT

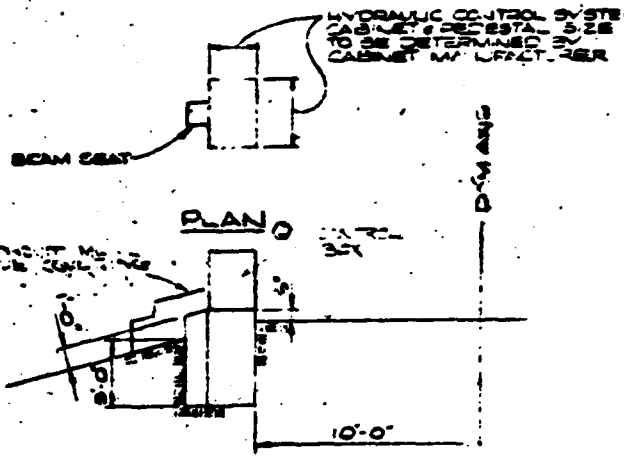


DEVELOPED SECTION
1" = 20'

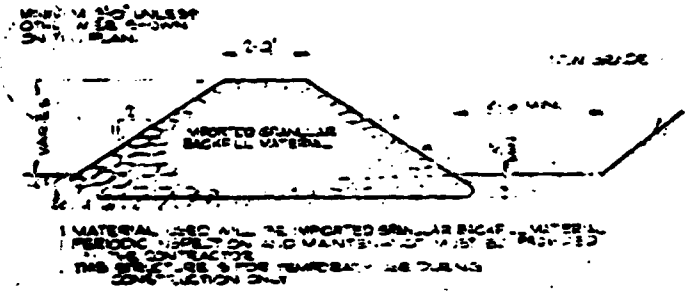


OUTLET WORKS PLAN
1" = 20'

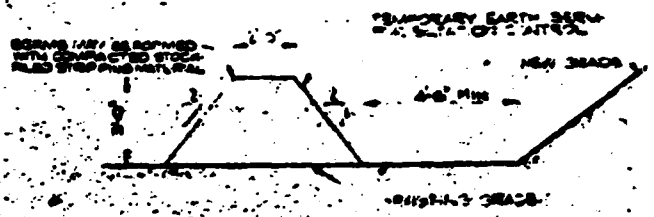




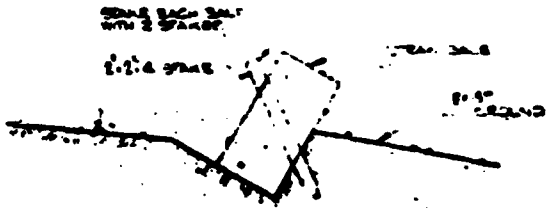
CONTROL CABINET FOOTING



SILT TRAP DRAIN FOR BERM (FILTER)



