

AD-A147 155

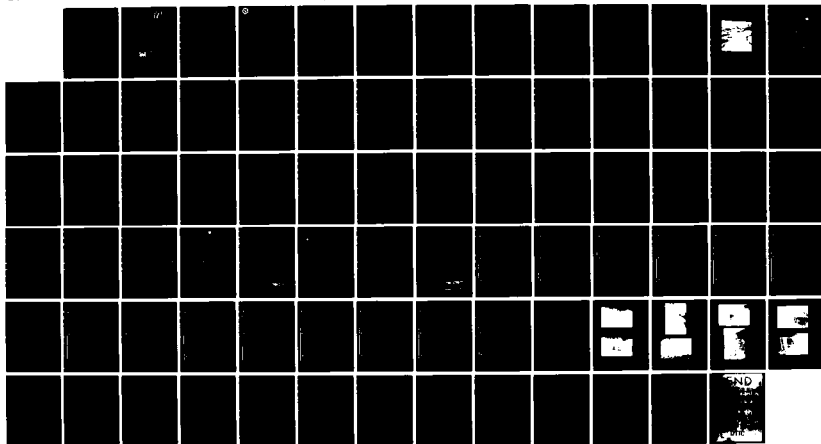
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
SHOE POND DAM (MA 001) (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV SEP 79

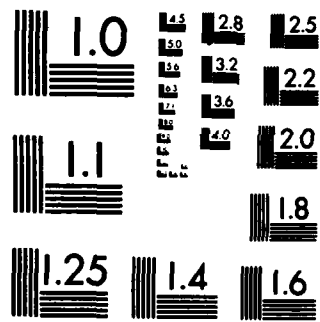
1/1

UNCLASSIFIED

F/G 13/2

NL





AD-A147 155

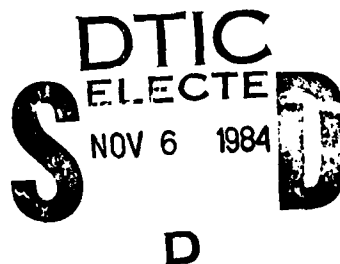
DANVERS RIVER BASIN
BEVERLY, MASSACHUSETTS



SHOE POND DAM
MA 00183

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**

DTIC FILE COPY



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

SEPTEMBER 1979

DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited

84 10 29 029

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER MA 00183	2. GOVT ACCESSION NO. AD A147155	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Shoe Pond Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE September 1979
		13. NUMBER OF PAGES 65
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES 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, Danvers River Basin Beverly, Mass.		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam at Shoe Pond is a 17 foot high, 250 foot long earth embankment with a concrete core wall. The dam is in fair condition. The dam has been classified in the "small" size and in the "significant" hazard categories. A test flood equal to $\frac{1}{2}$ the PMF was used to evaluate the capacity of the spillway.		



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

REPLY TO
ATTENTION OF:
NEDED

DEC 17 1979

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

Dear Governor King:

Inclosed is a copy of the Shoe Pond Dam 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, United Shoe Machinery Corporation, Beverly, Massachusetts.

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
MAX B. SCHEIDER

Incl
As stated

Colonel, Corps of Engineers
Division Engineer

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A/1	

SHOE POND DAM

MA 00183

DANVERS RIVER BASIN
BEVERLY, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA 00183

Name of Dam: Shoe Pond

Town: Beverly

County and State: Essex County, Massachusetts

Stream: Bass River - Tributary of the Danvers River

Date of Inspection: April 18, 1979

The dam at Shoe Pond is a 17 foot high, 250 foot long earth embankment with a concrete core wall. The dam, which was originally constructed in 1904, was raised 3 feet in 1941. The outlet works are located at the west abutment and consist of a 26.3-foot long weir with stoplogs and a low-level outlet. Discharge is over the stoplogs of the weir and over the top of the outlet gate. The effective length of the spillway is 33.0 feet with the crest at elevation (EL) 20.5. Discharge flows down a concrete-lined chute and into a lower pond. The difference in elevation between the upper and lower ponds is 9.6 feet. A 14-inch intake, passing through a gatehouse on the dam, provides water to United Shoe Machinery Corporation.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based on a visual inspection of the dam, a review of available data, and statements made by the Owner as to operation, maintenance, and past performance. Generally, the dam is in fair condition.

The following deficiencies were observed: a localized slump on the downstream slope of the dam, riprap missing on the upstream face of the dam, localized erosion and bushes growing on the crest of the dam, deteriorated concrete in the chute below the outlet works and on the pier out to the 14-inch intake, debris accumulated at the trash rack in the chute, and small trees and brush growing along the sides of the chute.

