AD-A155 496 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS PAYSON PARK RESERVOIR (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV DEC 79 1/1

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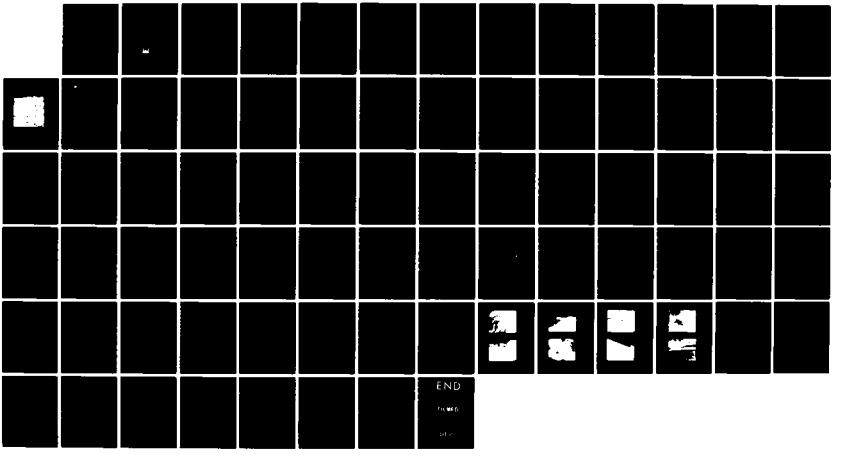

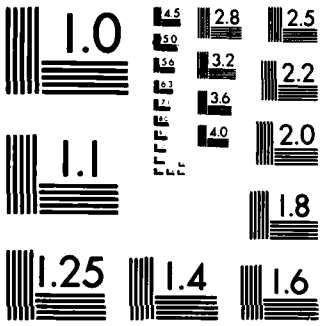

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BELMONT, MASSACHUSETTS

PAYSON PARK RESERVOIR
MA 00770

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER 1979

UNCLASSIFIED

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Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

DAMS, INSPECTION, DAM SAFETY,

Charles River Baisn
Belmont, Massachusetts
None- surface drainage to Mystic River

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

It is about 900 ft. long by 700 ft. wide and is separated into a north and south basin by a granite masonry division wall. There is a need for maintenance and monitoring to assure the continued performance of the reservoir and embankment. It is small in size with a high hazard' potential. It is recommended that the owner employ a qualified engineer to conduct a seismic stability analysis of the embankment.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF
NEDED

MAY 13 1980

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Payson Park Reservoir Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, City of Cambridge.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

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PAYSON PARK RESERVOIR

MA 00770

MYSTIC RIVER BASIN
BELMONT, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00770

Name of Dam: Payson Park Reservoir

Town: Belmont

County and State: Middlesex County, Massachusetts

Stream: None - surface drainage to Mystic River

Date of Inspection: September 27, 1979

Payson Park Reservoir provides storage and pressure for the City of Cambridge Water Supply System. Built in 1897, the off-stream reservoir is 900 feet long by 700 feet wide and is separated into a north and south basin by a granite masonry division wall. The earth embankment that surrounds the reservoir is about 2,225 feet long with a maximum height of 30 feet. The top of the embankment varies from El (elevation) 183.5 to 183.8. The interior slopes and bottom of the reservoir are lined with stone masonry and concrete, respectively, and surfaced with gunite.

Controls for the conduits discharging into and out of the reservoir are located in a gatehouse on the east side of the reservoir. These conduits consist of 40-inch diameter pipes which branch into two inflow and two outflow conduits all 40-inch diameter; one pair for each basin. Water is pumped into the reservoir from the Fresh Pond Filtration Plant in Cambridge and then allowed to discharge on demand. The operational high water level is at El 178.5, corresponding to a maximum storage capacity of 43 million gallons.

There are two high-level overflows and two low-level drains which connect to a 20-inch outlet conduit. The high-level outlets are 16-inch standpipes which overflow at El 180.4.

PAYSON PARK RESERVOIR

The low-level outlets are 12-inch drains with inverts at El 151.7 and El 151.8 in the north and south basins, respectively. The 20-inch outlet drain leads back to the Fresh Pond Filtration Plant.

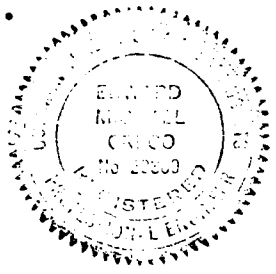
There is a need for maintenance and monitoring to assure the continued performance of the reservoir and embankment. This conclusion is based upon the visual inspection at the site, the available engineering data and past performance history.

The reservoir and embankment are generally in fair condition. The following deficiencies were observed at the site: cracking and leaking of the gunite lining in the north basin, severe rusting of the inflow and outflow conduits, erosion of exterior slopes along the south end of reservoir, growth of brush and saplings on the slope at the southwest corner of the reservoir, trees growing along the toe of the embankment, and several repairs needed in the gate house. A significant amount of seepage is also passing through the underdrain system. Some movement of the brick masonry in the manhole to the weir chamber east of the gatehouse was also detected.

Based on the Corps of Engineers' guidelines, the reservoir has been placed in the "small" size and "high" hazard category. The drainage area is 8.04 acres (0.013 square miles) and consists generally of the surface area of the reservoir. A test flood inflow (one-half the probable maximum flood (PMF) of 9.51 inches of rainfall during a six-hour period results in the reservoir pool at El 181.1, which is 2.4 feet below the lowest elevation on the top of the embankment. Therefore, the reservoir can contain 100 percent of the test flood without overtopping the embankment.

It is recommended that the Owner employ a qualified registered engineer to conduct a seismic stability analysis of the embankment, evaluate the need for removing the trees along the toe, and design an impermeable lining. The Owner should also repair the deficiencies listed above, as described in Section 7.3. The Owner should implement programs for annual technical inspections, surveillance of the embankment during periods of heavy rainfall, and a warning system for nearby residents.

The measures outlined above and in Section 7 should be implemented by the Owner within a period of one year after the receipt of this Phase I Inspection Report.



Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.
Massachusetts Registration
No. 29800

Stephen L. Bishop, P.E.
Vice President
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 19703

This Phase I Inspection Report on Payson Park Reservoir has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. 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 investigations, 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 continued care and inspection can there be any chance that unsafe conditions will be detected.

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 aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

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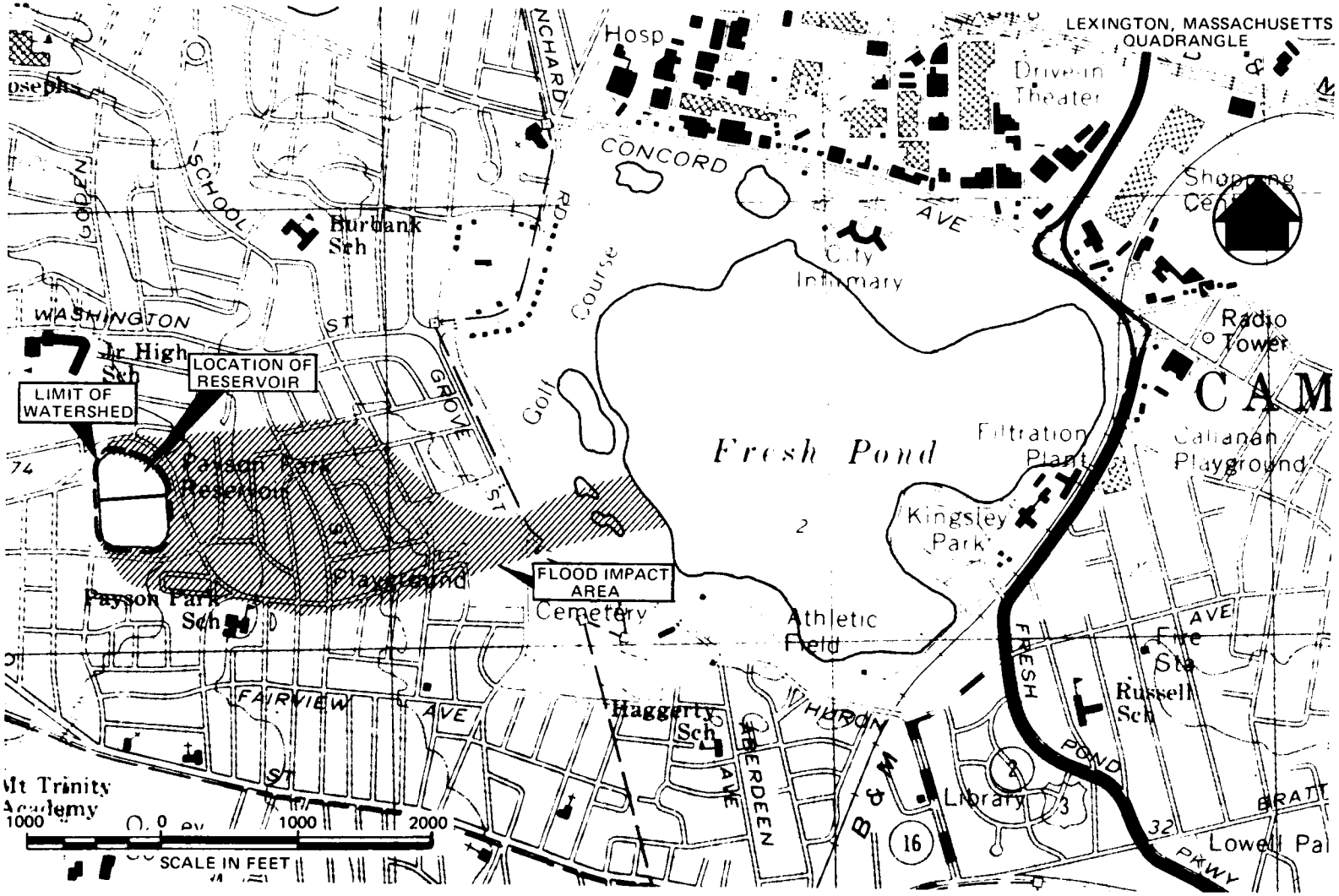
PAYSON PARK RESERVOIR
BELMONT, MASSACHUSETTS



LOCATION MAP – PAYSON PARK RESERVOIR

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

PAYSON PARK RESERVOIR

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, dated August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Divison of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-79-C-0054, dated March 27, 1979, has been assigned by the Corps of Engineers for this work.

b. Purpose:

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The reservoir is surrounded by Payson Road, Park Avenue, and Cushing Avenue and located in the Town of Belmont, Middlesex County, Massachusetts (see Location Map). The coordinates of the gatehouse at the reservoir are latitude 42 deg. 28 min. north and longitude 71 deg. 10.1 min. west.

b. Description of Dam and Appurtenances. Payson Park Reservoir is built above grade and surrounded by an earth embankment 2,225 feet long (see Figure B-1). The maximum height of the embankment is 30 feet at the southeast corner. The top of the embankment is 20 feet wide and varies from El 183.5 to 183.8. A gravel road and wrought iron fence are located on the top of the embankment. The interior slopes are 1.75:1 (horizontal:vertical), and the exterior slopes are 2:1. The bottom of the reservoir is flat and at about El 158.3. A gunite covering is on the interior slopes and bottom of the reservoir. The upper edge of the gunite varies from El 181.9 to 183.3, and the maximum operating level of the reservoir is at El 178.5. An interior wall separates the reservoir into two basins. The exterior slopes are covered with grass, and trees are located along the outside toe of the embankment.

Based on an 1897 plan of Payson Park Reservoir made for Cambridge Water Works, a typical embankment cross section is shown on Figure B-2. Borrow for the embankment is labeled "rolled earth filling". The interior slopes are paved with stone masonry underlain by stone ballast and stone dust. The bottom quarter of this slope is lined with brick paving on a concrete slab. A portland cement plastered, rubble masonry core wall is located within the embankment. The core wall is founded on a footing of the same composition and embedded in the natural soils of the hill. A concrete slab, 6 inches thick, founded on natural soil connects the core walls to the slab on the interior slope.

The bottom of the reservoir is a 6-inch concrete slab founded on natural ground. A 1/2-inch layer of asphalt was placed on top of it. A shallow, concrete footing located beneath the toe of the interior slope supports the concrete slabs for both the bottom and the interior slopes. The bottom slab ties into a 13-foot wide concrete footing at the center division wall. This large footing appears, according to the plan, to be founded on bedrock.

Payson Park Reservoir provides temporary storage and pressure for the City of Cambridge water supply system. Controls for the conduits discharging into and out of the reservoir are located in the gatehouse on the east side of the reservoir (see Figure B-3). Two 40-inch diameter inflow and outflow water supply pipelines enter the gate house. These branch into two inflow and two outflow conduits all 40-inch diameter; one pair for each basin. The inflow pipes lead from the gatehouse, through the embankment and diagonally across the bottom slab of the reservoir to the northwest and southwest corners (see Figures B-1 and B-3). The screened outflow conduits lead from a sump in the floor of the reservoir to the gatehouse where they connect with the water distribution system piping. The direction of flow through all conduits is controlled by check valves in the gate house. Each conduit has a motorized gate valve. The invert elevations of the conduits are shown on the drawings (see Figure B-3).

Two 12-inch low-level drains, one in the sump of each basin, connect to a single 20-inch diameter outlet conduit which conveys flow from the gate house to the Fresh Pond Filtration Plant. There are two 16-inch high-level emergency overflows. Each overflow consists of a vertical standpipe connected to the 40-inch outflow conduit and a diagonal standpipe connected to the 20-inch outlet conduit. These standpipes join to form the overflow rim at El 180.4. The top of the

standpipe is at El 182.3. The cover has been removed to install a water level recorder. Two 8-inch underdrains, one from each basin, also discharge into the outlet conduit.