EARTH BERM FOR SILTATION CONTROL



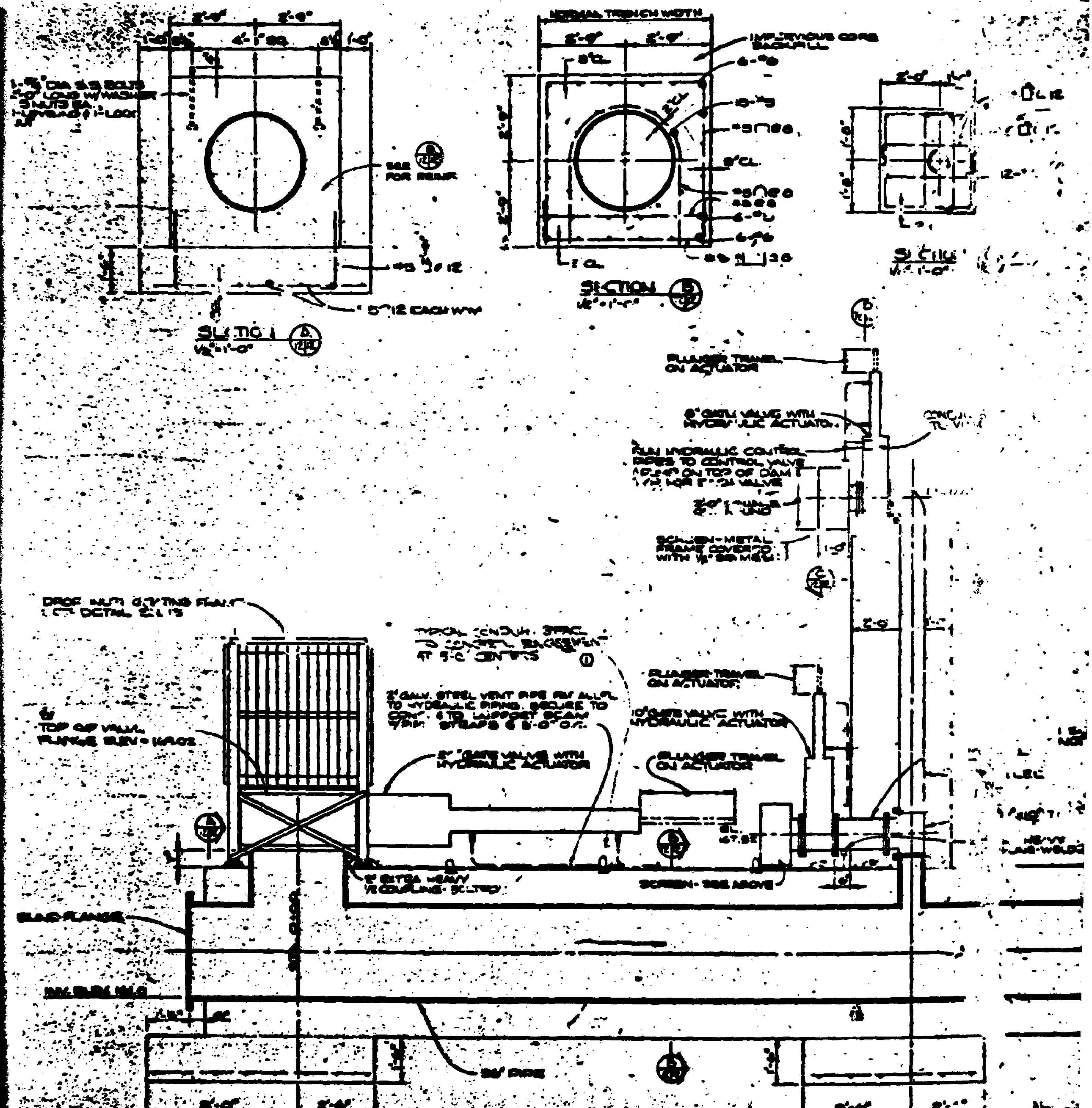
STRAWBALE FOR SILTATION CONTROL

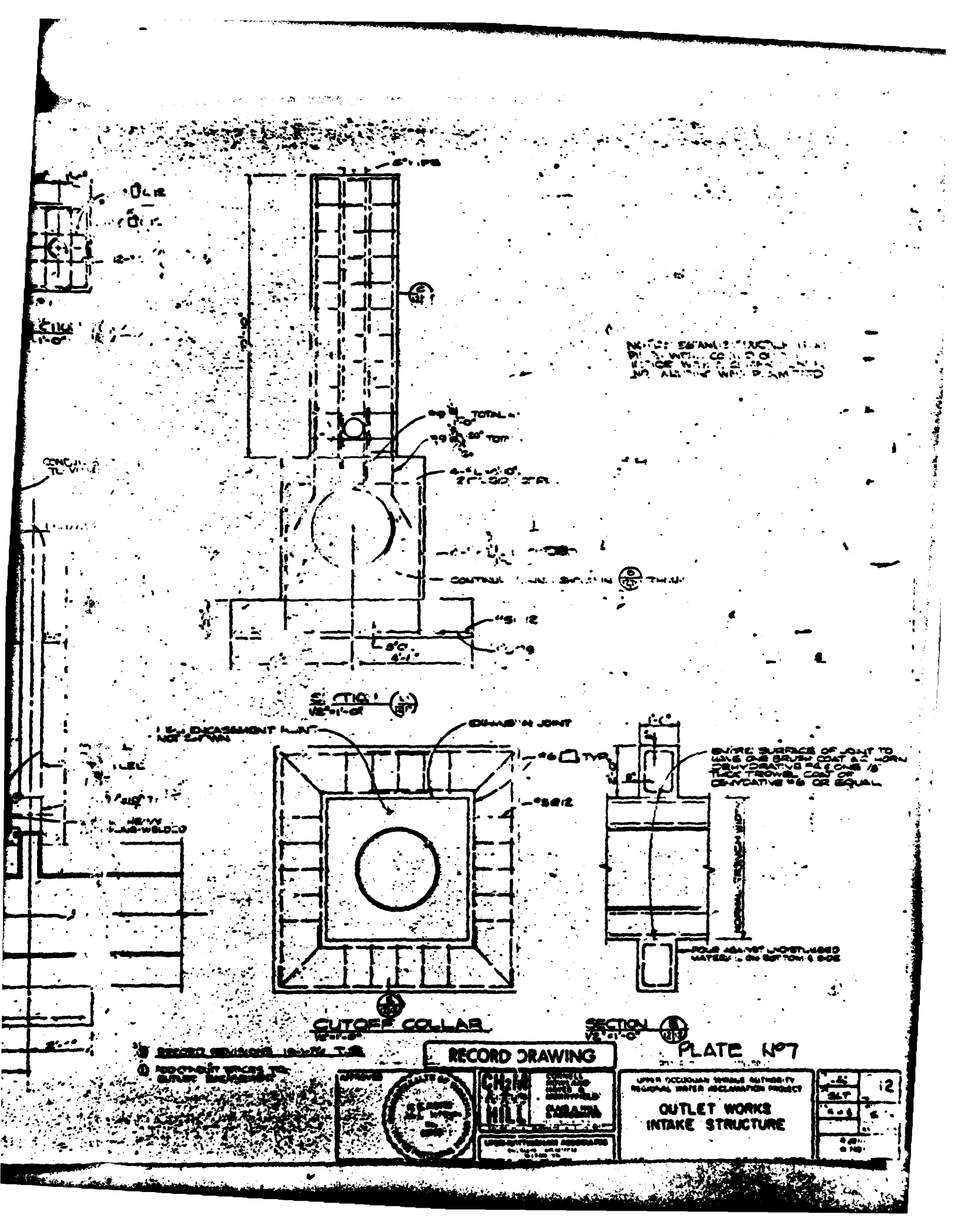
RECORD DRAWING

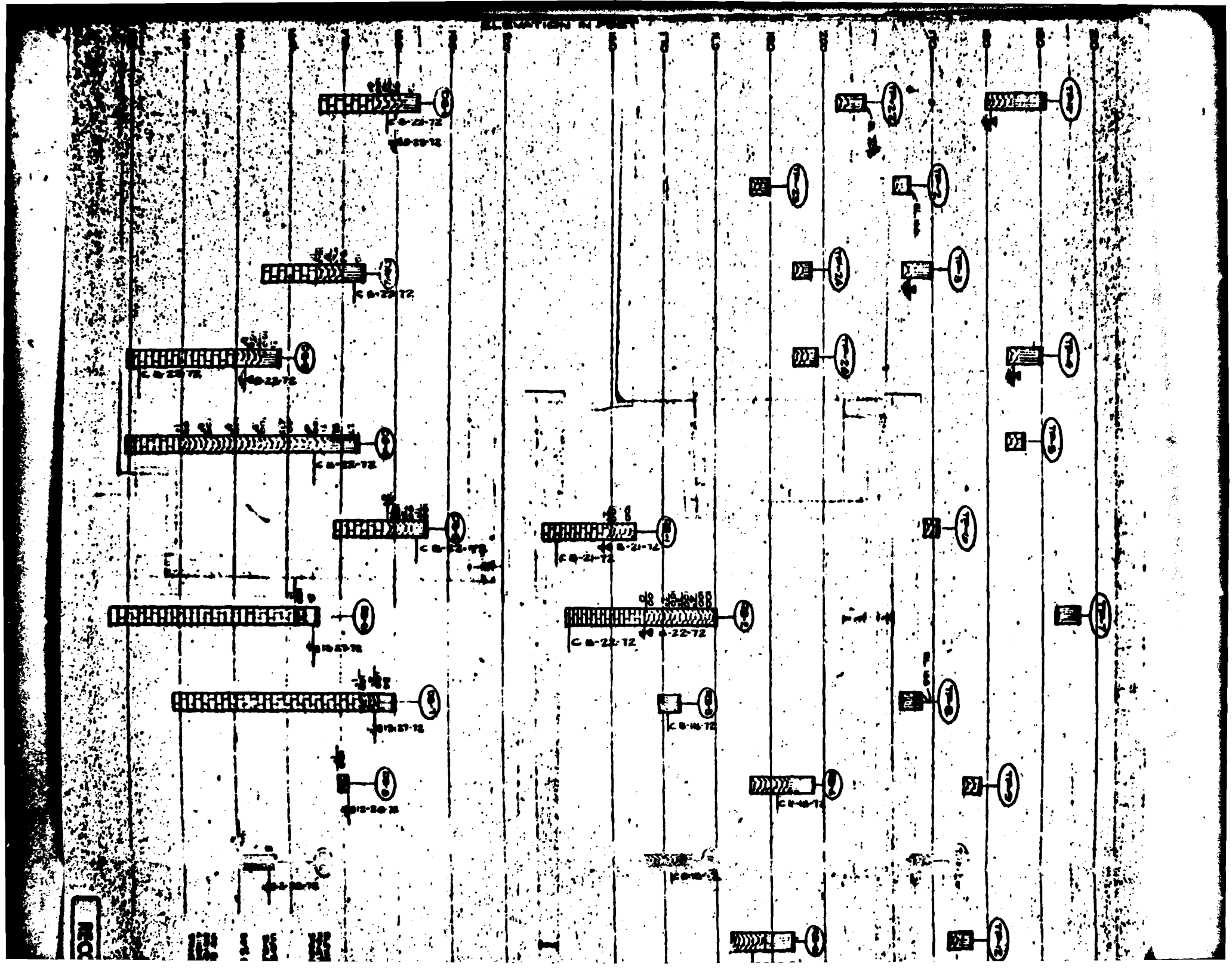
PLATE N° 6

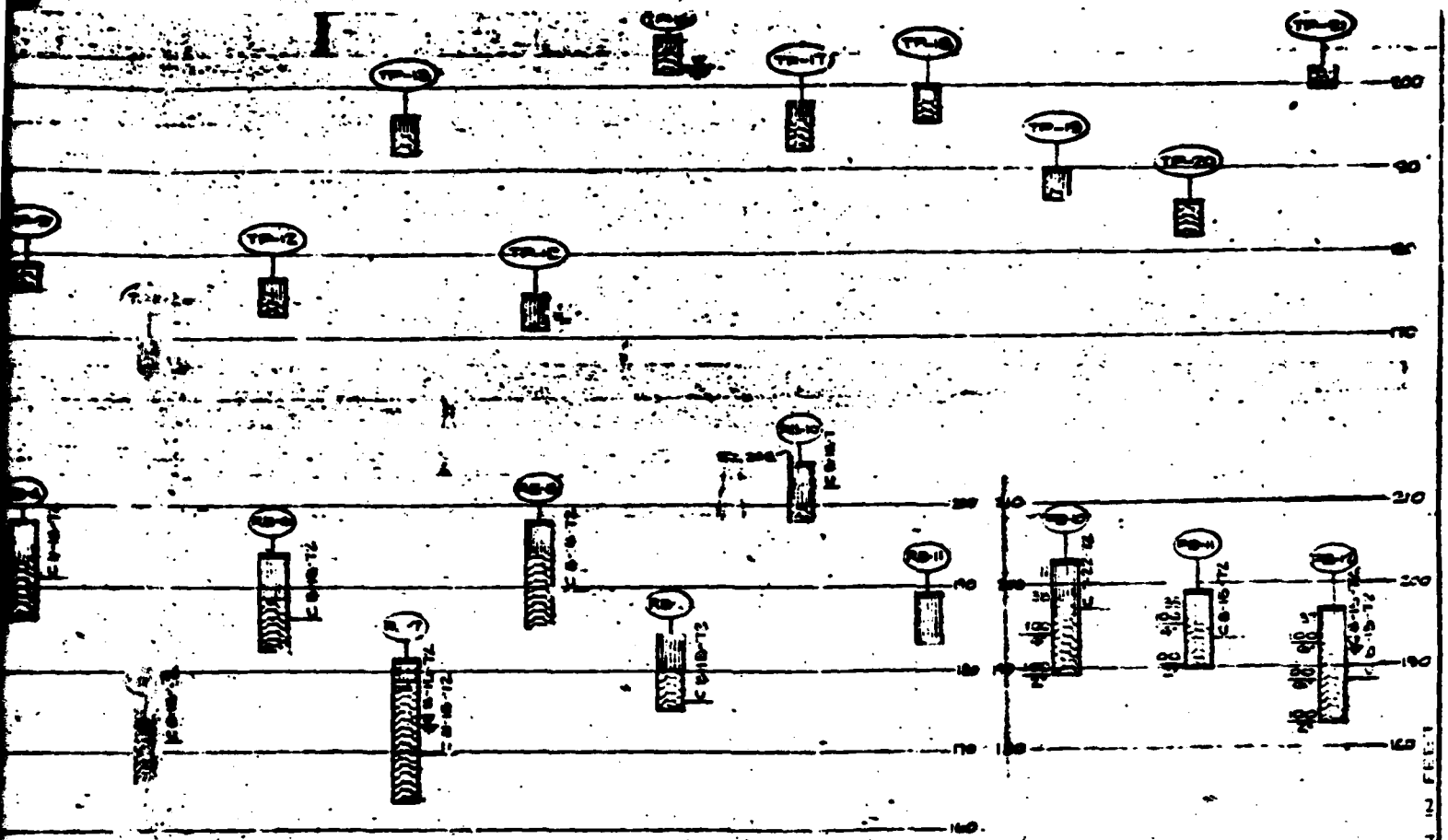
CH2M HILL

OUTLET WORKS
PLAN, PROFILE & DETAILS


NORMAL TRENCH WIDTH
IMPERVIOUS CORE BACKFILL
SEE FOR REINF.
SECTION
PLUNGER TRAVEL ON ACTUATOR
RUN HYDRAULIC CONTROL PIPES TO CONTROL VALVE
SCREEN - METAL FRAME COVERED WITH
10" GATE VALVE WITH HYDRAULIC ACTUATOR
8" GATE VALVE WITH HYDRAULIC ACTUATOR
PLUNGER TRAVEL ON ACTUATOR
SCREEN - SEE ABOVE
BLIND FLANGE
36" PIPE
TOP OF VALVE FLANGE
SECTION


EXPANSION JOINT
ENTIRE SURFACE OF JOINT TO HAVE ONE BRUSH COAT OF HORN DEHYDRATIVE #4 & ONE #8 TUCK TROWEL COAT OF DEHYDRATIVE #6 OR EQUAL
CUTOFF COLLAR
SECTION
RECORD DRAWING
PLATE NO 7
CH2M HILL
OUTLET WORKS
INTAKE STRUCTURE





BORING LOG SYMBOLS

TOPSOIL

RED BROWN CLAYEY SILT (fill)

DECOMPOSED SHALE AND SILTSTONE, RED BROWN CLAYEY SILT. DEFINED AS MATERIAL WITH A STANDARD PENETRATION BLOW COUNT GREATER THAN 50 AND LESS THAN

RED BROWN SHALE AND SILTSTONE. DEFINED AS MATERIAL WITH A STANDARD PENETRATION BLOW COUNT GREATER THAN

BORING LOG LEGEND

BLOWS/FT. OF STANDARD PENETRATION TEST (2" SPLIT SPOON SAMPLER)

UNDISTURBED SAMPLE (3" SHELBY TUBE)

CORE SAMPLE RECOVERY

SEE BORING LEGEND FOR DESCRIPTION OF SOIL SAMPLES OBTAINED IN ACCORDANCE WITH STANDARD PENETRATION TEST

MEASURED ELEVATION OF WATER LEVEL IN BORING ON THE DATE SHOWN.

MEASURED CAVE-IN DEPTH ON THE DATE SHOWN.

NOTES:

1. THESE LOGS REPRESENT ONLY THE OPINION OF THE ENGINEER AS TO THE CHARACTER OF MATERIALS ENCOUNTERED IN THE BORINGS OR TEST PITS. NO WARRANTY, EXPRESSED OR IMPLIED, IS GIVEN IN REGARD TO ANY VARIATIONS WHICH MAY OCCUR BETWEEN BORINGS OR TEST PITS.
2. TEST PITS WERE EXCAVATED USING A BACKHOE MOUNTED ON A JOHN DEERE 410 LOADER. THE CONTACT BETWEEN CLAYEY SILT, DECOMPOSED SHALE AND SILTSTONE AND SHALE AND SILTSTONE WAS BASED ON VISUAL CLASSIFICATION AND INSTABILITY OF EXCAVATION ONLY. TEST PITS WERE TERMINATED AT REFUSAL OF THE BACKHOE.
3. RESERVOIR BORINGS EXCEPT FOR #41 AND #42 WERE MADE WITH A POWER AUGER WITHOUT MAKING STANDARD PENETRATION TESTS. DISTINCTION BETWEEN CLAYEY SILT, DECOMPOSED SHALE AND SILTSTONE, AND SHALE AND SILTSTONE WAS BASED ON VISUAL CLASSIFICATION OF THE DRILL CUTTINGS AND THE INSTABILITY OF DRILLING ONLY.
4. FOR BORING LOCATIONS, SEE SHEET 3.

PLATE NO

RECORD DRAWING

CH2M HILL

UPPER OCCOQUAN SEWAGE AUTHORITY
REGIONAL WATER RECLAMATION PROJECT

SOIL BORING LOGS

15

APPENDIX II.
PHOTOGRAPHS.

Photo No. 1
DOWNSTREAM CHANNEL

Photo No. 2
DOWNSTREAM SLOPE OF DAM

Photo No. 3
SPILLWAY (LOOKING UP STREAM)

Photo No. 4
DISCHARGE CHANNEL FOR SPILLWAY

Photo No. 5
PLUNGE POOL

Photo No. 6
OUTLET CHANNEL FOR 36" OUTLET PIPE

APPENDIX III
FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam Upper Occoquan Regional Water Reclamation Plant Dam County Fairfax State Virginia Coordinates Lat 38° 48.3' Long 77° 27.4'

Date(s) Inspection May 1, 1980 Weather Sunny Temperature 70° F

Pool Elevation at Time of Inspection 182.5 msl Tailwater at Time of Inspection 154 msl

Inspection Personnel:

Schnabel Engineering Associates, P.C.
Raymond A. DeStephen, P.E.
Stephen G. Werner (recorder)

J. K. Timmons and Associates, Inc.
Robert G. Roop, P.E.
Donald Balzer (recorder)

State Water Control Board
Ed Constantine

Upper Occoquan Sewage Authority
Jane Hood

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	The slopes, crest, emergency spillway and abutment contacts were inspected and no cracks were noted. The downstream slope included a very good grass cover.	The embankment is well maintained