SHOE POND DAM

Based on the Corps of Engineers' guidelines, the dam has been classified in the "small" size and in the "significant" hazard categories. A test flood equal to one-half the probable maximum flood (PMF) was used to evaluate the capacity of the spillway. The drainage area is 1.65 square miles. Due to the restriction caused by the street embankment upstream, the test flood inflow was adjusted from 1,180 cubic feet per second (cfs) to 800 cfs. Due to the delay in the arrival of the peak discharge from upstream of the street embankment, the test flood outflow is estimated to be equal to the inflow of 800 cfs. This results in the pond at El 23.7 which is 0.8 feet above the low area upstream of the east abutment of the dam. The spillway (with stoplogs) can discharge 475 cfs which is 59 percent of the test flood outflow before the low area is overtopped. With the stoplogs removed, the spillway can discharge 660 cfs or 83 percent of the test flood before overtopping occurs.

It is recommended that the Owner employ a qualified engineering consultant to evaluate the localized slump on the downstream face of the dam and to perform a static and seismic analysis of the embankment. In addition, the Owner should repair the deficiencies listed above, as described in Section 7.3. The Owner should also implement a program of annual technical inspections, a plan for surveillance of the embankment during and after periods of high runoff, and a plan for notifying nearby residents in the event of an emergency at the project. The measures outlined above and in Section 7 should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.



Edward M. Greco

Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.

Approved by:

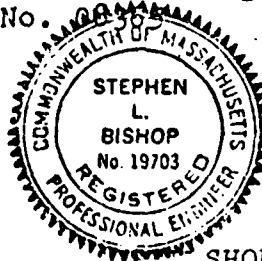
Stephen L. Bishop

Stephen L. Bishop, P.E.
Vice President

Metcalf & Eddy, Inc.

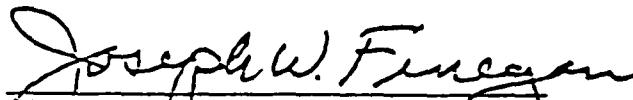
Massachusetts Registration
No. 19703

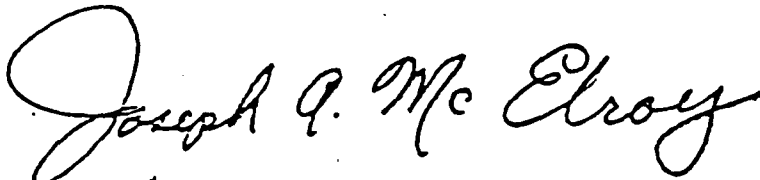
Connecticut Registration
No. 8365

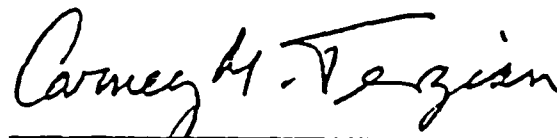


SHOE POND DAM

This Phase I Inspection Report on Shoe Pond Dam 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.


JOSEPH W. FINNEGAN, JR., MEMBER
Water Control Branch
Engineering Division


JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division


CARNEY M. TERZIAN, CHAIRMAN
Chief, Structural Section
Design 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 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.

SHOE POND DAM

TABLE OF CONTENTS

	<u>Page</u>
BRIEF ASSESSMENT	
PREFACE	
OVERVIEW PHOTO	iii
LOCATION MAP	iv
REPORT	
SECTION 1 - PROJECT INFORMATION	1
1.1 General	1
1.2 Description of Project	2
1.3 Pertinent Data	5
SECTION 2 - ENGINEERING DATA	10
2.1 General	10
2.2 Construction Records	10
2.3 Operating Records	10
2.4 Evaluation	10
SECTION 3 - VISUAL INSPECTION	11
3.1 Findings	11
3.2 Evaluation	13
SECTION 4 - OPERATING PROCEDURES	14
4.1 Procedures	14
4.2 Maintenance of Dam	14
4.3 Maintenance of Operating Facilities	14
4.4 Description of Any Warning System in Effect	14
4.5 Evaluation	14
SECTION 5 - HYDRAULIC/HYDROLOGIC	16
5.1 Evaluation of Features	16