About 80 feet downstream of the gatehouse, a weir chamber has been constructed on the 20-inch outlet conduit. Access to the chamber is through a manhole. On the day of the inspection, about 1 mgd was flowing over the weir.

c. Size Classification. Payson Park Reservoir is classified in the "small" category since the embankment has a maximum height of 30 feet and the reservoir has a maximum storage capacity of 166 acre-feet.

d. Hazard Classification. The reservoir is located on top of a hill overlooking Belmont and Cambridge. It is completely surrounded by residential development. In the event of a complete failure of the embankment, it is likely that the loss of more than a few lives and extensive damage to the dwellings would occur. Therefore, the reservoir has been placed in the "high" hazard category.

e. Ownership. The reservoir, although located in Belmont, Massachusetts, is owned by the City of Cambridge, Massachusetts Water Department. Mr. John Beckman, Watershed Manager (telephone 493-9020) granted permission to enter the property and inspect the reservoir.

f. Operators. The reservoir is operated by personnel from the Cambridge Water Department. A caretaker is present at the reservoir from 2:00 a.m. to 3:00 p.m., Monday through Friday. A second caretaker is present from 2:00 p.m. to 10:00 p.m., Tuesday through Thursday and Saturday and Sunday. The gate valves on the inflow and outflow conduits are normally kept open.

g. Purpose of the Dam. The reservoir is used to provide temporary storage and pressure for the City of Cambridge water supply system. Water

is pumped into the reservoir from the Fresh Pond Filtration Plant almost continuously as it is the only point of distribution to the City. The capacity of the reservoir at the operational high water level (El 178.5) is 43 million gallons.

h. Design and Construction History. The reservoir, embankment and inflow-outflow conduits were constructed in 1894. The facility was designed by the Water Works Extension of the City of Cambridge, Massachusetts, L.M. Hastings, City Engineer. Drawings were available at the City Engineer's office. The reservoir, gatehouse and piping appear to be built essentially as shown on the drawings. The only significant past construction change has been the addition of the mesh-reinforced gunite lining.

On the day of the inspection, the north basin was drained to remove debris and to repair the gunite lining on the interior slopes. Mr. Beckman indicated that the inflow and outflow conduits would be replaced at a later date.

A floating cover and liner for the reservoir are presently being designed. The cover will rise and fall with the fluctuating water level and will help to keep debris out of the water. The liner will prevent leakage.

i. Normal Operating Procedures. Pumps discharging water to the reservoir are operated to maintain a water level at about El 178.5. The maximum reported pumping rate is 27 million gallons per day (mgd) or about 42 cubic feet per second (cfs). Strip charts that record the reservoir level and pumping rates are located at the Fresh Pond Filtration Plant about 1 mile east of the reservoir. Personnel at the plant monitor the charts 24 hours a day and adjust pumping rates accordingly.

The gate valves for the inflow and outflow conduits are kept open. The facilities are checked daily by the caretakers. Occasionally, when debris builds up in the reservoir,

one basin is drained using the low-level outlet. The north basin was drained the day of the inspection. Gates along the fence are kept locked. The doors to the gatehouse are kept locked except when the caretaker is present.

1.3 Pertinent Data

a. Drainage Area. The reservoir is located near the top of a hill with the top of the embankment above natural ground. Surface runoff drains away from the reservoir embankment. The drainage area consists of the surface area of the reservoir and the upper portion of the interior embankment slopes. This drainage area is 8.04 acres (0.013 square miles).

b. Discharge. Normal discharge is conducted by twin 40-inch conduits, which lead through the eastern embankment and into the gatehouse. The intake for each conduit is screened and lies on the bottom of the reservoir at about El 157.6. In the gatehouse, the twin 40-inch conduits discharge into a single 40-inch water supply pipeline. Motor-operated gate valves are located in the gatehouse.

If the water in the reservoir rises above the normal high level, two 16-inch overflow standpipes in the gatehouse would carry flow through a 20-inch outlet conduit to the Fresh Pond Filtration Plant (see Figure B-3). The rims of the overflow standpipes are at El 180.4 (see Appendix D, page D-3). Presently, the plate at the top of each standpipe has been removed to install the water level recorders. Therefore, if the water level in the reservoir rose to El 182.3, water would begin to flood the valve pit of the gatehouse.

The 16-inch overflow standpipes can discharge an estimated 19.1 cfs with the water surface at El 183.5 which is the low point on the top of the embankment. The Test Flood analysis is based on an initial reservoir level at El 180.4 (rim of overflows) and assumes no inflow

or outflow through the 40-inch conduits. The test flood outflow (one-half PMF) is estimated to be 3 cfs with the reservoir level at El 181.1. Therefore, the overflows can discharge 100 percent of the test flood without overtopping the embankment.

The reservoir was built in 1897 and has never reportedly been overtopped. Records of the water level, which is controlled by pumping, are kept at the Fresh Pond Filtration Plant. The maximum reservoir level is recorded to be El 178.9.

c. Elevation (feet above National Geodetic Vertical Datum of 1929 (NGVD)). A bench-mark was established at El 181.5 on the top of the masonry wall dividing the reservoir. This elevation was established by the City of Cambridge.

(1) Top of dam: 181.9 to 183.3 - top of gunite lining
183.5 to 183.8 - top of earth embankment

(2) Test flood pool: 181.1

(3) Design surcharge (1894 design): 180.4 rims of overflow standpipes

(4) Full flood control pool: Not Applicable (N/A)

(5) Maximum operating pool: 178.5

(6) Spillway crest: None (overflow drains at El 180.4)

(7) Upstream portal invert diversion tunnel: None

(8) Streambed at centerline of dam: N/A

(9) Maximum tailwater: N/A

d. Reservoir

(1) Length of maximum pool: 540 feet

(2) Length of maximum operating pool: 540 feet

(3) Length of flood control pool: N/A

e. Storage (acre-feet)

(1) Test flood surcharge: 146 at El 181.1

(2) Top of dam: 166 at El 183.5

(3) Flood control pool: N/A

(4) Maximum operating pool: 132

(5) Spillway crest: N/A

f. Reservoir Surface (acres)

(1) Top dam: 8

(2) Test flood pool: 7.7

(3) Flood control pool: N/A

(4) Maximum operating pool: 7.4

(5) Spillway crest: N/A

g. Dam (earth embankment and reservoir)

(1) Type: earthfill - stone masonry and gunite lined

(2) Length: 2,225 feet

(3) Height: maximum 30 feet

(4) Top width: 20 feet

(5) Side slopes: 2:1 exterior
1.75:1 interior

(6) Zoning: None

(7) Impervious core: stone masonry and rubble

(8) Cutoff: stone masonry and gunite lining on inside slopes

(9) Grout curtain: None

i. Spillway. Normal discharge is carried by two 40-inch outflow conduits leading to a single 40-inch water supply main. Discharge is normally controlled by the demand of water use, however, flow can be stopped by closing valves in the gatehouse. High water levels are controlled by two 16-inch overflows which lead to a 20-inch outlet conduit. The rims of the overflows are at El 180.4.

j. Regulating Outlets. Under normal conditions, the water level is regulated by the pumping rate into the reservoir. The water level is constantly monitored, and when it reaches El 178.5, the pumps are shut down. The water is carried to the reservoir by a 40-inch water main which splits into two 40-inch inflow conduits at the gatehouse. Check valves on the conduits direct the flow, and motorized-gate valves are present to stop flow when necessary (see Figure B-3).

Water in the reservoir can be drawn down through 12-inch drains which lead to the 20-inch outlet conduit. The inverts of the 12-inch drains are shown on the drawings to be at El 152.

SECTION 2

ENGINEERING DATA

2.1 General. There are numerous design, working, shop and as-built drawings, dated from 1894 to 1915, available at the Cambridge City Engineer's office. These drawings show plans, sections, and details of the reservoir, gatehouse and piping system. Selected portions of 1897 as- built plan are included in Appendix B (Figures B-2 and B-3). Drawings available at the Cambridge City Engineer's office are listed on Pages B-4 and B-5 of Appendix B. Construction specifications and records are not available.

The City of Cambridge retained Camp, Dresser, and McKee, Inc. of Boston, Massachusetts to study the continued utilization of Payson Park Reservoir as a finished water supply. Their report was completed on July 21, 1978. A copy of this report was obtained from the consultant. Recommendations of the study included installation of a flexible cover and liner and the repair of several items which were not maintained. Borings were taken for the purpose of foundation information for a rigid cover. Observation wells were installed at two locations along the top of the northeasterly and southeasterly embankments. One observation well at the northeast corner of the embankment was observed at the time of the field survey.

An inspection report prepared by personnel from the District Office of the Massachusetts Department of Public Works is also included in Appendix B. No other plans, specifications or computations are available from the Owner, County or State agencies relative to the design, construction or repair of the reservoir or embankment.

We acknowledge the assistance and cooperation of the following people: the personnel of the Massachusetts Division of Waterways and Department of Public Works; Messrs. John Beckman, Cambridge Watershed Manager, Jim Rice, City Engineer and John Kussack, Cambridge DPW; and Mr. Joseph Downing of Camp, Dresser, and McKee.

2.2 Construction Records. The only construction records available are the working and as-built drawings referred to in Section 2.1.

2.3 Operating Records. Continuous records of the water level, pumping rates and hours of pumping are automatically maintained at the Fresh Pond Filtration Plant.

2.4 Evaluation

a. Availability. There are design, working, shop and as-built drawings available for the reservoir. Constructions specifications and records are not available.

b. Adequacy. The lack of hydraulic and structural computations and detailed construction records did not allow for a definitive review. Therefore, the evaluation of the adequacy of the reservoir is based on review of available drawings, visual inspection, past performance history, and engineering judgment.

c. Validity. Comparison of the as-built drawings with the field survey conducted during the Phase I inspection indicates that the available information is valid.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The Phase I Inspection of the Payson Park Reservoir was performed on September 27, 1979. A copy of the inspection checklist is included in Appendix A. An inspection and evaluation of the condition of the reservoir was conducted in 1977-1978 by an engineering consultant. Some of that information is referred to in this report. An inspection of the reservoir was made by personnel from District 4 of the Massachusetts Department of Public Works on March 19, 1974 (see pages B-6 through B-11). There were no deficiencies noted in that report.

b. Dam (reservoir and embankment). Payson Park Reservoir is impounded by an approximately rectangular, earth embankment with stone masonry and gunite. The bottom of the reservoir is a concrete slab covered with gunite. During the inspection, the north basin was empty. Vertical cracking was observed in the gunite lining the interior slopes and bottom slab. Some slight bulging of the lining was also noted in the north basin. Seepage was visible at three locations (see Figure B-1). Flows estimated at 10 to 20 gallons per minute (gpm) were observed passing through a series of cracks in the bottom slab adjacent to the sump in the north basin (see Appendix C photograph No. 5). Two 1-inch diameter holes which appeared to have formed around vertical reinforcing bars discharged an estimated 1 gpm each into the western portion of this basin. An estimated 1 gpm was observed leaking from a crack in the gunite at the top of the chamber at the base of the center baffle wall (see Appendix C photograph No. 6). Because the south basin of the reservoir was in use, an inspection of that lining could not be made. An estimated flow of 1 mgd was discharging through the underdrain of the reservoir on the day of the inspection.

The existing inflow and outflow conduits are the original 40-inch riveted steel pipes installed in 1894. These pipes are severely deteriorated and have rusted through in several locations (see Appendix C photograph No. 2).

The embankment is constructed of rolled earth fill with 2:1 grass covered exterior slopes. Along the south and east sides of the reservoir, the exterior embankment slope consists of a double berm. Severe erosion was observed along the lower berm of the south end of the reservoir and at the southwest corner. This corner, which is also heavily trespassed, is overgrown with brush and saplings. Several large maple trees are growing on the outside slope and along the toe of the embankment (see photographs No. 7 and No. 8). The only indication of movement in the embankment slopes, other than slight depression and bulges caused by erosion, was observed in the manhole that contains the weir chamber. The upper 5 courses of brick were displaced approximately 1-inch to the east. The concrete and stone aprons at the stairway leading up to the gatehouse have settled slightly.

c. Appurtenant Structures. There is no spillway at this site. Flow through the conduits leading into and out of the reservoir is controlled by valves located within the gatehouse located on the east side of the reservoir. The building is made of large stone masonry below the ground surface with a double brick masonry facade exposed above ground. The brick masonry is in poor condition. Above all window and door arches the brick masonry and stone work have separated and fallen away or are severely cracked (see Appendix C photograph No. 1).

There are three levels in the gatehouse. The entrance level is used to house the control and recording mechanisms and the caretaker's office. A trap door and a corroded metal ladder lead to the valve pit. There are two

levels in the pit. A timber plank floor through which the valve stems and overflow standpipes pass exists just above the 40-inch gate valves. From this level the cover plates of the overflow standpipes were observed to be removed to allow access for the float wires of the water level recorder. The covers should be placed back on top of the overflows to prevent water from flowing out the top and flooding the lower level of the gatehouse. The lower level houses gate valves for all the piping (see Appendix C photograph No. 4). There is a hole in the top of the 12-inch drain pipe from the north basin. This results in flooding of the gatehouse when the north basin is drained.

At a later reinspection of the gatehouse, a strong odor of gas was present in the valve pit. Gas is used for heating the building.

d. Reservoir Area. The reservoir is located near the top of a hill, and the drainage area is limited to the surface area of the reservoir and the upper portion of the interior embankment slopes. The reservoir is completely surrounded by residential development. Surface runoff which drains down from the top of the hill bypasses the reservoir, since the embankment is higher than the adjacent ground.

e. Downstream Channel. There is no discharge channel or stream at this site. Normal discharge flows into a 40-inch water supply pipeline leading out of the gatehouse. Overflow and drawdown flows are transmitted through a 20-inch drain to the Fresh Pond Filtration Plant.

3.2 Evaluation. The above findings indicate the reservoir and embankment are in fair condition. The facility is generally well maintained, however, there are several items which require attention. Recommended measures to improve these conditions are stated in Section 7.3.