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movements or cracking were noted on the dam or downstream beyond the embankment toe.	-
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing or erosion was noted. The upstream slope is completely blanketed with riprap. Soils exposed in the embankment consist of clayey silt and silt (ML) to silty sand (SM) materials. The upstream and downstream slopes were measured at approximately 4H:1V.	In good condition.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The vertical and horizontal alignment of the dam appeared to be good. A gravel road occupies the crest of the dam.	The gravel road is in good condition.
RIPRAP FAILURES	Riprap (3" to 2'±) blankets the upstream slope of dam and also lines the plunge pool and outlet channel. The riprap was in good condition and appeared to be functioning properly.	-

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The junction of the embankment and abutments were vegetated. Red micaceous shale with thin sandstone interbeds are exposed along the right side of the spillway discharge channel. Measured bedrock strikes 62° NE and dips 11° NW. Jointing was noted in the rock. No faults were observed at the site. Surface soils ranged from clayey silts (ML) to silty sands (SM) and for the most part are derived from the in-place weathering of underlying bedrock.	The embankment-abutment contacts are in good condition.
ANY NOTICEABLE SEEPAGE	No seepage was encountered. Damp ground conditions were the result of earlier rainfall.	The lake level was 5.5 ft below normal pool
STAFF GAGE AND RECORDER	None observed	A staff gage should be installed.
DRAINS	Two 6-inch concrete toe drain pipes. No flow was observed from the right pipe and only a trickle of water was exiting from the left pipe. Water in the outlet channel was covered with algae.	-

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Iron pipe. All mechanical features (valves) are in good operating condition according to Mr. Wozniak.	In good condition
INTAKE STRUCTURE	Submerged; could not be observed.	-
OUTLET STRUCTURE	Concrete indicated no sign of deterioration and no erosion was observed.	Excellent condition
OUTLET CHANNEL	Riprap lined; no erosion indicated.	Good condition
EMERGENCY DRAINS	None.	-

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	Concrete indicated no signs of deterioration	Good condition
APPROACH CHANNEL	No erosion indicated.	Good condition
DISCHARGE CHANNEL	Concrete chute, no concrete deterioration	Good condition
BRIDGE AND PIERS	None	-

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slightly to moderately sloping. Ranges from well grassed and open to wooded. Pool level was drawn down on the riprap face. Valley slope is approximately 10H:1V.	-
SEDIMENTATION	None observed	Recent soundings taken by the authority indicated very little sedimentation.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Good condition, some sloughing of banks.	-
SLOPES	Five (5) ft wide and 4 ft deep channel with 2H:1V side slopes. Adjacent valley slopes are 5H:1V. Cover is lightly wooded.	-
APPROXIMATE NO. OF HOMES AND POPULATION	Two (2) commercial dwellings on Bull Run at intersection of Route 29.	A breach in the dam could potentially damage the downstream dwellings.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Four 1-inch pipes exist along the crest of the dam for monitoring horizontal and vertical control.	No recent readings have been taken.
OBSERVATION WELLS	None	-
WEIRS	None	-
PIEZOMETERS	Sixteen (16) along downstream slope. Following readings taken with M-Scope: No. 2A - 26.66' No. 2B - 14.81' No. 6A - 7.73' No. 6B - 10.00'	Consistent with previous readings.
OTHER	Water levels are measured with a survey level periodically as piezometers are read.	