SHOE POND DAM

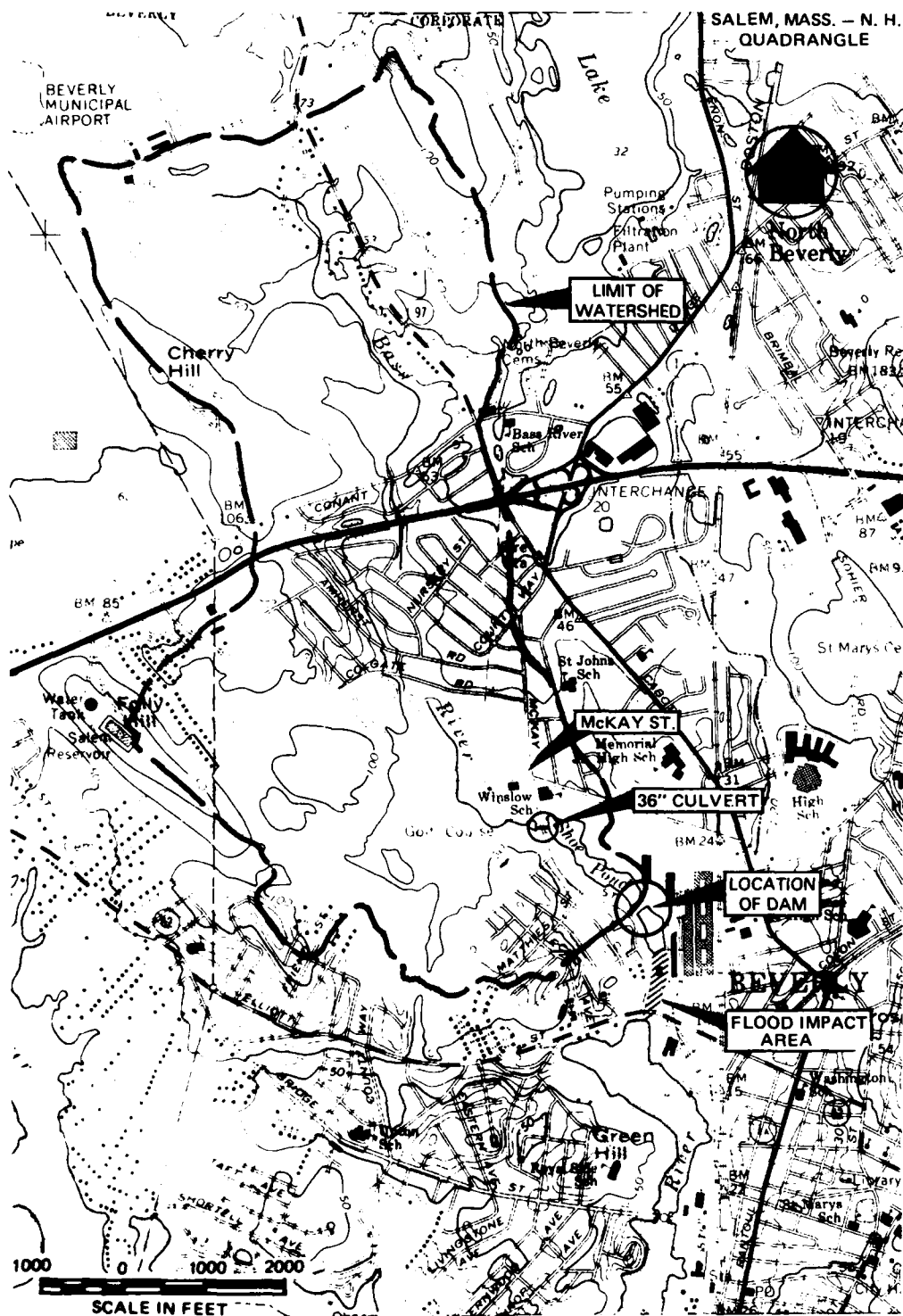
TABLE OF CONTENTS (Continued)

	<u>Page</u>
SECTION 6 - STRUCTURAL STABILITY	19
6.1 Evaluation of Structural Stability	19
SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES	21
7.1 Dam Assessment	21
7.2 Recommendations	22
7.3 Remedial Measures	22
7.4 Alternatives	23
APPENDIXES	
APPENDIX A - PERIODIC INSPECTION CHECKLIST	
APPENDIX B - PLANS OF DAM AND PREVIOUS INSPECTION REPORTS	
APPENDIX C - PHOTOGRAPHS	
APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS	
APPENDIX E - INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS	

SHOE POND DAM

**OVERVIEW
SHOE POND DAM
BEVERLY, MASSACHUSETTS**





LOCATION MAP - SHOE POND DAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

SHOE POND DAM

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 Division 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.