SECTION 4

OPERATING PROCEDURES

4.1 Procedures. A maximum of three 12 mgd pumps can be operated at the Fresh Pond Filtration Plant to maintain the reservoir pool at El. 178.5. Automatic, continuous-chart recorders monitor the water level in the reservoir. However, there is no emergency shut-off for the pumps if the water level exceeds El 178.5. When all three pumps are used, the combined maximum flow is reported to be 42 cfs (27 mgd).

The gate valves of the conduits leading into and out of the reservoir are normally kept open. The gate valves are operated only when a basin is drained. The reservoir and appurtenances are visually inspected daily by the caretakers. The fence gates and the gatehouse doors are kept locked when the caretaker is not present.

4.2 Maintenance of Reservoir and Embankment. The reservoir and embankment are in fair condition. However, erosion and growth of vegetation is occurring on the exterior slopes of the embankment. The north basin was drained for cleaning and repairs the day of the visual inspection. At that time, numerous cracks and seepage was observed in the concrete lining. Severe rusting of the conduits was also observed.

4.3 Maintenance of Operating Facilities. The masonry facade of the gatehouse is in poor condition. Provisions should be made to cover the tops of the overflow standpipes. The gas leak at the meter in the gatehouse valve pit should also be investigated. The corroded metal ladder should be replaced, and the low-level drain for the north basin should be repaired.

4.4 Description of Any Warning System in Effect. The water level in the reservoir is continuously recorded on a chart at the Fresh Pond Filtration Plant. The chart is manually checked and the pumping rate altered accordingly 24 hours a day.

4.5 Evaluation. There is a regular program of maintenance inspections and surveillance for Payson Park Reservoir. However, there is no regular program of technical inspections or a plan for warning nearby residents in case of an emergency at the site. This is extremely undesireable considering that the dam is in the "high" hazard category. The above programs should be implemented, as recommended in Section 7.3.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General. Payson Park Reservoir is located near the top of a hill in Belmont and provides distribution, pressure and storage for the City of Cambridge water supply. The reservoir is impounded by an approximately rectangular, earth embankment lined with stone masonry and gunite. The embankment varies in height to a maximum of about 30 feet. The drainage area consists of the surface area of the reservoir which is 8.04 acres (0.013 square miles).

The reservoir level is controlled by pumping at a normal rate of 24 mgd (37 cfs) with a maximum reported rate of 27 mgd (42 cfs). The pool level is automatically recorded at the Fresh Pond Filtration Plant, and the pumps are manually shut down when the water level reaches 178.5. Overflow is through two ungated, 16- inch standpipes, one for each basin of the reservoir. The overflows have rims at El. 180.4 (see Appendix D, page D-3) and lead to a single 20-inch outlet conduit.

The reservoir has two 12-inch, low-level drains used to lower the water level for maintenance. Drawdown of the reservoir in anticipation of a storm could be achieved by shutting off the pumps and allowing normal outflow by demand to lower the pool.

b. Design Data. There are no hydraulic or hydrologic computations available for the design of the reservoir.

c. Experience Data. The water level is continuously monitored with automatic chart recorders. The recorders are located in the gatehouse with a readout at the Fresh Pond Filtration Plant. Personnel monitor the chart records 24 hours a day. Although the maximum recorded water level was at El 178.9, it was reported that the water level has exceeded El

180.4 within the last year. The reason is not known. This was confirmed by the fact that the floats and wires of the water level recorders had been washed into the overflow standpipes. The reservoir has not reportedly been overtopped since its construction in 1897.

d. Visual Observations. The reservoir and embankment are generally well maintained. A caretaker is present at the facility daily and the reservoir level is constantly monitored.

e. Test Flood Analysis. According to the Corps of Engineers' guidelines, the reservoir has been placed in the "small" size category and the "high" hazard category. A test flood ranging from a one-half to a full probable maximum flood (PMF) should be used to evaluate the overtopping potential of the reservoir. A one-half PMF was used for this analysis.

The Test Flood (one-half the PMF) inflow to the 8.04 acres of reservoir and drainage area consists of direct precipitation of 9.51 inches in 6 hours, assuming no losses. The Test Flood analysis consisted of determining the maximum rise in water level due to this rainfall and evaluating the effect of uncontrolled pumping. The analysis is based on a pool level starting at El. 180.4 (rim of overflows) and assumes no flow into the water supply pipelines.

Hydraulic analyses indicate that overflow standpipes can discharge an estimated flow of 19.1 cfs when the reservoir level is at El 183.5 which is the low point on the top of the embankment. The Test Flood produces a maximum outflow of 3 cfs with the reservoir level at El 181.1. Therefore, the overflow standpipes can discharge 100 percent of the test flood without overtopping the embankment. If in addition to the rainfall, the pumps continued to supply 42 cfs during the Test Flood, the reservoir level would rise to approximately the top of the embankment. Under these conditions, the overflow standpipes would probably flood the valve pit of the gatehouse.

f. Dam Failure Analysis. The peak discharge rate due to failure was calculated to be 10,600 cfs based on an assumed 50-foot (twice height) long breach of the embankment and a head of 25 feet.

The surrounding ground is higher than the reservoir bottom on all sides except at the southeast corner of the reservoir. A typical failure wave would flow down Payson Road, to Elm Street, across the golf course and into Fresh Pond (see flood impact area on Location Map). The flow would drop approximately 90 feet in the first 1,200 feet of street and then about 20 feet in the next 1,300 feet of street and finally about 50 feet in 1,500 feet to the pond. The reservoir is completely surrounded by residential development. The water moving toward Fresh Pond would severely damage houses along Payson Road and Elm Street as well as flood the surrounding residences. It is likely that more than a few lives would be lost if the embankment were to fail. Accordingly, the embankment has been placed in the "high" hazard category.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The evaluation of the structural stability of Payson Park Reservoir is based on review of available drawings, reports and the visual inspection conducted on September 27, 1979. A detailed discussion of the visual inspection is given in Section 3, Visual Inspection. As discussed, the reservoir and embankment are generally in fair condition. No seepage, severe bulging, or settlement of the embankment was observed. However, seepage occurred in 1977 through the Cushing Avenue embankment which has since been repaired. This illustrates that with age the structure is becoming more susceptible to leakage. During the field inspection, an estimated flow of 1.0 to 1.2 mgd was observed passing through the underdrain system which is located just below the bottom slab. This is an unsatisfactory condition.

b. Design and Construction Data. There are numerous sheets of design, working, shop and as-built drawings dated from the year 1894 to 1915, available at the Cambridge City Engineer's Office. Copies of selected portions of an as-built drawing are included in Appendix B. Construction specifications are not available. There are no structural or hydraulic computations available from the Owner, State or County, relative to the design, construction or repair of the reservoir and embankment.

The Cambridge Water Department engaged a consultant to study the continued utilization of Payson Park Reservoir. As part of this study eight borings were taken to establish foundation conditions in the embankment. Four borings were taken in the bottom of the north basin, two at the top of the exterior slope of the north embankment and two in opposite locations at the south embankment. Borings in the

bottom indicate that shale or dense till are within 5 feet the bottom slab. The embankment is comprised of various layers of silty sand and gravel with some clay. The density of these layers increases with depth. The borings within the embankment ranged in depth from 20.5 to 32.0 feet. Refusal was encountered at the north end of the reservoir indicating that may be closer to the surface there.

There is no other information on the shear strength or permeability of the soil and/or rock materials of the embankment. The embankment is unzoned earth fill with exterior slopes at 2:1 and interior slopes at 1.75:1 (see typical section Appendix B, Figure B-2). Stone paving was placed on the interior slope which was later lined with gunite in the 1930's.

c. Operating Records. The only instrumentation ever installed at Payson Park Reservoir were two observation wells installed in borings as referenced above. However, only one can be monitored since the second was reportedly buried. The well is located in the northeast portion of the reservoir at the top of the exterior slope (see Appendix B Figure B-1). It is a 1-1/2-inch outside diameter, capped, galvanized metal pipe painted yellow. When the boring was performed, the water in the well was at El 163.5. The water level in the well on September 27, 1978 was at El 160.5 with the north basin drained. On a subsequent visit on November 29, 1978, with the water level at El 173.9 in the north basin the water in the well was at El 162.25.

The observation well installed in early November 1977 in the south embankment indicated that the groundwater was at about El 170.0. At that time, a leak was reported near the reservoir on Cushing Avenue. The high water level in the observation well confirmed that leakage was passing through the embankment at that end of the reservoir.

d. Post-Construction Changes. Based on field measurements and discussions with personnel from the Cambridge Water Department, the embankment and reservoir appear to be built essentially as shown on the as-built drawing, except for the later addition of a gunite lining.

e. Seismic Stability. The dam is located in Seismic Zone No. 3. There is limited data available at this time to evaluate the seismic stability of the embankment. Information is required on th in-situ properties of the embankment and foundation material. Considering that the reservoir is in the "high" hazard category, a seismic evaluation of the embankment should be conducted, as recommended as Section 7.2.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Based upon review of available drawings, the visual inspection of the site and past performance, there are deficiencies which must be corrected to assure the continued performance of Payson Park Reservoir. Generally, the reservoir and embankment are considered to be in fair condition. However, maintenance of several items is lacking. Also significant seepage is being collected in the underdrain system.

Hydraulic analyses indicate that the two 16-inch overflow standpipes can discharge a flow of 19.1 cfs with the water surface at 183.5, which is the low point on the top of the embankment. An outflow test flood of 3 cfs (one-half PMF) with the reservoir level at El. 181.1 will not overtop the embankment under normal operating conditions.

b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of the reservoir and embankment is based primarily on review of a recent engineering report and available drawings, visual inspection, past performance and engineering judgment.

c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within one year after the receipt of this Phase I Inspection Report.

d. Need for Additional Investigation. Additional investigations to further assess the adequacy of this dam are needed, as discussed below in Section 7.2.

7.2 Recommendations.

Due to the lack of data concerning the embankment and foundation

materials and the seepage being collected in the underdrain system, it is recommended that the Owner employ a qualified registered engineer to conduct the following studies and make appropriate recommendations:

a. Investigate and evaluate the seismic stability of the embankment,

b. Investigate the need to remove the trees growing along the outside toe of the embankment, and

c. Design an impermeable lining for the reservoir. The previous study referred to in Section 2 recommended a Hypalon lining. This would be acceptable provided that it is properly designed and installed.

The Owner should implement the recommendations of the engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:

(1) monitor and measure the leakage through the underdrain system to evaluate the effectiveness of the impermeable lining to be installed as recommended in Section 7.2.

(2) repair cracks in the lining of the north basin. Drain the south basin and repair any cracks in the lining

(3) replace the 40-inch diameter inflow-outflow conduits

(4) relocate the water level recorder and replace the covers on the overflows. Consideration should be given to an automatic emergency shutoff system from the water level recorder to the pumps

(5) replace the corroded steel ladder in gatehouse (mid-level)

(6) locate and repair the gas leak in the gatehouse

(7) repair the hole in the drain pipe for the north basin of the reservoir

(8) repair erosion on the exterior slopes of the embankment along the south end of the reservoir

(9) remove brush and saplings from the exterior slope at the southwest corner of reservoir.

(10) repair masonry facade of gatehouse

(11) monitor lateral movement in the manhole containing the weir chamber. Additional movement should be evaluated.

(12) implement a systematic program of maintenance inspections of the reservoir and its appurtenances. This should include checking of all gates to insure that they are operable. All repairs and maintenance should be in accordance with all applicable State regulations.

(13) conduct annual technical inspections of the reservoir and appurtenances

(14) institute a plan for surveillance of the embankment during and after periods of heavy rainfall and a plan for warning nearby residents in the event of an emergency at the project.

7.4 Alternatives. There are no recommended alternatives.

APPENDIX A

PERIODIC INSPECTION CHECKLIST

PAYSON PARK RESERVOIR

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Payson Park Reservoir

DATE 9/27/79

TIME 07:30

WEATHER Clear

W.S. ELEV. 178.5 U.S. None DN.S.