APPENDIX IV
OPERATIONS SUMMARY

EFFLUENT RESERVOIR

PURPOSE AND INTENT

The reservoir is meant to serve three primary purposes:

1. It provides an aquatic ecological system to achieve the supplemental nitrogen removal demonstrated at the South Lake Tahoe effluent reservoir.

2. It acts as a detention pond for the treatment plant effluent offering the ability to greatly dilute the effects of a temporary deterioration in plant effluent quality. (A dilution factor of 1,000 for 24 minutes of plant effluent flow at 10.9 mgd.)

3. It serves as a water recreational area offering fishing, boating, swimming, and other water contact sports.

DESIGN CRITERIA

Reservoir Area	56 acres
Reservoir Storage Volume	180 million gallons (552 acre-feet)
Normal Water Surface Variation	0.50 ft
Normal Discharge (ultimate plant development)	50 cfs

Spillway Discharge:

100-year design storm	775 cfs
Design flood	3,350 cfs
Design capacity	3,500 cfs

DESCRIPTION

The treated plant effluent discharges into the effluent reservoir, overflows into Bull Run Creek, and finally flows into the Occoquan Reservoir--preserving a badly needed water resource in the Occoquan Basin.

The effluent dam and reservoir is located in northeast Virginia 25 miles west of Washington, D.C., and 15 miles south of Dulles International Airport. The contributing watershed to the dam has an area of 0.89 square miles and is, for the most part, undeveloped at this time. The elevation of the watershed rises from an elevation of 160 feet above sea level at the dam to a maximum of 340 feet. The watershed consists of rolling hills with a maximum watercourse of one mile which gives a runoff time (time of concentration) of approximately 30 to 45 minutes.

The effluent reservoir has an area of 56 acres and a storage volume of 180 million gallons (552 acre-feet). Ultimately, the plant will have a continuous discharge to the effluent reservoir of 50 cfs. The reservoir spillway is designed for a maximum discharge of 3,500 cfs. A multiple valved intake structure is provided to allow drawoff at various levels. (Refer to Figure VI-G1.) The ability to draw off water at various levels in the reservoir during the summer months when the reservoir is stratified is desirable for controlling algae buildup or other unfavorable conditions.

Table VI-G1 presents a summary of the reservoir cross sections. Figure VI-G2 shows the location of these cross sections.

EMERGENCY OPERATIONS AND FAILURE FEATURES

Prior to discharging into the effluent reservoir, the treated plant effluent passes through the effluent automatic stop gate. This gate closes when the plant effluent fails to meet the monitored discharge standards. A mechanical or electrical failure of this valve is extremely critical. (Refer to the Failure Modes and Effects Analysis, page A-33.)

If the stop gate fails to operate properly under automatic control, the "OPEN" and "CLOSE" pushbuttons may be manually operated at the gate. If these pushbuttons fail to operate the gate, the gate can be operated by turning the manual handwheel operator.

During the period when the gate fails to operate in the automatic mode, it will be necessary to manually close the gate at any time the computer signals the effluent quality is below standard. The gate will also have to be manually opened when the effluent quality again becomes acceptable.

OPERATION PROCEDURES

STARTUP

Upon completion of the effluent dam construction, a 36-inch blind flange is used to close off the open tee of the intake structure. The three valves at the intake structure are closed. To keep the 36-inch line empty when the outlet system is not in use, the 36-inch butterfly valve at the terminal

structure should be left open. The water then accumulates in the reservoir until the water surface reaches Elevation 187.5, starts to flow over the weir structure, and flows through the 24-inch spillway pipe to the stilling basin. The reservoir is now in normal operation.

ROUTINE OPERATION

The reservoir water surface will vary from a normal elevation of 188.0 to the maximum probable storm elevation of 190.6 as it discharges from 50 cfs to 3,500 cfs over the spillway.

SHUTDOWN

If it is necessary to drain the reservoir for inspection or maintenance, the 36-inch hydraulic gate valve at the intake structure is opened. The 36-inch butterfly valve in the terminal structure is then gradually opened to drain the reservoir at the desired rate. The rate of release should be slow to prevent a sudden drawdown condition from developing in the dam embankment. Generally, releases should be controlled so the drop in water surface is limited to 1 foot per day.

EMERGENCY

In the case of an emergency when the rapid draining is necessary, all the upstream gate valves and the downstream butterfly should be fully opened.

ABNORMAL OPERATION

Thermal, nutrient, or dissolved oxygen stratification in the effluent reservoir could cause undesirable algae growth or

other unfavorable conditions. Algae can be removed from the lower depths of the reservoir to prevent a long-term buildup of nutrients by drawing water out of the reservoir at one of two different levels below the surface. An 8-inch hydraulic gate valve is provided at the intake structure at Elevation 177.5 and a 10-inch hydraulic gate valve at Elevation 166.5. When drawing off water through one of these gate valves, the 36-inch butterfly valve at the terminal structure must be throttled to control the discharge rate.

OUTLET SYSTEM

Normally, the reservoir will be full with the water level controlled by the spillway crest. If it is necessary to release flow through the outlet works, the order in which the valves are opened and closed can affect the operation of the system. The following are suggested steps for the least effort and wear on the system:

1. The 36-inch pipe should be empty when the system is not being used. The downstream butterfly valve should be left open.

2. To release water, open the upstream valve or valves.

   The 36-inch gate valve could require pressures above 1,000 psi to start its motion due to the friction buildup and the differential pressure. If the 36-inch valve lines approach maximum operating pressure of 2,000 psi, check the steps outlined in the section "Hydraulic System." If operating methods are correct and valve is still difficult to open, attempts should be made to equalize the pressure on both sides of the 36-inch valve. To

equalize the pressure [illegible] butterfly valve, (b) open either the 8-inch or [illegible]-inch or both upstream gate valves, and (c) when the outlet pipe is full of water (bubbles and boils stop at the valve [illegible]), open the 36-inch gate valve. The downstream butterfly valve can then be opened to start the flow of water.

3. To stop flow of water through the pipe close the upstream valve. In case of malfunction of the upstream valves or when a quick shutoff is necessary, the downstream butterfly valve can be used to stop flow through the outlet system.

HYDRAULIC VALVE OPERATING SYSTEM

Figure VI-G3 shows a sketch of the hydraulic valve operating system. To open or close any of the upstream gate valves the following steps are suggested:

1. Check oil level in reservoir.

2. After the pump handle has been rotated into place, pull up on the lever to the right of handle to close the check valve. If the check valve is not closed, pressure cannot build up in the system.

3. Place pointer on left side of pump to either "open" or "close" position.

4. All the gate valves are marked by diameter size on the control panel. On the control panel there are two (2) hand selector valves (position each

other for each of the three gate valves. For whichever valve chosen, open both hand selector valves by turning counterclockwise both hand selector valves to the fully open position. If both sides are not opened, the fluid cannot return and the piston on the gate valve will not move in either direction. Pressure will continue to rise if both hand selector valves are not opened.

5. Start pumping using the pump handle.

   The position of the gate valves is difficult to determine. It can be approximated by counting strokes or timing the duration of the pumping and observing changes in the pressure gauge.

6. The pressure in the system rises abruptly when valve is fully opened or closed. Once the valve is opened or closed, do not continue to pump. To fully open or close the 36-inch valve, approximately 15 minutes of constant pumping is necessary. The smaller valves are opened in 5 to 6 minutes. To unseat the 36-inch valve, more than 1,000 psi (maximum allowable pressure 2,000 psi) may be necessary. Once the seal is broken, the operating pressure should be less than 1,000 psi.

After the valve is "opened" or "closed":

1. Close both hand selector valves completely by turning the valves clockwise.

2. Push the check valve lever down to release the pressure built up in the system.

It is important to periodically exercise the system by operating all the valves. At least once a year is suggested.

INSPECTION PROCEDURES

The dam embankments, strip drain system, abutments, spillway chute, retaining wall and stilling basin, spillway underdrain system, and piezometers should be checked in detail on a bimonthly basis until the reservoir level reaches normal pool elevation and piezometer levels have stabilized. During this period, settlement measurements should be taken on a monthly basis unless results indicate more frequent checks are needed.

After conditions have stabilized, inspections and piezometer measurements should be made on at least a monthly basis. Records should be kept and the data reported to and reviewed by qualified personnel.