PARTY:

IN SOUTH BASIN:
NORTH BASIN DRAINED

1. W. Checchi
2. F. Sviokla
3. P. Reilly
4. M. Larson
5. L. Branagan
6. J. Risitano
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Inlet/Outlet	Branagan/Risitano	
2.	Embankment	Risitano/Larson	
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT Payson Park Reservoir DATE 9/27/79

PROJECT FEATURE Dam (Reservoir) NAME J. Risitano

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT North Basin Drained for cleaning and repairs	
Crest Elevation	183.5 - 183.8
Current Pool Elevation	178.5 (Operational High Water Level)
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible in the embankment; frequent vertical cracking in lining; and the bottom slab in basin
Pavement Condition	Grass covered exterior slopes and crest; mesh reinforced gunite over brick-paved lining on interior slopes
Movement or Settlement of Crest	Some surface ruts; nothing significant perceptible
Lateral Movement	Frequent slight bulging of gunite lining; suspect exterior slope bulging along south and east slopes
Vertical Alignment	Flat and symetrical
Horizontal Alignment	Rectangular
Condition at Abutment and at Concrete Structures	Two stone stairways at each end of the baffle wall; concrete & stone aprons at easterly stairway have settled
Indications of Movement of Structural Items on Slopes	Manhole east of gatehouse; upper five five courses displaced approximately 1 incl to the east; located at toe of slope
Trespassing on Slopes	Heavy, especially at NW corner; access road on crest; joggers and senior citizens
Sloughing or Erosion of Slopes or Abutments	Heavy erosion along exterior slope along south end and SW corner of reservoir
Rock Slope Protection - Riprap Failures	NA Reinforced gunite lining over brick paving
Unusual Movement or Cracking at or near Toes	Slight depression about 8' in diameter at toe of southerly exterior slope
Unusual Embankment or Downstream Seepage	None visible
Piping or Boils	Leakage thru cracks and holes in bottom slab of North Basin; the worst flow = 10-20 gpm
Foundation Drainage Features	Under drain system
Toe Drains	None visible
Instrumentation System	Observation well at top of slope on NE corner of reservoir

(CMD See Page Study)

PERIODIC INSPECTION CHECK LIST

PROJECT Payson Park Reservoir DATE 9/27/79

PROJECT FEATURE Center Baffle Wall NAME J. Risitano

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
DIKE EMBANKMENT (center baffle wall) Crest Elevation	North Basin drained for cleaning and repairs
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	Where gunite thinned out and at bottom of North Basin
Pavement Condition	Fair
Movement or Settlement of Crest	None visible
Lateral Movement	None visible
Vertical Alignment	Level
Horizontal Alignment	Straight
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None visible
Trespassing on Slopes (baffle wall)	Caretaker and vandals
Sloughing or Erosion of Slopes or Abutments	None visible
Rock Slope Protection - Riprap Failures	NA
Unusual Movement or Cracking at or near Toes	Minor horizontal cracks in gunite surface especially at chamfer
Unusual Embankment or Downstream Seepage	Estimated 1 gpm @ base of wall top of chamfer midway across baffle wall
Piping or Boils	None visible
Foundation Drainage Features	None visible
Toe Drains	NA
Instrumentation System	NA

PERIODIC INSPECTION CHECK LIST

PROJECT Payson Park Reservoir DATE 9/27/79

PROJECT FEATURE Gatehouse NAME J. Risitano

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
CUTLET WORKS - CONTROL TOWER	Granite block foundation and superstructure
a. Concrete and Structural	
General Condition	Fair
Condition of Joints	Good except very minor cracking with some newly patched areas
Spalling	NA
Visible Reinforcing	NA
Rusting or Staining of Concrete	Lower and middle level of gatehouse on stone walls
Any Seepage or Efflorescence	Along stone wall in lower section
Joint Alignment	NA
Unusual Seepage or Leaks in Gate	None visible
Cracks	Above all window and door arches; brick facade & stone capping seperated and fell away from interior brick work on east side
Rusting or Corrosion of Steel	Deteriorated metal ladder
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

NOTE 12 inch underdrain pipe flowing 9 inches deep passes thru lower level of gatehouse, the outlet is a 12 inch pipe approximately flowing at 2.6 cfs

PERIODIC INSPECTION CHECK LIST

PROJECT Payson Park Reservoir DATE 9/27/79

PROJECT FEATURE Inlet - Outlet NAME J. Risitano

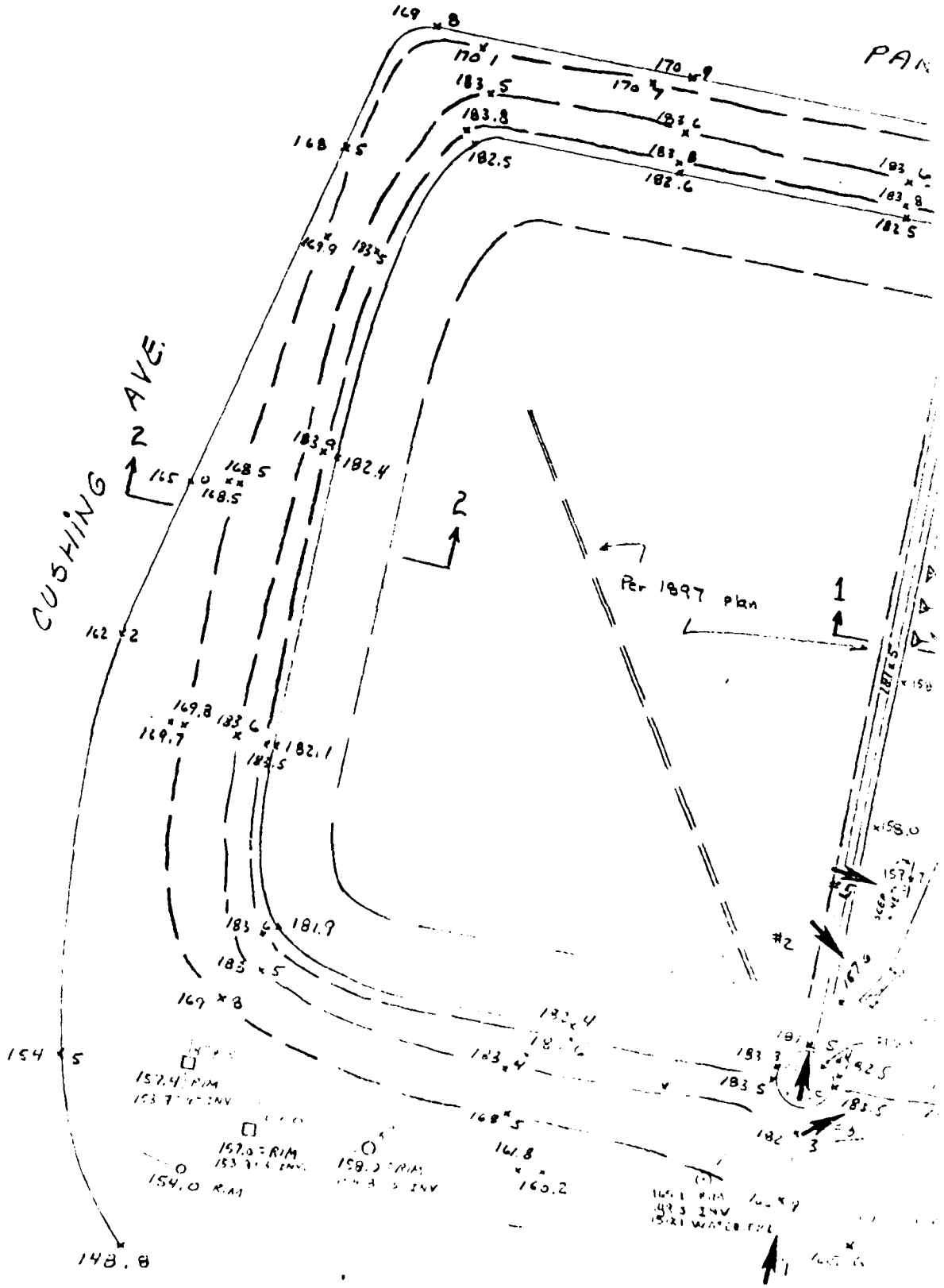
DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel	
Loose Rock or Trees Over-hanging Channel	
Condition of Discharge Channel	

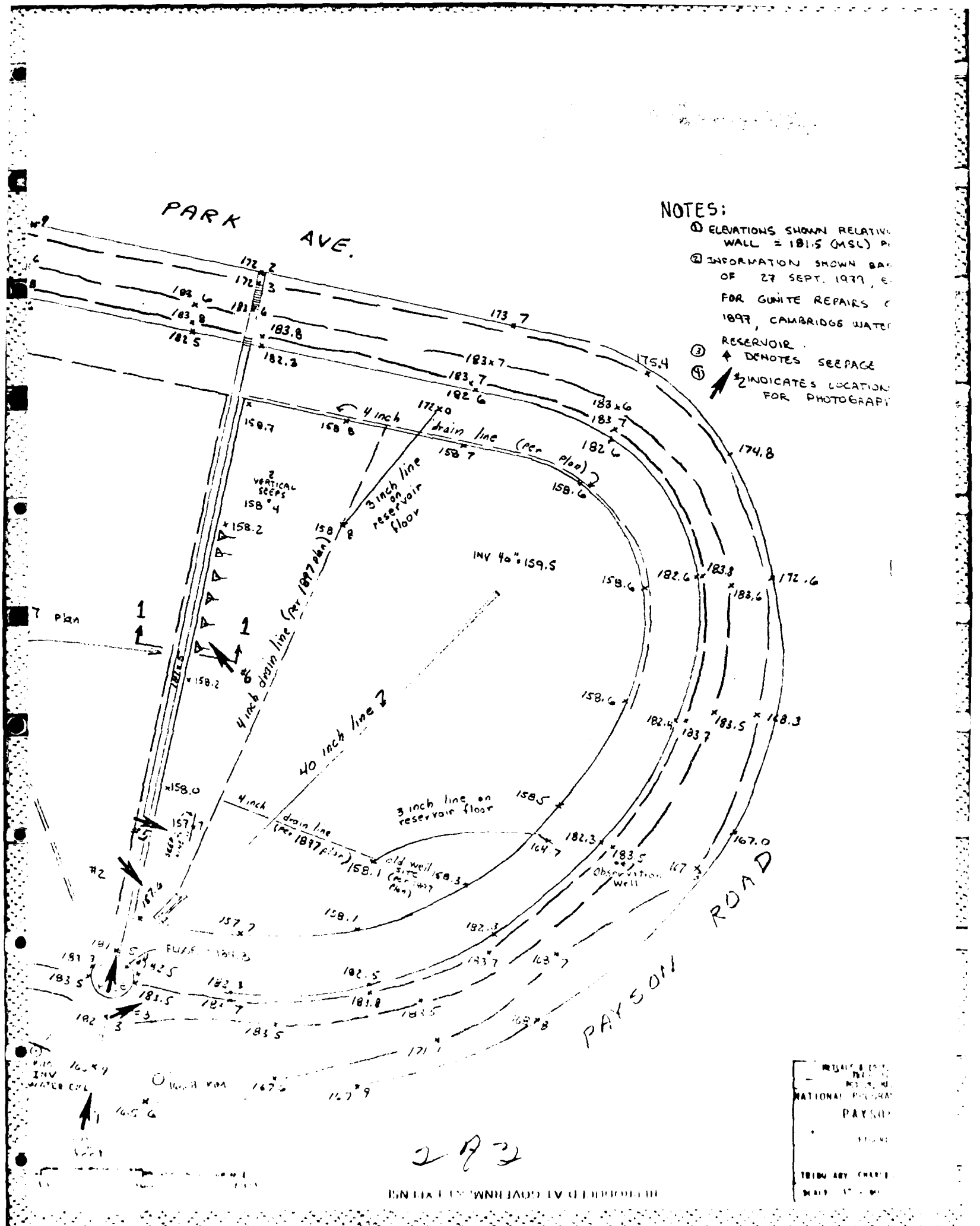
NOTE: Reservoir discharges into Cambridge Water Distribution System through a 40 inch riveted steel pipe. Water is pumped in thru a similar pipe from the Fresh Pond Filtration Plant. The inlet pipe has a screen over it which is in good condition. The pipe itself is the original and is in very poor condition, highly fractured with several locations where it has rusted through.

APPENDIX B

PLANS OF RESERVOIR



METCALF & EDDY, INC.


PARK AVE.
NOTES:
① ELEVATIONS SHOWN RELATIVE
WALL = 181.5 (MSL) P
② INFORMATION SHOWN BA
OF 27 SEPT. 1979, E
FOR GUNITE REPAIRS
1897, CAMBRIDGE WATE
RESERVOIR.
③ ▲ DENOTES SEEPAGE
④ ½ INDICATES LOCATION
FOR PHOTOGRAP
4 inch drain line (per Plan)
3 inch line on reservoir floor
2 VERTICAL SEEPS
158.4
INV 40" = 159.5
4 inch drain line (per 1897 plan)
40 inch line
3 inch line on reservoir floor
4 inch drain line (per 1897 plan)
old well site (per 1897 Plan)
Observation Well
#2
#6
PAYSON ROAD
NATIONAL
PAYSO

2 R 2

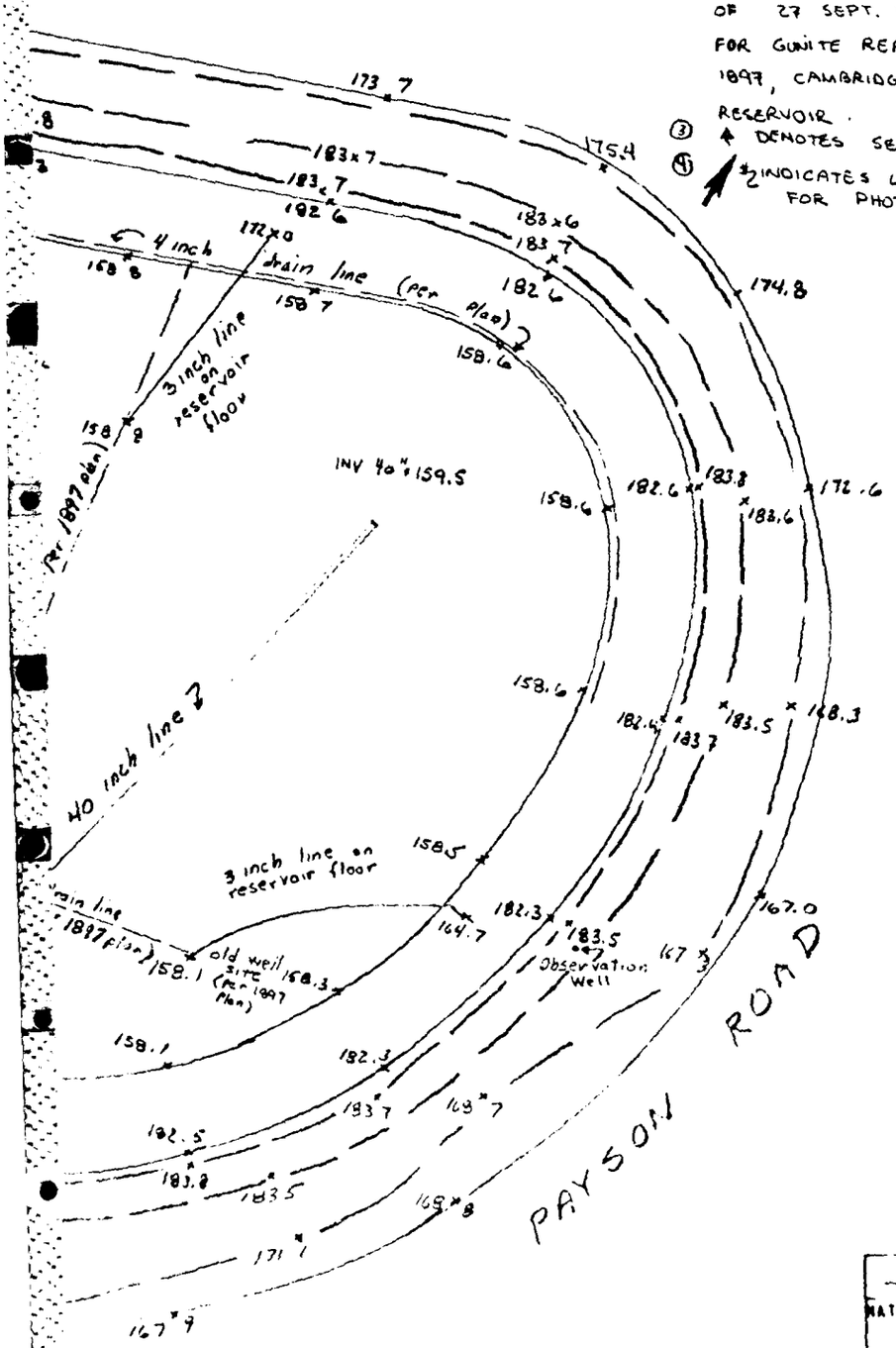
NOTES:

① ELEVATIONS SHOWN RELATIVE TO RESERVOIR PARTITION WALL = 181.5 (MSL) PER CITY OF CAMBRIDGE

② INFORMATION SHOWN BASED ON FIELD SURVEY OF 27 SEPT. 1979, EASTERLY CELL DRAINED FOR GUNITE REPAIRS ON SAID DATE: PLAN OF 1897, CAMBRIDGE WATER WORKS, PAYSON PARK RESERVOIR.

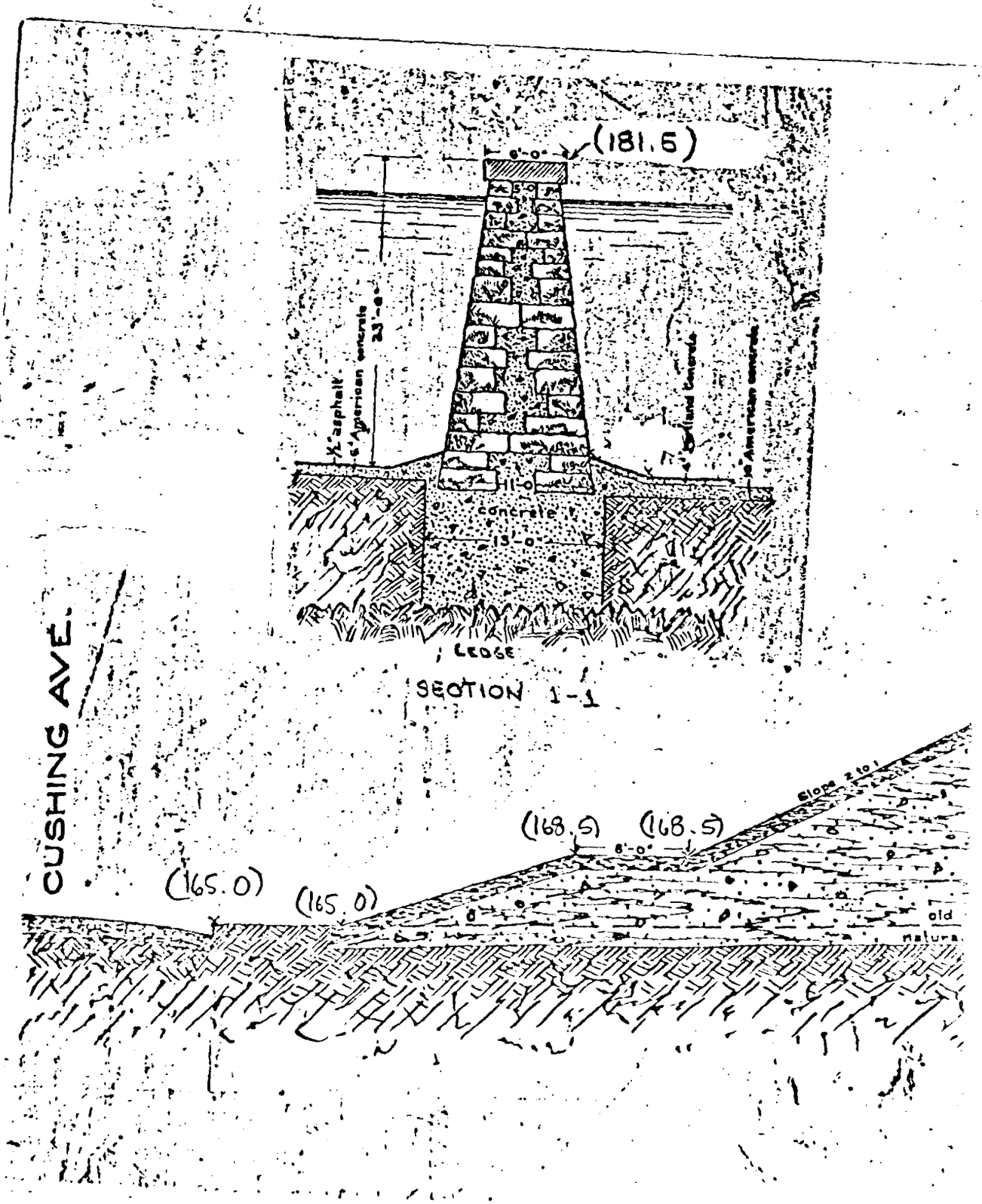
③ ↑ DENOTES SEEPAGE

④ ½ INDICATES LOCATION AND DIRECTION OF VIEW FOR PHOTOGRAPHS

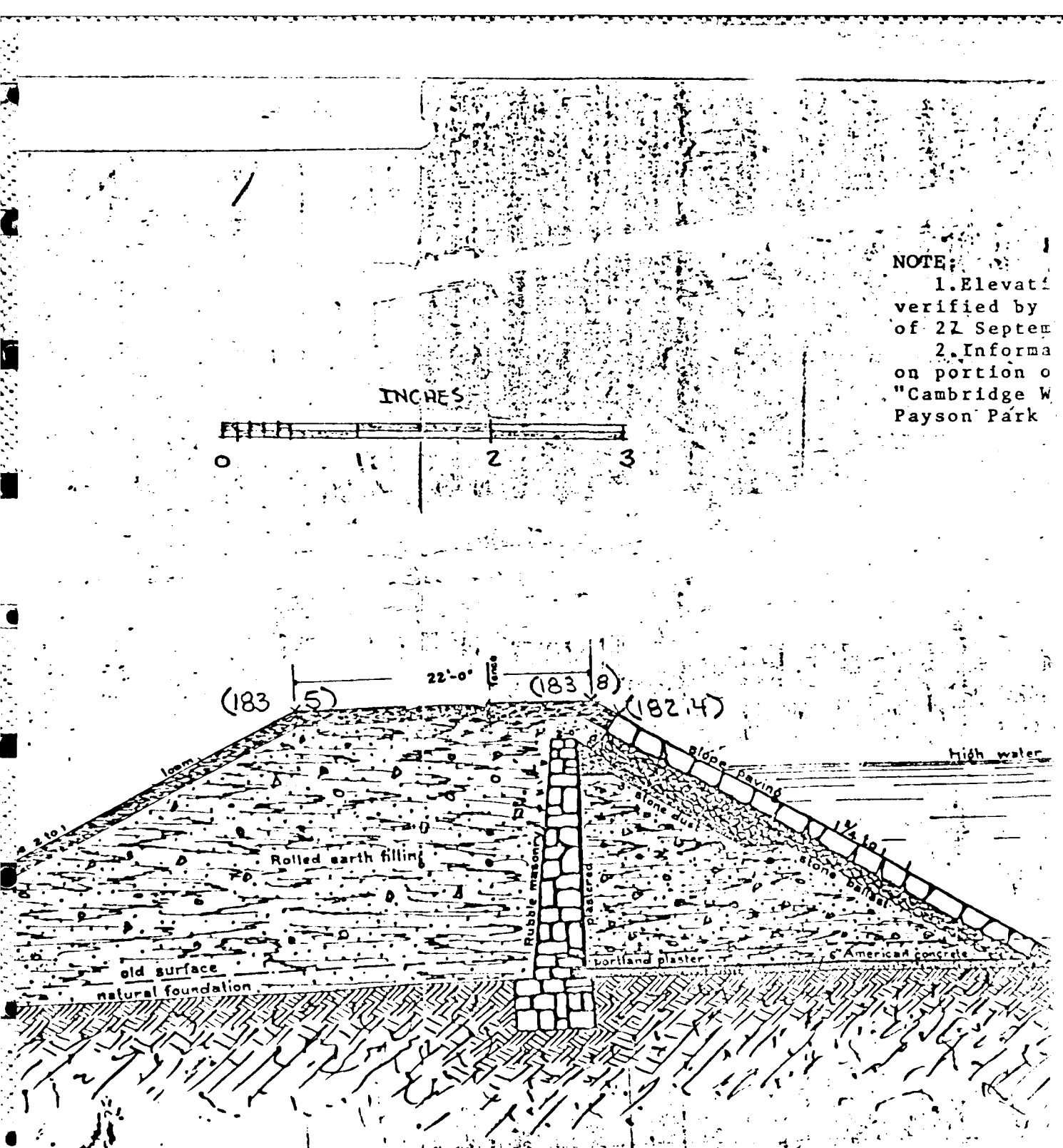


METCALF & EDDY, INC. BOSTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON FED DAMS	
PAYSON PARK RESERVOIR	
FIGURE 8-1 PLAN OF RESERVOIR	
TRIBUTARY CHARLES RIVER	MASSACHUSETTS
SCALE: 1" = 80'	DATE SEPTEMBER, 1979

3 of 3



NOTE:
1. Elevat
verified by
of 27 Septem
2. Informa
on portion o
"Cambridge W
Payson Park

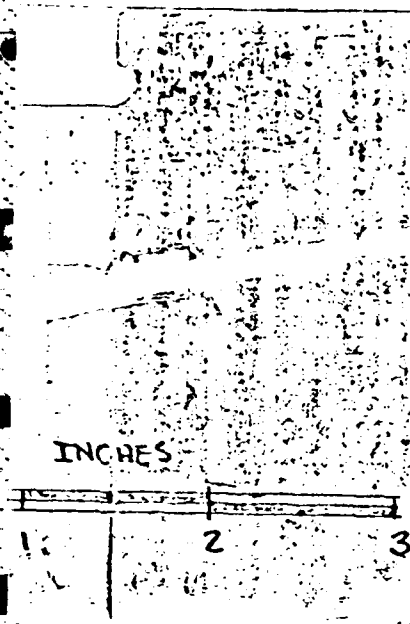


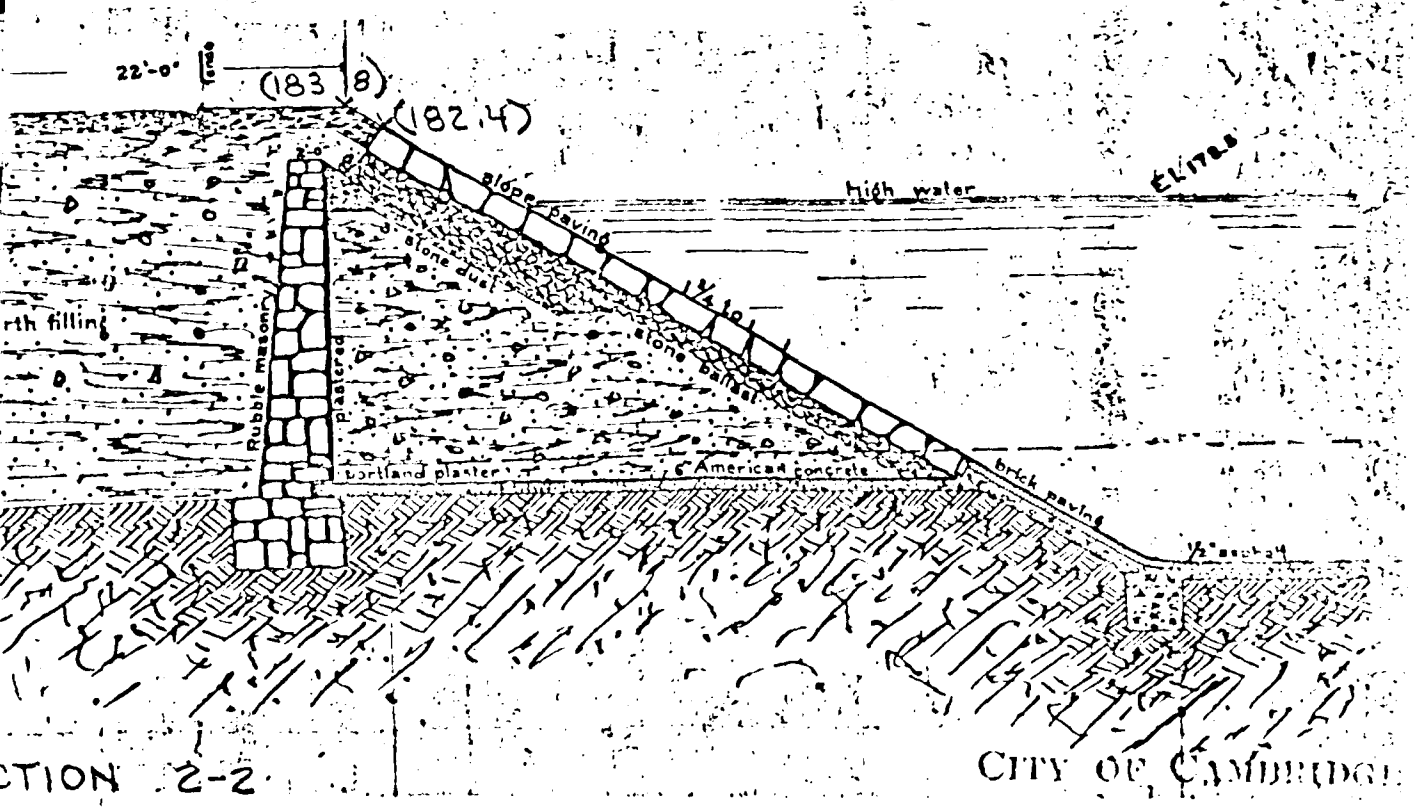
SECTION 2-2

NATIONAL
P
TRIBUTARY
SCALE

NOTE:

1. Elevation in parenthesis verified by field inspection of 27 September, 1979.
2. Information shown based on portion of plan titled "Cambridge Water Works, Payson Park Reservoir, 1897".