EMBANKMENT

The crest and downstream slopes of the embankments should be inspected for visual evidence of settlement, slides, cracks, bulging, or other signs of movement or erosion. When the reservoir is drawn down, the upstream slopes should be checked also. The settlement monuments should be checked for changes in alignment and elevation monthly until the reservoir is filled and the piezometers stabilized, and annually thereafter.

Careful inspections should be made of both the upstream and downstream slopes of the main embankment and the short dam for evidence of rodent mounding, tunneling or borings.

Any activity of rodents on the embankments should be eliminated and damage corrected.

ABUTMENTS

The abutments should be inspected for any erosion and visual evidence of movement, slides, or cracks.

SPRINGS OR WET SPOTS

Examination of the embankment and abutments and downstream valley should be made for seepage or springs or unusual growth of grass and vegetation. All springs and seeps should be located and recorded on the plan of the dam and flow measurements recorded. Construct weirs to measure flow when necessary. The results should be reviewed for changes in the flow. Sample and test seepage water for soil particles (which may indicate internal erosion or piping from the dam or abutments).

PIEZOMETERS

The piezometers should be read with the electric well depth gauge provided. A rag tape with a weight could be used but will not be as dependable. The piezometers should be read any time the reservoir rises suddenly above the spillway crest and if the reservoir is emptied. Check the hole in the cap to be sure the piezometer is vented to the atmosphere. See Figure VI-G4 for a location and numbering of the piezometers.

SETTLEMENT MONUMENTS

Accurate surveying techniques should be used to monitor the settlement monuments. A check on the elevator bench mark

Any activity of rodents on the embankments should be eliminated and damage corrected.

ABUTMENTS

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Examination of the embankment and abutments and downstream valley should be made for seepage or springs or unusual growth of grass and vegetation. All springs and seeps should be located and recorded on the plan of the dam and flow measurements recorded. Construct weirs to measure flow when necessary. The results should be reviewed for changes in the flow. Sample and test seepage water for soil particles (which may indicate internal erosion or piping from the dam or abutments).

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SETTLEMENT MONUMENTS

Accurate surveying techniques should be used to monitor the settlement monuments. A check on the elevator bench mark

should be made each time to ensure that no settlement has taken place. See Figure VI-G5 for the monument locations and elevations.

STRIP DRAIN

Examination of the exit drain pipe should be made. The amount of flow should be recorded. Sample the flow and test for any soil particles (which may indicate internal erosion or piping).

SPILLWAY

The general condition of the spillway entrance slopes, weir wall chute, underdrain system and stilling basin should be made after each heavy flow. The log boom should be checked to ensure the cables are positioned properly. The water level in the underdrain manholes should be noted and signs of clogging or flooding reported. The concrete walls, slabs, and weirs should be inspected for any cracks, seepage, or movement at construction joints. Inspect the downstream channel and riprap for erosion.

OUTLET

Inspect the submerged portions of the outlet structures, the valves, and hydraulic system each time the reservoir is drained. Inspect the outlet pipe by crawling through it and the terminal structure once a year. Condition of the trash-racks and the tubing under water should be noted. Regular checks of the air vent should be made to make sure it is not plugged. When the outlet is discharging, there should be an audible sucking of air at the vent opening. Each valve should be checked individually for leakage or mal-functioning and any difficulty in opening of the valves noted.

The hydraulic control box should be checked for any vandalism. The flexible hoses should be checked for any spots showing wear or leaks. The terminal structure should be checked for any cracks, especially around the 36-inch pipe where it enters the terminal structure for evidence of seepage along the encased pipe. Any seepage inside the structure or along the outside should be noted.

RESERVOIR

When the reservoir is drawn down, examination of the plant discharge pipe should be made for any undermining or removal of the pipe base. Periodically, measurements of the reservoir silting can be made using the cross-sections shown in the appendix. Inspect the shoreline for (1) evidence of landslides, (2) erosion at creeks, (3) erosion by waves.

PHOTOGRAPHS

Each year a series of photographs should be taken. These photos should show details as well as overall views. Return to the same spot each year to take the photos.

MAINTENANCE PROCEDURES

FLOATING DEBRIS

Floating debris collected by log booms should be floated to shallow areas where it can be removed. Debris accumulating at the stilling basin exit may cause damage to the fence and flood gate and should be removed. Every attempt should be made to prevent large debris from entering the spillway where it could become lodged and prevent efficient discharge over the weirs or cause damage to spillway chute and stilling

basin. When the reservoir is lowered, any debris around the intake box should also be disposed of.

EROSION CONTROL

The construction areas stripped of plant growth have been seeded with grass to reduce erosion. It may be necessary to reseed several areas. Drainage on the crest of the dam should be checked, and periodic grading should be done to prevent water from ponding in the road. Ditching, drains, and repairs to eroded areas should be made to protect the dam and abutments. The upstream slope of the short dam is not protected with riprap. It is possible that some erosion of this surface will occur with time, and maintenance may be required. The spillway and outlet channel may require maintenance and additional riprap.

CLEARING

Brush and trees which start to grow on the downstream face of the dam and abutments should be cut. Vegetation should be removed from the channel in front of the exit drain pipe so that flow from the pipes can be observed.

SPILLWAY

Any damage to the log boom, weir walls or stilling basin caused by floating debris should be repaired. Repair erosion of the concrete with epoxy or other materials required.

RESERVOIR SILTING

Silt carried by the tributary creeks will settle in the reservoir. Filling the reservoir as previously indicated will limit the amount of silt which settles around the intake

structure. However, silt will eventually collect around the inlet, and it may be necessary to remove this material some time in the future.

OUTLET SYSTEM

Periodic maintenance should be performed by operating the system using all the valves.

SEEPAGE CONTROL

If seepage or damp spots are observed on the slope of the dam, abutments, or in the valley downstream, recommendations for maintenance should be made by a qualified person with a thorough knowledge of the dam design and construction. Examples of maintenance steps may be the construction of drains and filters and surface erosion protection. Also, if the uplift pressure measured by the piezometers is high, then methods such as additional foundation drain wells may be required.

GRASS MOWING

Complete mowing of the site should be scheduled bi-weekly during the growing seasons. At all times the vegetation should be mowed before its height exceeds 12 inches and before weeds go to seed. The grass should not be cut to a height less than 6 inches.

Any unusual growth patterns or color changes in the grass should be reported. For proper applications of fertilizers or other chemicals the local agricultural extension agent or Soils Conservation Service agent should be consulted.

VALVING SUMMARY

Mode of Operation	Valving
Normal operation	1. All intake structure valves are closed. 2. The 36-inch butterfly valve at the terminal structure is open.
Drawing off water at depths of 10.5 or 21.5 feet	1. Open the appropriate 8- or 10-inch drawoff valve at the intake structure. 2. The 36-inch butterfly valve at the terminal structure should be open.
Draining the reservoir	1. Open the 36-inch gate valve at the intake structure. 2. Control the flow with the 36-inch butterfly valve at the terminal structure.