CTION 2-2

CITY OF CAMBRIDGE

METCALF & EDDY, INC. ENGINEERS BOSTON, MASS.

U.S. ARMY ENGINEER DIV. N. ATLANTIC CORPS OF ENGINEERS NEW YORK, N.Y.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PAYSON PARK RESERVOIR

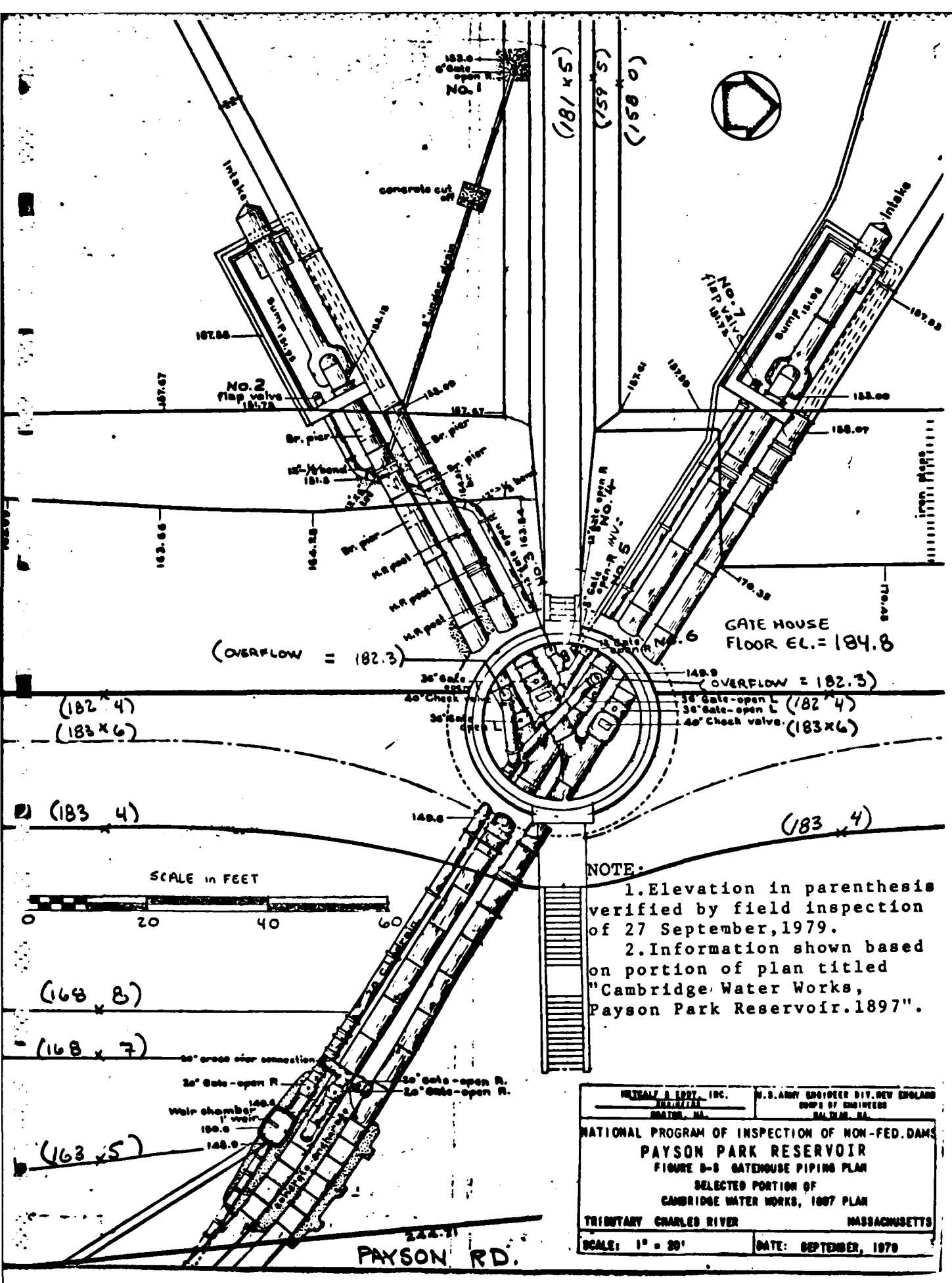
FIGURE B-2 SECTIONS

SELECTED PORTIONS OF CAMBRIDGE WATER WORKS, 1897 PLAN

TRIBUTARY CHARLES RIVER MASSACHUSETTS

SCALE: NO SCALE DATE: SEPTEMBER, 1979

39-3


(181 x 5)
(159 x 5)
(158 0)
Intake
concrete cut off
No. 7 flap valve
Intake
No. 2 flap valve
Br. pier
Br. pier
Br. pier
Br. pier
M.R. pool
M.R. pool
M.R. pool
GATE HOUSE
FLOOR EL. = 184.8
(OVERFLOW = 182.3)
OVERFLOW = 182.3)
(182 x 4)
(183 x 6)
(183 x 4)
(183 x 4)
SCALE in FEET
0
20
40
60
NOTE:
1. Elevation in parenthesis verified by field inspection of 27 September, 1979.
2. Information shown based on portion of plan titled "Cambridge Water Works, Payson Park Reservoir. 1897".
(168 x 8)
(168 x 7)
(163 x 5)
PAYSON RD.
NITEALF & EDDY, INC.
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
PAYSON PARK RESERVOIR
FIGURE B-8 GATEHOUSE PIPING PLAN
SELECTED PORTION OF
CAMBRIDGE WATER WORKS, 1897 PLAN
TRIBUTARY CHARLES RIVER
MASSACHUSETTS
SCALE: 1" = 20'
DATE: SEPTEMBER, 1979

DATE	DESCRIPTION	REFERENCE
	CAMBRIDGE WATER WORKS **PAYSON PARK**	
1894	plan of water mains 40" Pipe line	C.ENG. 5309,
1894	general plan new high service reservoir 40'=1"	C.ENG. 2903,
1894	section of reservoir	C.ENG. 2904,2905
1894	reservoir, cross sect. of bank	C.ENG. 2906,2907
1894	cross sec. of middle bank high service res.	C.ENG. 2908,
1894	ground plan gate chamber & Steps	C.ENG. 2909,
1894	ground plan of steps at high service reservoir	C.ENG. 2910,
1894	detail of puddle joint near gate house	C.ENG. 2911,
1894	high serv. reservoir detail of steps at Gate HO.	C.ENG. 2912,
1894	reservoir, study for Gate house	C.ENG. 2913,
1894	reservoir plan of piping in gate house (CHANGED)	C.ENG. 2914,
1894	detail of strainer	C.ENG. 2915,
1894	detail of Swivel joint for strainer	C.ENG. 2916,
1894	plan of gate house	M.M. Tidd. C.E. 291
1894	reservoir, cross sect. at gate house & service main	C.ENG. 2919,
1894	reservoir high serv. detail of masonry division wall	C.ENG. 2921,
1894	reservoir, area & dimensions of earth division wall	2922,
1894	reservoir, area & dimensions of embankment	C.ENG. 2923,
1894	details of pipe & strainer	C.ENG. 2924
1894	reservoir working plan high serv. reservoir cross sec. 20'=1"	C.ENG. 5130,5126.
1894	reservoir, 40" light water valve	Chapman V.CO.2965,
1894	reservoir, plan of pipes in gate chamber O.K.	2940,2941,
1894	plan of pipe specials	2942,2944, 2945,2946,
1896	finished plan of reservoir 20'=1"	
1894	plan of pipes at gate house TRACING	5175 5171,
1894		2943,
1889	20" water gate with spur gears	Chapman V.CO. 3302,
1889	30" water gate with spur gears	Chapman V.CO. 3303,
	plan of M.H. head (KENDALL& SONS)	2763,
1892	lots on Payson Park Land CO.	Whtman 2764,
1892	30" steam & water valve with spur gears & indicator	3305,
1894	Payson PK. Res. cross sec. off embankment as built	2692,
1894	gear stand for 36" valve	C.ENG. 2901,
1894	plan of pipes at gate house	C.ENG. 2943,
1894	stands for valves	Chapman V. CO.2952,
1894	Flooring for gate house	C.ENG. 2953,
1894	plan of 40" check valve	Coffin V. CO. 2962,
1894	plan of 40" light water valve	Coffin V. CO. 2964,
1894	comp. sheet for 40" steel pipe over	Fountain TER. C.ENG.2966.
1894	Comp. sheet for 40" steel sect, pipe bridge 90'span at W. BR. F.R.R.	C.ENG. 2967,
1894	detail of pipe bridge over W.BR. F.R.R.	C.ENG. 2968,2969
1894	plan of [illegible]	C.ENG. [illegible]

DATE	DESCRIPTION		REFERENCE
	CAMBRIDGE WATER WORKS **PAYSON PARK**		
1895	pipe line, profile through Brattle St. as Laid, Mason St. to Mercer circle		3332,
1895	pipe line, plan of Tee & gate s at Huron Ave. connection force mains		3333,
1895	plan & sect. of chamber for 36" gate at Huron Ave.		3334,
1895	pipe line, plan & sect. of chamber for 30" valve at Huron Ave. connec. with force main		3335,
1895	pipe line profiles sect. 40" steel pipe plot		3336,
1895	pipe line & sections of force & supply mains		BP-4348,
1895	pipe line details of cast iron manhole		5156,
1895	pipe line sect. 1 working plan Pump'g sta. at P.	C.ENG.	5161,
1895	pipe line section 2 working plan Park Ave.	C.ENG.	5162,
1895	pipe line section 3 working plan Cider Mill to W. of Grove St.	C.ENG.	5163,
1895	pipe line sect. 4 working plan near School St.	C.ENG.	5164,
1895	pipe line Sect. 5 working Plan Reservoir	C.ENG.	5165,
1895	pipe line, section 6 working plan Mass. Ave. to Cushing	C.ENG.	5166,
1895	pipe line section 7 working plan	C.ENG.	5167,
1895	pipe line, section 8, working Plan	C.ENG.	5168,
1895	" " working plans & profiles	Tracings "	neg. 28,
1895	reservoir, details of special stones	C.ENG.	5169,
1895	reservoir, details of all the special stones used		5172,
1895	reservoir, plan & profile for 15" drain		5173,
1895	reservoir, cross sec. of rock, earth, etc, made in 1895		5174,
1895	details of gate chamber		2695,
1895	plan showing ppogress of concrete		2696,2697,
1896	plan showing progress of Brick & granite paving		2699,
1896	plan showing progress of concrete & slope paving		2698,
1896	reservoir, details of gate house		2954,2955,2956,2957,
1896	reservoir, details of gate chasmber		2958,2959,2960,
1896	reserboir, detail of steel air chamber for the pumping station		3337,
1896	plan of chamber for connections at pumping station		3338,
1896	reservoir, final plan scale 20'=1" plan	C.ENG.	5171,5126,5130,
1897	study for steps at gate house		2700,
1897	reservoir, tracing of as finihsed		5195 T,
1898	plan showing change of Cushing Ave. (Belmont)		2691, N386,N391,
1898	lots on cor. cushing Ave. & Payson RD.		2763,
1878	watershed map of Charles, Sudbury, Shawshine & Mystic Rivers		A-159 ,
1911	Reservoir, plan & details of drain to Cider Mill Pond Plans A,B,C,		A-156,
1914-15	Rainfall, El. of water in Res. and weir readings leakage	T	A-251,
1914	at seque. Profile of rainfall El. water & leakage at Paysonn Park reservoir	T	A-251,
1895	pipe line special castings, gates etc. on main from Payson PK. to Cambridge	C.ENG.	B.P. 4348.

B-7

OK FILE

INSPECTION REPORT - DAMS AND RESERVOIRS

(1.) Location: ~~City~~/Town BELMONT DAM No. 4-9-26-1

Name of Dam PAYSON PARK RESERVOIR DAM

Inspected by A. Z. PIZAN & F.H. PARE

Date of Inspection 3-19-'74

(2.) Owners: per: Ass. ✓ Prev. Inspection

Reg. of Deeds Pers. Contact

1. CITY OF CAMBRIDGE, 795 MASS. AVE., CAMBRIDGE, MASS-02139 876-6800
Name St. & No. City/~~Town~~ State Tel.No.

2. Name St. & No. City/Town State Tel.No.

3. Name St. & No. City/Town State Tel.No.

(3.) Caretaker: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

CITY OF CAMBRIDGE WATER DEPT, 250 FRESH POND PKWY, CAMBRIDGE, MASS.-02140 864-5300
Name St. & No. City/Town State Tel.No.

(4.) No. of Pictures taken NONE

(5.) Degree of Hazard: (if dam should fail completely)*

1. Minor 2. Moderate

3. Severe ✓ 4. Disastrous

*This rating may change as land use changes (future development)

(6.) Outlet Control: Automatic Manual

Operative Yes: no.

Comments: NONE. OUTLET WATER PIPES GRAVITY FEED HOMES

(7.) Upstream face of Dam Condition:

1. Good ✓ 2. Minor Repairs

3. Major Repairs 4. Urgent Repairs

Comments:

DAM NO. 4-9-26-1

(8) Downstream Face of Dam: Condition: 1. Good ✓ 2 Minor Repairs____

3. Major Repairs____ Urgent Repr____

Comments:_____

(9) Emergency Spillway: Condition: 1. Good____ 2. Minor Repairs____

3. Major Repairs____ 4. Urgent Rep____

Comments: THERE IS NO EMERGENCY SPILLWAY.

(10) Water level @ time of inspection 10 ft. above____ below ✓

top of dam ✓ Principal spillway____

Other____

(11) Summary of Deficiencies Noted:

Growth (Trees and Brush) on Embankment NO DEFICIENCIES NOTED

Animal Burrows and Washcuts____

Damage to slopes or top of dam____

Cracked or Damaged Masonry____

Evidence of Seepage____

Evidence of Piping____

Erosion____

Leaks____

Trash and/or debris impending flow____

Clogged or blocked spillway____

Other____

DAM NO. 4-9-26-1

(12) Remarks & Recommendations: (Fully Explain)

DAM IS IN GOOD CONDITION.

(13) Overall Condition:

1. Safe ✓
2. Minor repairs needed _____
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)

Recommend removal from inspection list _____

DESCRIPTION OF DAM
DISTRICT #4

Submitted by FRANCIS H PAGE (ACAM) PIZAN Dam No. 4-9-26-1
Date 3-19-74 City/Town BELMONT
Name of Dam PAYSON PARK RESERVOIR DAM

1. Location: Topo Sheet No. 31A
Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: 1890 Year/s of subsequent repairs UNKNOWN

3. Purpose of Dam: Water Supply ✓. Recreational ____
Irrigation ____. Other ____

4. Drainage Area: 0.5 SQ. Mi. 320 ACRES.

5. Normal Ponding Area: 1.167 acres; Ave. Depth 12'
impoundment: 42 MIL gals; 14 acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir i.e. summer homes etc. 50 PERMANENT HOMES AROUND RESERVOIR

7. Dimensions of Dam: Length 750' Max. Height 10'
Slopes: Upstream Face 2:1
Downstream Face 2:1
Width across top 10'

8. Classifications of Dam by Materials:
Earth ____. Conc. Masonary ✓. Stone Masonary ____
Timber ____. Rockfill ____. Other ____

9. A. Description of present land usage downstream of dam: 10 % rural; 90 % urban
B. Is there a storage area or flood plain downstream of dam: which could accommodate the impoundment in the event of a complete dam failure no ✓. yes ____.

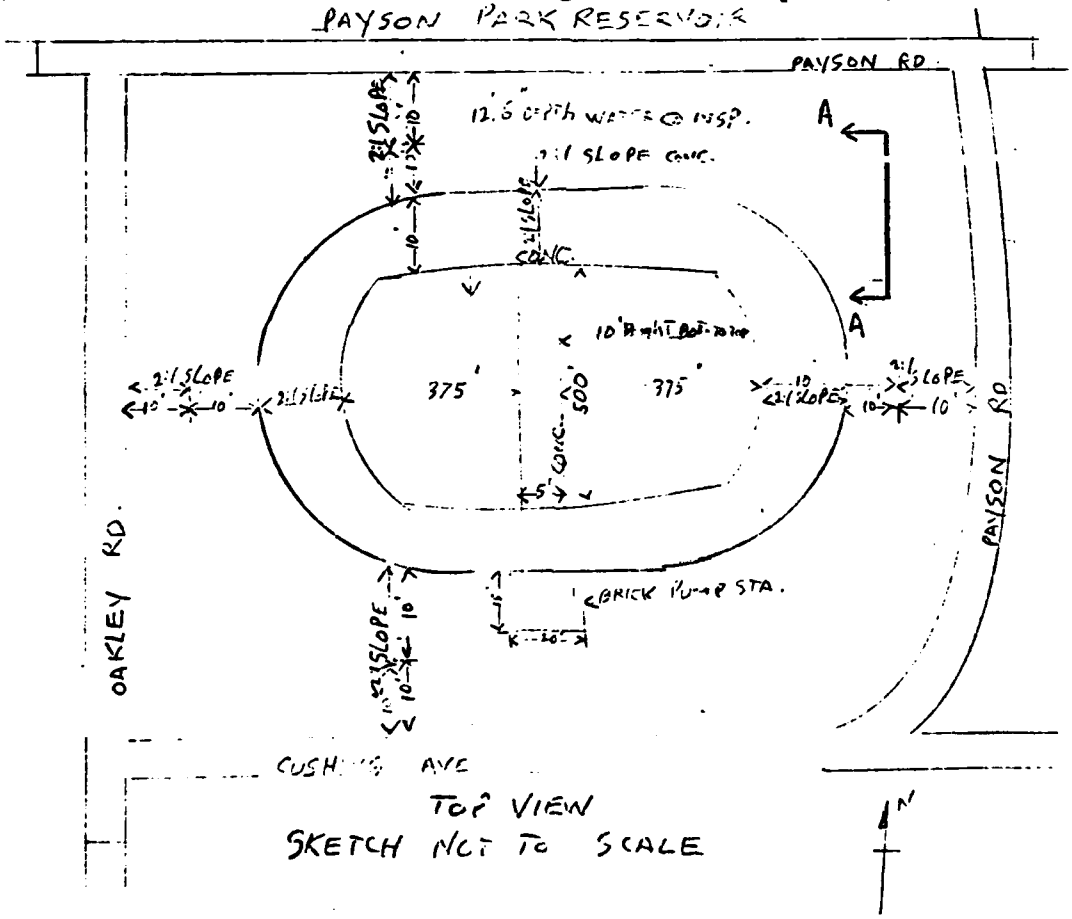
DAM NO. 4-9-26-1

10. Risk to life and property in event of complete failure.

No. of people EST. 150.
No. of homes " 50.
No. of businesses NONE.
No. of industries " .
No. of utilities .
Railroads NONE.
Other dams " .
Other .

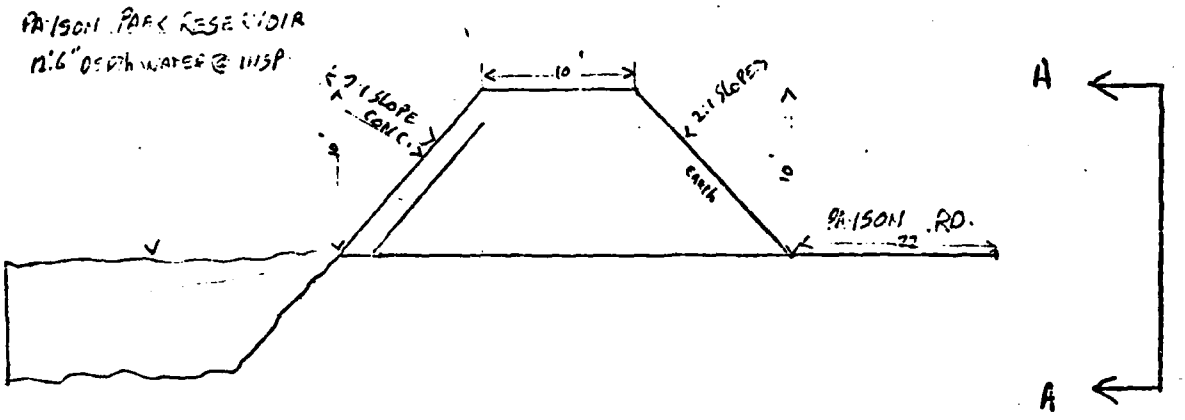
Type
Type

11. Attach sketch of dam to this form showing section and plan 8½" x 11" Sheet.



4-9-26-1

PAYSON PARK RESERVOIR
11.6" DEPTH WATER @ 1115P



X SECTION AA

SKETCH NOT TO SCALE

APPENDIX C

PHOTOGRAPHS

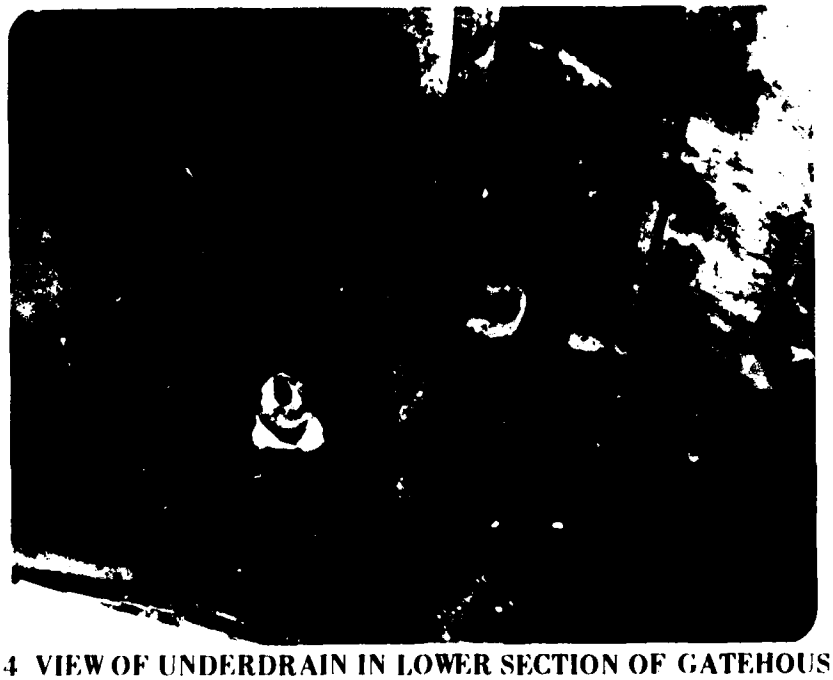
(For location and direction of view of photographs, see Figure B-1 in Appendix B.)

PAYSON PARK RESERVOIR

NO. 1 VIEW OF GATEHOUSE

NO. 2 VIEW OF INLET AND OUTLET

NO. 3 VIEW OF GUNITE LINING IN NORTH BASIN

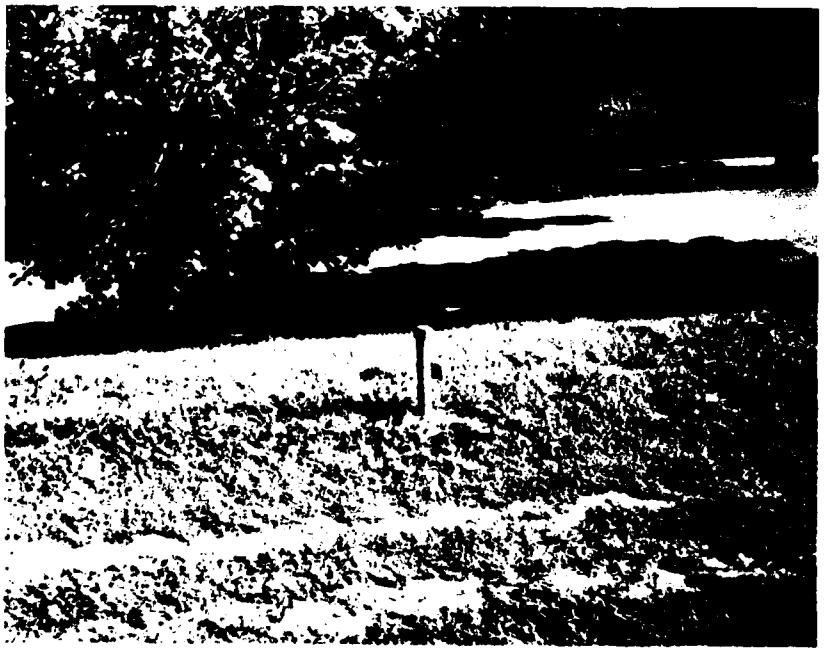


NO. 4 VIEW OF UNDERDRAIN IN LOWER SECTION OF GATEHOUSE

NO. 5 VIEW OF LEAKAGE THROUGH
CRACKS IN BOTTOM OF NORTH BASIN

NO. 6 VIEW OF LEAKAGE THROUGH
BOTTOM OF CENTER BAFFLE WALL

NO. 7 EXTERIOR SLOPE AND TOE OF EMBANKMENT



NO. 8 OBSERVATION WELL ON TOP OF EMBANKMENT

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

PAYSON PARK RESERVOIR

Project Nat. Review of Non Federal Dams Acct. No. 6356 Page 1 of 6
Subject Middlesex County, Ma Comptd. By LEB Date 11/19/79
Detail PAYSON PARK RES Ck'd. By John R Keaton Date 12/ :79

(I) Test Flood

A- Classification

Size : Small ; Hazard : High, Test Flood : ½ to Full PMF

Use : ½ PMF = ½ PMP

B Tributary Area

Use direct rainfall on full tributary area of 8.04 ac. Trib. area based on high point of perimeter dike, about 6 to 10 feet outside of gunited surface

C - Rainfall

Hour Ending	Full PMP Incr. Rain (in.)	Half PMP Incr. Rain (in.)	Half PMP Rain Rate (in./hr.)	Half PMP Inflow (cfs.)	Half PMP Incr. Vol. (ac.ft.)
1	1.52	0.76	0.76	6.2	0.51
2	1.71	0.86	0.86	7.0	0.58
3	1.90	0.95	0.95	7.7	0.64
3:30	3.61	1.81	3.62	29.3	1.21
4	5.70	2.85	5.70	46.2	1.91
5	3.04	1.52	1.52	12.3	1.02
6	1.52	0.76	0.76	6.2	0.51
					Σ = 6.38 ac.ft.