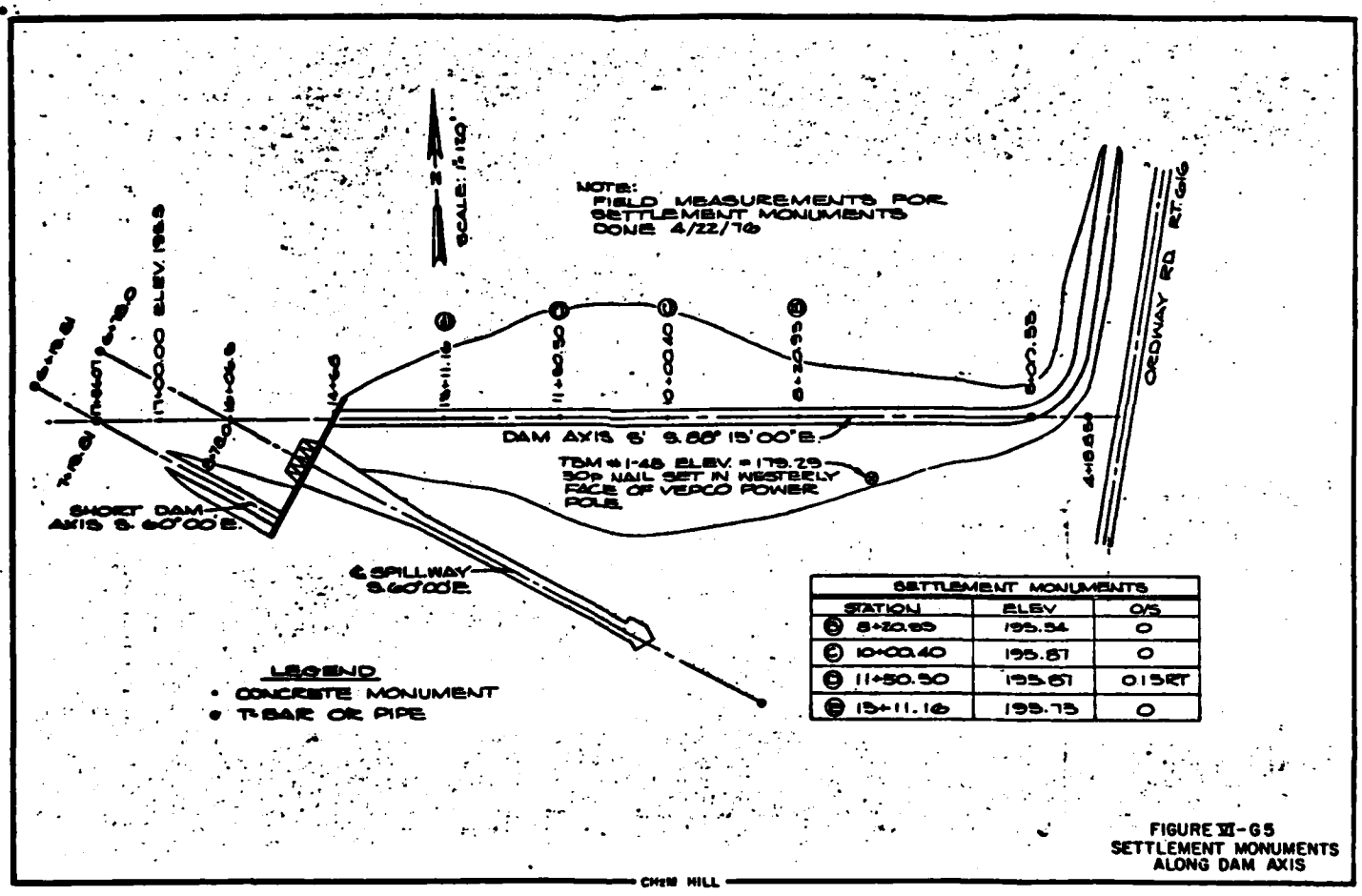


FIGURE XII-G5
SETTLEMENT MONUMENTS
ALONG DAM AXIS

APPENDIX V
PIEZOMETER READINGS

READINGS FOR PIEZOMETER No. 1

SHEET NO. ___ OF ___

PROJECT NO. WB128.3

PIEZ. 1 A

ELEV. OF TOP OF PIPE = 185.95

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. (Bottom 26.75 / 159.23)	
6-23-77	26.57	159.41	+0.01
7-9-77	26.52	159.46	+0.05
7-22-77	26.47	159.51	+0.05
8-8-77	26.48	159.50	-0.01
8-19-77	26.45	159.53	+0.03
9-2-77	26.45	159.53	—
9-15-77	26.45	159.53	—
10-4-77	26.45	159.53	—
10-25-77	26.50	159.48	-0.05
11-9-77	26.47	159.51	+0.03
12-16-77	26.52	159.46	-0.05
1-27-78	26.50	159.46	—
2-24-78	26.48	159.48	+0.04
3-29-78	26.42	159.56	-0.32
4/28/78	26.47	159.51	-0.05
5/30/78	26.51	159.47	-0.04
6/16/78	26.62	159.36	-0.11
11/18/78	26.56	159.42	+0.06
5/19/79	26.60	159.38	-0.04
10/13/79	26.57	159.41	+0.03
2/11/80	26.64	159.39	-0.07

PIEZ. 1 B

ELEV. OF TOP OF PIPE = 175.45

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF.
6-23-77	16.06	169.92
7-9-77	Dry	—
7-22-77	16.05	169.93
8-8-77	16.06	169.92
8-19-77	16.06	169.92
9-2-77	16.06	169.92
9-15-77	16.06	169.92
10-4-77	16.05	169.93
10-25-77	16.05	169.93
11-9-77	16.03	169.95
12-16-77	16.1	169.88
1-27-78	16.08	169.90
2-24-78	16.05	169.93
3-29-78	15.98	170.00
4/28/78	16.04	169.94
5/30/78	16.05	169.93
6/16/78	16.09	169.89
11/18/78	16.04	169.91
5/19/79	16.10	169.88
10/13/80	16.08	169.90
2/11/80	16.04	169.94

CHAMBERS

READINGS FOR PIEZOMETER No. 2

SHEET NO. 2 OF

PROJECT NO. W-0128.3

3/5

PIEZ. 2A

ELEV. OF TOP OF PIPE = [illegible]

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF.	
6-23-77	26.60	158.61	—
7-9-77	26.60	158.61	—
7-22-77	26.59	158.62	+0.01
8-8-77	26.60	158.61	-0.01
8-19-77	26.62	158.59	-0.02
9-2-77	26.62	158.59	—
9-15-77	26.62	158.59	—
10-4-77	26.64	158.57	-0.02
10-25-77	26.65	158.56	-0.01
11-9-77	26.65	158.56	—
12-14-77	26.66	158.55	-0.01
1-27-78	26.61	158.60	+0.05
2-[illegible]-78	26.63	158.58	-0.02
3/29/78	26.61	158.60	+0.02
4/28/78	26.67	158.54	-0.06
5/30/78	26.62	158.59	+0.05
6/16/78	26.62	158.59	—
11/18/78	26.63	158.58	-0.01
5/19/79	26.67	158.54	-0.04
10/13/79	26.61	158.60	+0.06
2/11/80	26.66	158.55	-0.05

PIEZ. 2B

ELEV. OF TOP OF PIPE = 185.21

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF.
6-23-77	14.79	170.42
7-9-77	14.80	170.41
7-22-77	14.79	170.42
8-8-77	14.78	170.43
8-19-77	14.80	170.41
9-2-77	14.79	170.42
9-15-77	14.79	170.42
10-4-77	14.79	170.42
10-25-77	14.79	170.42
11-9-77	14.79	170.42
12-14-77	14.81	170.40
1-27-78	14.80	170.41
2-29-78	14.79	170.42
3/29/78	14.82	170.39
4/28/78	14.77	170.44
5/30/78	14.77	170.44
6/16/78	14.95	170.26
11/18/78	14.86	170.35
5/19/79	14.92	170.29
10/13/79	14.83	170.38
2/11/80	14.78	170.43

CH2M HILL

READINGS FOR PIEZOMETER No. 3

SHEET NO. ___ OF ___

PROJECT NO. W0128.3

GLG

PIEZ. 3 A

ELEV. OF TOP OF PIPE = 165.93

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. (ELEV. OF BOTTOM 149.83)	
6-23-77	6.55	159.38	-0.82
7-9-77	6.83	159.10	-0.28
7-22-77	6.58	159.35	+0.25
8-8-77	6.61	159.32	-0.03
8-19-77	6.75	159.18	-0.14
9-2-77	6.68	159.25	+0.07
9-15-77	6.97	158.96	-0.29
10-4-77	7.03	158.90	-0.06
10-25-77	6.97	158.96	+0.06
11-9-77	6.33	159.60	+0.36
12-16-77	6.18	159.75	+0.15
1-27-78	3.75	162.18	+2.43
2-24-78	5.81	160.12	-2.06
3-29-78	5.30	160.63	+0.53
4/28/78	5.68	160.25	-0.35
5/30/78	5.84	160.09	-0.16
6/16/78	6.34	159.59	-0.50
11/15/78	6.27	159.66	+0.07
5/19/79	6.18	159.75	+0.11
10/13/79	6.30	159.63	-0.12
2/11/80	6.11	159.82	+0.19

PIEZ. 3 B

ELEV. OF TOP OF PIPE = 166.00

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. (ELEV. OF BOTTOM 154.5)
6-23-77	4.67	161.26
7-9-77	4.93	161.00
7-22-77	4.95	160.98
8-8-77	5.17	160.76
8-19-77	5.40	160.53
9-2-77	5.55	160.38
9-15-77	5.82	160.11
10-4-77	5.97	159.96
10-25-77	6.03	159.90
11-9-77	5.73	160.20
12-16-77	5.45	160.48
1-27-78	5.39	160.54
2-24-78	4.02	161.91
3-29-78	2.90	163.03
4/28/78	3.35	162.58
5/30/78	4.49	161.46
6/16/78	4.31	161.62
11/15/78	4.45	161.48
5/19/79	4.11	161.82
10/13/79	3.95	161.98
2/11/80	3.64	162.29