D- Pumping Rate

Res. supplied by 3 - 12 mgd pumps. Max. reported pumping rate is ±27 mgd or 42 cfs

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 2 of 6
Subject Middlesex County, Mass. Comptd. By LEB Date 11/19/79
Detail PAYSON PARK RES Ck'd. By J. R. Benton Date 12/1/79

(II) Reservoir Volumes

@ el. 158.3±: 2.496 ac + 2.775 ac = 5.271 ac
@ el. 182.4±: 3.556 ac + 3.835 ac = 7.721 ac
} 2.45 ac in 24.1' *

* Can be linear over this range

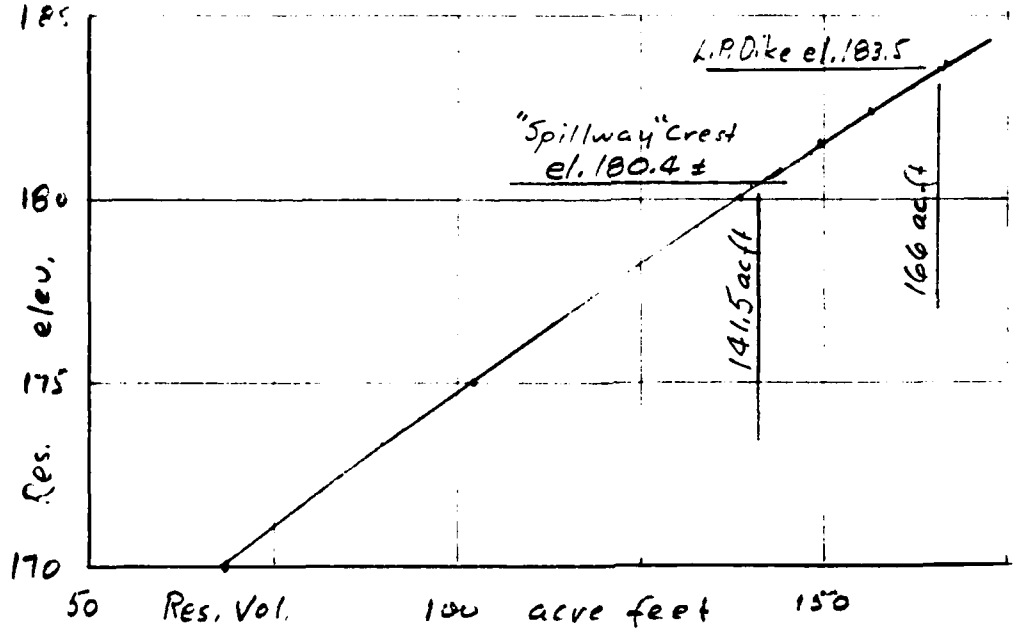
@ el. 181.5: $5.271 + \frac{23.2}{24.1}(2.45) = 7.629$ ac (±)

Add $515(6)\left(\frac{1}{43560}\right) = .071$ ac. to any area

	Area	Δh	ΔVol	Vol.	Vol.
El. 158.3±	5.271 ac			0	0
		23.2'	149.64		
El. 181.5	7.629 ac			149.64	48.75
		0'	0		
El 181.5	7.700 ac.			149.64	48.75
		0.9	6.97		
El 182.4	7.792			156.61	51.03
		1.3	10.29		
El 183.7±	8.036			166.90 ac. feet	54.38 million gal

[Vol. = 5.271 h + .0508 h^2 up to el. 181.5±]

(Note: Dam cap is 43.10 million gal or 132.28 ac. feet)



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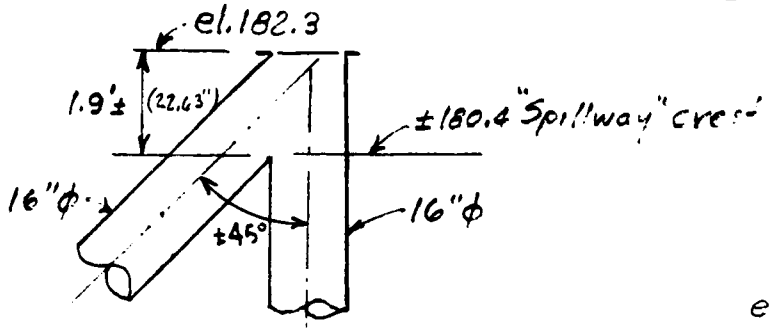
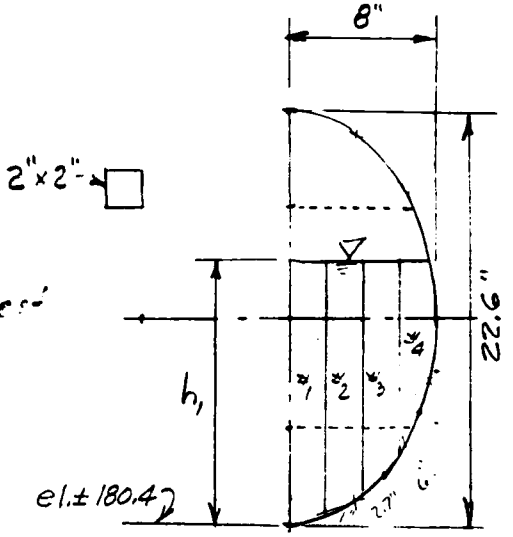
(III) Discharge Relations

A - Overflow Pipe





Divide outflow into 6-2" wide sections, sym. about vert. axis
For each section: $q = 3.3(2")h^{1.5} \cong 3.3(\text{Area})h^{1/2}$

$h_2 \cong h_1 - 1"$, $h_3 \cong h_1 - 2.7"$, $h_4 \cong h_1 - 6"$

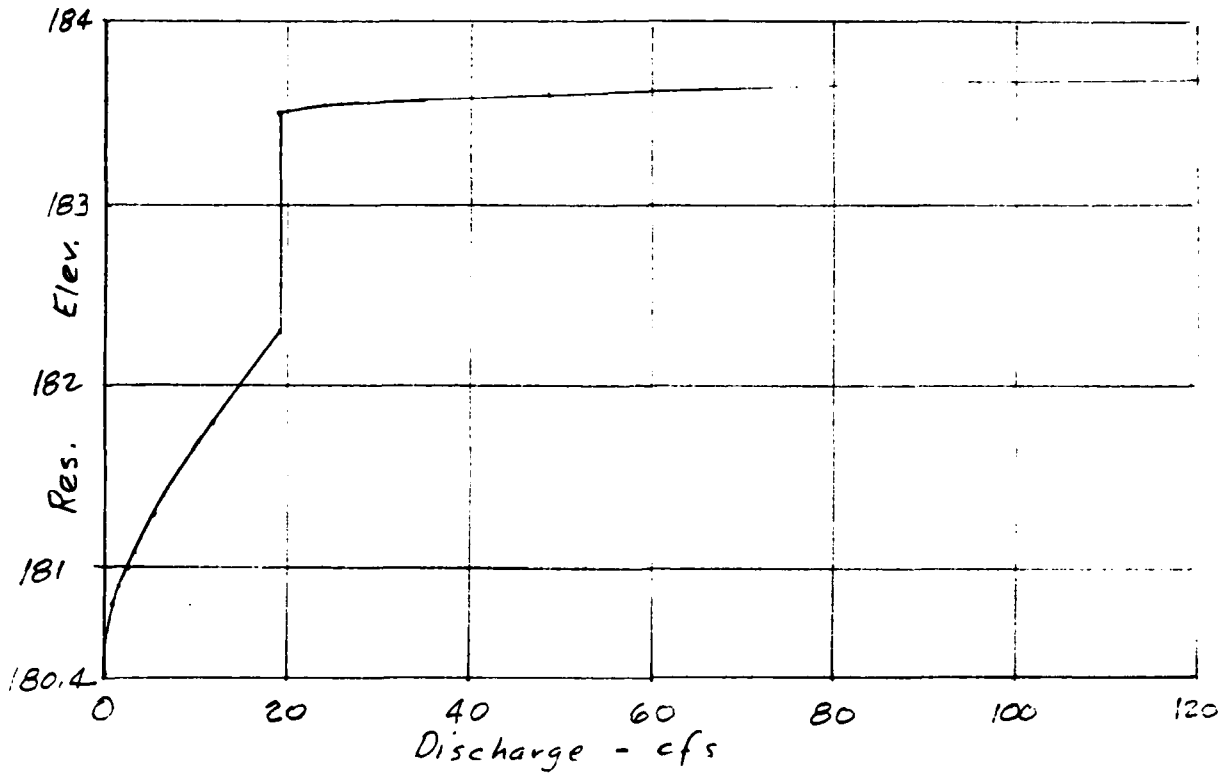
Water El.	180.8	181.3	181.8	182.3
A_1	10 in² - .069	22 in² - .153	34 in² - .236	Orifice Flow
h_1	5.3" - .442	11.3" - .942	17.3" - 1.442	$Q = CA\sqrt{2gh}$
q_1	.15	.49	.93	
A_2	9 in² - .062	21 in² - .146	33 in² - .229	$C = 0.61$
h_2	4.3" - .358	10.3" - .858	16.3" - 1.358	$A = \pi(.95)(.67) = 2.0 ft^2$
q_2	.12	.45	.88	
A_3	6 in² - .042	18 in² - .125	30 in² - .208	$h = \frac{1}{2}(1.9) = 0.95$
h_3	2.6" - .216	8.6" - .717	14.6" - 1.217	No head increase due to overflow to valve pit.
q_3	.06	.35	.76	
A_4	— —	10 in² - .069	20 in² - .139	
h_4	— —	5.3" - .442	11.3" - .942	
q_4	—	.15	.46	
Σq	.33	1.44	3.02	
Q/pipe	.66 cfs	2.88 cfs	6.04 cfs	9.54 cfs
Q_A	1.32 cfs	5.76 cfs	12.08 cfs	19.08 cfs

B - Dike Crest

320' @ 183.5 (L.P.), 454' @ 183.6, $q = 2.55h^{1.5}$

Res El. 183.6 - Q = 30 cfs
" " 183.7 Q = 70 + 40 = 110 cfs

(IV) Reservoir Elevation vs Discharge



(V) Maximum Reservoir Elevations

A - ½ PMF Storm (Res. @ Spillway Crest El. - no inflow/outflow)

Hour Ending	Vol. In. (ac ft.)	Ave Res El.	Discharge Q cfs	Discharge Vol (ac ft)	New Res. El.	Vol. Stored (ac ft)
1	0.51	180.4±	—	—	180.4±	0.51
2	0.58	180.45±	—	—	180.45±	1.09
3	0.64	180.7±	1	.08	180.7±	1.65
3:30	1.21	180.8±	1.3	.05	180.8±	2.81
4	1.91	180.9±	2	.09	181.0±	4.64
5	1.02	181.0±	3	.25	181.1±	5.41
6	0.51	181.1±	3	.25	181.1±	5.77

Max. Res. El. 181.1±

(V) Maximum Reservoir Elevations (Cont.)

B - Uncontrolled Pumping (no outflow)

Max. Rate is ± 27 mgd = 42 cfs = 3.47 ac ft/hour

Max Spillway Rate = 19 cfs = 1.57 ac ft/hour

Net Storage Rate 1.90 ac ft/hour

Time to Rise from "spillway" crest to L.P. in dike (el. 183.5)

$$\frac{166 \text{ ac ft} - 141.5 \text{ ac ft}}{1.90 \text{ ac ft/hr}} = 12.9 \text{ hours}$$

C - Uncontrolled Pumping plus ½ PMF Storm (no outflow)

6 hr., ½ PMF storm raises reservoir to el. 181.1 or total storage vol. of 147 ac. ft. Reservoir at el. 183.5, the dike L.P. has a storage vol. of 166 ac. ft. The max. pumping inflow rate is 27 mgd or 3.47 ac. ft per hour.

Vol. avail. for Uncontr. Pump. = 166 - 147 = 19 ac. ft.

Time to use above Vol. = $\frac{19}{3.47}$ = 5.47 hours

After 5.47 hr., rainfall ≈ 0. Thus continued uncontrolled pumping would raise reservoir to elev. ± 183.6, where over dike outflow equals pumped inflow.

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 6 of 6
Subject Middlesex County, Mass. Comptd. By LEB Date 11/20/79
Detail PAYSON PARK RES. Ck'd. By J.R. Resitano Date 12/3/79

(VI) Failure of Dam

Peak Failure Flow:

Pond Elevation - 183.5 (L.P. on dike crest)
Toe Elevation — 158.3 (± bot. of res.)
$Y_o = 25.2$

Dam Length Subject to Breaching $\cong 2^* \times Y_o \simeq 50'$
~~$W_o = 1.4 Y_o$~~

*Based on photo of earth dam failure

$$Q_{P_1} = 1.68\, W_o\, (Y_o)^{1.5} = 1.68\,(50)\,(25.2)^{1.5} = \underline{10600 \text{ cfs}}$$

Storage Volume Released:

Storage Above ~~Spillway~~ Cent. Wall (el. 181.5) = 166 − 150 = 16 ac-ft
Storage Below ~~Spillway~~ " " (So. Basin) ± ½ (150) = 75 "
S = Total Storage = 91 " "

Channel Hydraulics:

No Existing Channel. Surrounding ground higher than res. bottom on all sides except at south east corner. Failure at this corner is likely to send flow down Payson Road to Elm St. toward Forest Pond. Flow would drop ± 90 feet in the 1st ± 1200' of street, and then ± 20 feet in the next ± 1300 feet.

At the end of the steep section of ± 50' wide street:

$$90' \simeq \frac{V^2}{2g} + S_e\,(1200)\;;\quad S_e = \left(\frac{Vn}{1.49\,R^{1/3}}\right)^2;\quad n = .02,\ R \simeq y$$

$$90 = V^2\left[\frac{1}{2g} + \left(\frac{.02}{1.49\,y^{1/3}}\right)^2 1200\right] = V^2\left[.01553 + .21621\left(\frac{1}{y}\right)^{2/3}\right]$$

$$V = \frac{10600}{50\,y}\;;\quad y \simeq 4.7 \text{ ft}\quad V \simeq 45 \text{ fps}$$

Time to Drain:

$$\frac{43560\ (91)}{3600\,(1/2)\,(10600)} = 0.21 \text{ Hours, or } 12.5 \text{ Minutes}$$

METCALF & EDDY, ENGINEERS

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

PAYSON PARK RESERVOIR

NOT AVAILABLE AT THIS TIME

END

FILMED

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DTIC