CH2M HILL

READINGS FOR PIEZOMETER No. 4

SHEET NO. __ OF __

PROJECT NO. W B128.3 NI ③ Ⓐ

PIEZ. 4 A
ELEV. OF TOP OF PIPE = 166.88

PIEZ. 4 B
ELEV. OF TOP OF PIPE = 166.88

DATE	DEPTH TO WATER SURF.	ELEV. OF 29.65 BOTTOM WATER SURF. 137.23		DATE	DEPTH TO WATER SURF.	ELEV. OF 14.93 WATER SURF.
4-15-77	8.90	157.98	+0.10	4-15-77	0.67	166.21
4-29-77	8.90	157.98	—	4-29-77	0.73	166.15
5-13-77	8.95	157.93	-0.05	5-13-77	0.76	166.12
6-6-77	9.10	157.78	-0.15	6-6-77	0.84	166.04
6-23-77	9.50	157.38	-0.40	*6-6-77 Siphoned down to	= 2.67	164.21
7-9-77	9.75	157.13	-0.25	6-23-77	2.48	164.40
7-22-77	9.50	157.38	+0.25	7-9-77	2.42	164.46
8-8-77	9.56	157.32	-0.06	7-22-77	2.38	164.50
8-19-77	9.52	157.36	+0.04	8-8-77	2.44	164.44
9-2-77	9.50	157.38	+0.02	8-19-77	2.46	164.42
9-9-77	9.47	157.41	+0.03	9-2-77	2.46	164.42
9-15-77	9.50	157.38	-0.03	*9-2-77 Siphoned to =	10.70	156.18
10-4-77	9.58	157.30	-0.08	9-9-77	10.57	156.31
10-25-77	9.62	157.26	-0.04	9-15-77	10.57	156.31
11-9-77	9.18	157.70	+0.44	10-4-77	10.57	156.31
12-16-77	9.00	157.88	+0.18	10-25-77	10.56	156.32
1-27-78	8.48	158.40	+0.52	11-9-77	10.55	156.33
2-24-78	8.98	157.90	-0.50	12-16-77	10.59	156.29
3-29-78	8.49	158.39	+0.49	1-27-78	10.62	156.26
4/28/78	8.76	158.12	-0.27	2-24-78	10.56	156.32
5/30/78	8.73	158.15	+0.03	3-29-78	10.54	156.34
6/16/78	8.93	157.95	-0.20	4/28/78	10.57	156.31
11/16/78	8.85	158.03	+0.08	5/30/78	10.57	156.31
5/19/79	8.78	158.10	+0.07	6/16/78	10.53	156.35
10/12/79	8.70	158.18	+0.08	11/18/78	10.63	156.25
2/11/80	8.60	158.28	+0.10	5/19/79	10.46	156.42
				10/13/79	10.36	156.52
				2/11/81	10.25	156.63

CHAN

READINGS FOR PIEZOMETER No. 5

SHEET NO. 2 OF

PROJECT NO. W 8128.3

(A) (B) N

PIEZ. 5 A

ELEV. OF TOP OF PIPE = 167.58

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. 148.88	
11-23-77	10.65	156.93	-0.15
7-9-77	10.80	156.78	-0.15
7-22-77	10.58	157.00	+0.22
8-8-77	10.47	157.11	+0.11
8-19-77	10.50	157.08	-0.03
9-2-77	10.43	157.15	+0.07
9-15-77	10.63	156.95	-0.20
10-4-77	10.57	157.01	+0.06
10-25-77	10.50	157.08	+0.07
11-9-77	10.23	157.35	+0.27
12-1-77	10.30	157.28	-0.07
1-27-78	10.14	157.44	+0.16
2-29-78	10.35	157.23	-0.21
3-29-78	9.33	158.25	+1.02
4/28/78	10.37	157.21	-1.04
5/30/78	10.43	157.15	-0.06
6/16/78	10.64	156.94	-0.21
11/18/78	10.41	157.12	+0.18
5/19/79	10.55	157.03	-0.09
10/13/79	10.38	157.20	+0.17
2/11/80	10.24	157.34	+0.14

PIEZ. 5 B

ELEV. OF TOP OF PIPE = 167.58

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF.
11-23-77	11.09	156.49
7-9-77	11.10	156.48
7-22-77	11.10	156.48
8-8-77	11.10	156.48
8-19-77	11.11	156.47
9-2-77	10.57	157.01
9-15-77	10.45	157.13
10-4-77	10.50	157.08
10-25-77	10.50	157.08
11-9-77	9.78	157.80
12-1-77	10.51	157.07
1-27-78	9.15	158.43
2-29-78	10.43	157.15
3-29-78	10.41	157.17
4/28/78	10.45	157.13
5/30/78	9.51	158.07
6/16/78	9.70	157.88
11/18/78	9.63	157.95
5/19/79	9.36	158.22
10/13/79	9.47	158.11
2/11/80	9.28	158.30

V-5

CHAM | READINGS FOR PIEZOMETER No. 6 | SHEET NO. 9 OF | PROJECT NO W.0128.3

PIEZ. 6 A
ELEV. OF TOP OF PIPE = 165.32

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. (23.2 bottom 142.12)	
6-23-77	10.92	157.40	-0.26
7-9-77	11.06	157.26	-0.14
7-22-77	10.81	157.51	+0.25
8-8-77	10.77	157.55	+0.04
8-19-77	10.78	157.54	-0.01
9-2-77	10.70	157.62	+0.08
9-15-77	10.87	157.45	-0.17
10-4-77	10.86	157.46	+0.01
10-25-77	10.80	157.52	+0.06
11-9-77	10.30	158.02	+0.50
12-16-77	10.35	157.97	-0.05
1-27-78	9.95	158.37	+0.04
2-24-78	10.49	157.83	-0.54
3-29-78	6.67	161.65	+3.82
4/28/78	10.26	157.96	-3.69
5/30/78	10.09	158.03	+0.07
6/16/78	10.47	157.85	-0.18
11/18/78	10.72	157.60	-0.25
5/19/79	10.35	157.97	+0.37
10/13/79	10.21	158.11	+0.14
2/11/80	10.10	158.22	+0.11

PIEZ. 6 B
ELEV. OF TOP OF PIPE = 165.32

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. (13.7 bottom 151.62)
6-23-77	11.24	157.08
7-9-77	11.09	157.23
7-22-77	10.98	157.34
8-8-77	10.90	157.42
8-19-77	10.79	157.53
9-2-77	10.69	157.63
9-15-77	10.60	157.72
10-4-77	10.50	157.82
10-25-77	10.45	157.87
11-9-77	10.34	157.98
12-16-77	8.10	160.72
1-27-78	6.95	161.37
2-24-78	6.10	160.22
3-29-78	10.00	158.32
4/28/78	6.83	161.49
5/30/78	6.50	161.82
6/16/78	7.92	160.40
11/18/78	7.87	160.45
5/19/79	7.99	160.33
10/13/79	7.77	160.55
2/11/80	7.63	160.69

CHAIN | READINGS FOR PIEZOMETER No. 6 | SHEET NO. 2 OF | PROJECT NO W8128.3

(E, D)

PIEZ. 6A
ELEV. OF TOP OF PIPE = 165.32

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. (23.2 bottom 142.12)	
6-23-77	10.92	157.40	-0.28
7-9-77	11.06	157.26	-0.14
7-22-77	10.81	157.51	+0.25
8-8-77	10.77	157.55	+0.04
8-19-77	10.78	157.54	-0.01
9-2-77	10.70	157.62	+0.08
9-15-77	10.87	157.45	-0.17
10-4-77	10.86	157.46	+0.01
10-25-77	10.80	157.52	+0.06
11-9-77	10.30	158.02	+0.50
12-16-77	10.35	157.97	-0.05
1-27-78	9.95	158.37	+0.04
2-24-78	10.49	157.83	-0.54
3-29-78	6.67	161.65	+3.82
4/28/78	10.36	157.96	-3.69
5/30/78	10.09	158.03	+0.07
6/16/78	10.47	157.85	-0.18
11/18/78	10.72	157.60	-0.25
5/19/79	10.35	157.97	+0.37
10/13/79	10.21	158.11	+0.14
2/11/80	10.10	158.22	+0.11

PIEZ. 6B
ELEV. OF TOP OF PIPE = 165.32

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. (13.7 bottom 151.62)
6-23-77	11.24	157.08
7-9-77	11.09	157.23
7-22-77	10.98	157.34
8-8-77	10.90	157.42
8-19-77	10.79	157.53
9-2-77	10.69	157.63
9-15-77	10.60	157.72
10-4-77	10.50	157.82
10-25-77	10.45	157.87
11-9-77	10.34	157.98
12-16-77	8.10	160.72
1-27-78	6.95	161.37
2-24-78	6.10	162.32
3-29-78	10.00	158.32
4/28/78	6.83	161.49
5/30/78	6.50	161.82
6/16/78	7.92	160.40
11/18/78	7.87	160.45
5/19/79	7.99	160.33
10/13/79	7.77	160.55
2/11/80	7.63	160.69

CHANNEL

READINGS FOR PIEZOMETER No. 7

SHEET NO. 2 OF

PROJECT NO W0128.3

E 16

N

PIEZ. 7 A

ELEV. OF TOP OF PIPE = 178.28

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. 27.95 150.33	
6-23-77	17.15	161.13	-0.65
7-9-77	17.34	160.94	-0.19
7-22-77	17.12	161.16	+0.22
8-8-77	17.22	161.06	-0.10
8-19-77	17.30	160.98	-0.08
9-2-77	17.30	160.98	—
9-15-77	17.48	160.80	-0.18
10-4-77	17.55	160.73	-0.07
10-25-77	17.64	160.64	-0.09
11-9-77	17.12	161.16	-0.52
[illegible]	17.04	161.24	+0.08
[illegible]	17.22	161.05	-0.18
[illegible]	16.64	161.64	+0.58
3-29-78	16.33	161.95	+0.31
4/25/78	16.48	161.80	-0.05
[illegible]	16.72	161.56	-0.24
6/16/78	17.24	161.04	-0.52
11/14/78	17.10	161.18	+0.14
5/19/79	17.25	161.03	-0.13
10/13/79	17.05	161.23	+0.20
2/11/80	16.87	161.41	+0.18

PIEZ. 7 B

ELEV. OF TOP OF PIPE = 175.22

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. [illegible]
6-23-77	17.08	161.20
7-9-77	17.19	161.09
7-22-77	17.22	161.06
8-8-77	17.27	161.01
8-19-77	17.31	160.97
9-2-77	17.34	160.94
9-15-77	17.45	160.83
10-4-77	17.36	160.92
10-25-77	17.51	160.71
11-9-77	17.22	161.01
[illegible]	17.24	161.04
[illegible]	16.95	161.33
3-29-78	17.13	161.15
4/25/78	17.23	161.05
5/30/78	16.91	161.37
6/16/78	17.24	161.04
11/14/78	17.43	160.85
5/19/79	17.37	160.91
10/13/79	17.29	160.99
2/11/80	17.17	161.11
	16.85	161.43

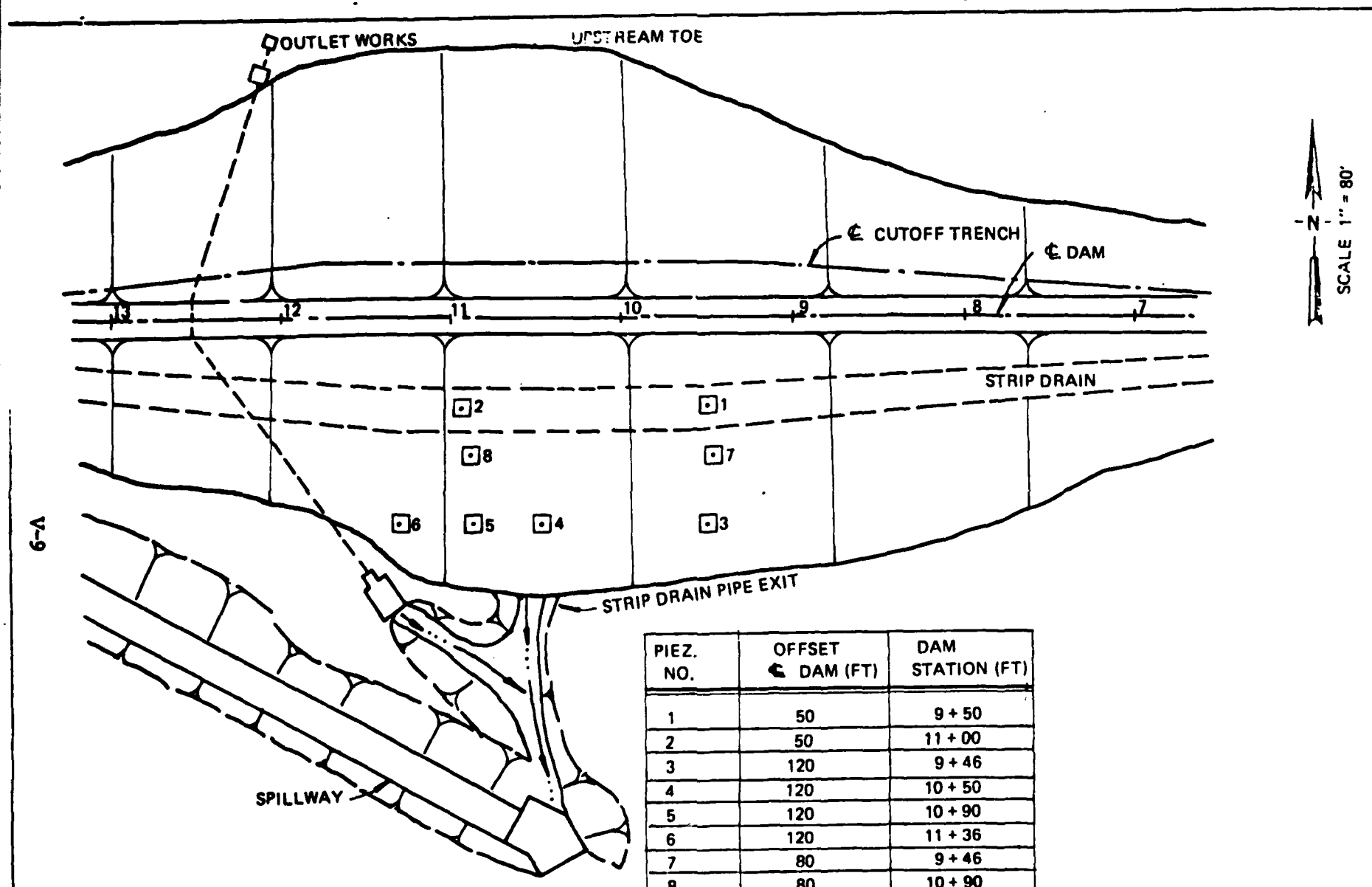
CH2M HILL

READINGS FOR PIEZOMETER No. 8 — SHEET NO. 2 OF ___ — PROJECT NO. W 8128.3

PIEZ. 5 A — ELEV. OF TOP OF PIPE = 175.50

PIEZ. 5 B — ELEV. OF TOP OF PIPE = 175.5[illegible]

DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF. (34.6 Elev. 143.9)		DATE	DEPTH TO WATER SURF.	ELEV. OF WATER SURF.
6-23-77	20.37	158.13	-0.37	6-23-77	dry	—
7-9-77	20.47	158.03	-0.10	7-9-77	dry	—
7-22-77	20.25	158.25	+0.22	7-22-77	dry	—
8-8-77	20.16	158.34	+0.09	8-8-77	dry	—
8-19-77	20.20	158.30	-0.04	8-19-77	dry	—
9-2-77	20.10	158.40	+0.10	9-2-77	dry	—
9-15-77	20.23	158.27	-0.13	9-15-77	dry	—
10-4-77	20.18	158.32	+0.05	10-4-77	dry	—
10-25-77	20.18	158.32	—	10-25-77	dry	—
11-9-77	19.88	158.63	+0.30	11-9-77	dry	—
12-1[illegible]-77	19.78	158.72	+0.09	12-16-77	dry	—
1-27-78	19.35	159.15	+0.43	1-27-78	dry	—
[illegible]-24-78	19.73	158.77	-0.38	[illegible]-24-78	dry	—
[illegible]-29-78	19.45	159.05	+0.28	[illegible]-29-78	dry	—
[illegible]/28/78	19.67	158.83	-0.22	4/27/78	dry	—
[illegible]/30/78	19.[illegible]3	158.87	+0.05	5/30/78	dry	—
[illegible]/16/78	19.80	158.70	-0.17	6/16/78	dry	—
[illegible]/18/79	19.76	158.74	+0.04	11/18/78	dry	—
5/19/79	19.51	158.99	+0.25	5/19/79	dry	—
10/13/79	19.44	159.02	+0.03	10/13/79	dry	—
2/11/80	19.23	159.27	+0.25	2/11/80	dry	—



PIEZ. NO.	OFFSET ℄ DAM (FT)	DAM STATION (FT)
1	50	9 + 50
2	50	11 + 00
3	120	9 + 46
4	120	10 + 50
5	120	10 + 90
6	120	11 + 36
7	80	9 + 46
8	80	10 + 90

FIGURE VI-G4
PIEZOMETER LOCATION

APPENDIX VI - REFERENCES

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3. Geologic Map of Virginia, Virginia Division of Mineral Resources, 1963
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5. Section 4, Hydrology, Part 1, Watershed Planning, SCS National Engineering Handbook, Soil Conservation Service, U. S. Department of Agriculture, 1964.
6. Hydrometerological Report No. 33, U. S. Department of Commerce, Weather Bureau, U. S. Department of Army, Corps of Engineers, Washington, D. C., April 1956.