SHOE POND DAM

1.2 Description of Project

- a. Location. The dam is located on the Bass River, a tributary of the Danvers River, in the Town of Beverly, Essex County, Massachusetts (See Location Map and Overview Photo). The coordinates of this location are Latitude 42 deg. 33.6 min. north and Longitude 70 deg. 53.4 min. west.
- b. Description of Dam and Appurtenances. The dam is a 250-foot long earth embankment (See Figures B-1 and B-2 and photographs in Appendix C). The height of the dam is about 17 feet, which is the original height of 14 feet (shown on sketch on page B-3) plus 3 feet which was added in 1941. According to a previous inspection and construction report (see page B-3), the dam has a concrete core wall which was raised 3 feet and extended in length in 1941. The crest of the dam is 13 to 15 feet wide and varies from El 23.7 to El 24.0. There is a gravel pathway on the crest from the east abutment to the outlet works (see Photo No. 1), and an 8-foot high chain-link fence is located on the upstream edge of the crest. The upstream face slopes at 2:1 (horizontal to vertical) and is covered with riprap to approximately El 22.0. There are several slabs of concrete overlying the upper riprap stones. Above this elevation, the slope is covered with grass and bushes (See Photo No. 3). The downstream face, which is covered with grass, slopes at 3:1. There is riprap at the toe of this slope to protect the embankment from erosion due to wave action on the lower pond (See Photo No. 6).

The outlet works, which are located at the west abutment (See Photo No. 2), consist of a sharp-crested weir adjacent to a low-level slide gate (see photograph No. 2). Discharge from the spillway and low-level outlet is into an open concrete chute leading to the lower pond. The approach to the spillway has 16-foot long vertical concrete training walls and a stone bottom. The concrete crest of the spillway is at El 19.8. Stoplogs are set on top of the weir to El 20.5. The chute below the weir is 165 feet long and varies in width

SHOE POND DAM

from 33 feet at the weir to 15 feet wide at the point of discharge into the lower pond. The chute slopes at 2 percent and has a concrete floor and walls. A trash rack is located about 30 feet downstream from the spillway.

The low-level outlet for the dam consists of a gate 5.7 feet wide and 5 feet high located adjacent to the spillway. The top and bottom elevations of the gate are the same as the weir with stoplogs. The gate and weir are separated by a 1-foot wide, 7-foot long concrete wall. The low-level gate is manually operated from a platform above the gate.

There is a 14-inch diameter intake pipe that leads from the pond to a concrete reservoir at the United Shoe Machinery Corporation, located east of the dam. There is a wood and concrete pier from the crest of the dam out to the upstream end of the intake. The invert of the intake is at El 16.0. Control valves for the pipe are located in a wooden gate house on the upstream face of the dam.

McKay Street, at the north end of Shoe Pond, forms an embankment that attenuates the drainage into the pond. There is a 36-inch diameter culvert under McKay Street that discharges into Shoe Pond (See Figure B-2 in Appendix B).

- c. Size Classification. Shoe Pond Dam is classified in the "small" category since it has a maximum height of 17 feet and a maximum storage capacity of 58 acre-feet.
- d. Hazard Classification. Immediately downstream of the dam is the lower holding pond. On the east side of the lower pond there are two factory buildings of the United Shoe Machinery Corporation complex (See Overview Photo and Location Map). The smaller building is used for storage, while the other building is occupied and used in the manufacturing process. South of the factory is the main parking lot for the factory. The outlet for the lower pond is a culvert that extends under Elliott Street and discharges into the Bass River.

SHOE POND DAM

Failure of the dam when the pond is at the crest of the dam would produce a flood wave about 3 feet high passing through parts of some factory buildings, the main parking lot, and across Elliott Street. It is possible that this flood wave could result in appreciable property damage and the loss of a few lives. Accordingly, the dam has been placed in the "significant" hazard category.

- e. Ownership. The dam is owned by United Shoe Machinery Corporation which is located at Elliott Street, Beverly, Massachusetts (telephone 617- 927-4200). The Manager of Plant Engineering for United Shoe Machinery Corporation is Mr. Bruce Paul, who granted permission to enter the property and inspect the dam.
- f. Operator. The dam is operated by personnel from United Shoe Machinery Corporation.
- g. Purpose of Dam. The water from Shoe Pond is used for fire protection and for cooling the turbines in the United Shoe Machinery Corporation factory. The water is also used for irrigation of the golf course on the west side of McKay Street. The water is used at the golf course only when the level in Shoe Pond is above El 16.0.
- h. Design and Construction History. The dam at Shoe Pond was constructed about 1904. The dam was constructed with a concrete core wall and a "hard compact clay" on the upstream side. The core wall extends to "solid ground". At the time of the original construction, the maximum hydraulic height between the upper and lower ponds was 12.0 feet. The elevation of the crest of the dam was 2 feet above the maximum pond level.

In 1934, repairs were made to the spillway, and the upper slope was paved. The 1940 inspection report (see Appendix B) states that the intent of United Shoe Machinery Corporation was to raise the dam 2 to 3 feet. In 1941, the work on raising the core wall and dam to the present elevation of 23.5 + feet was started. The core wall was extended to

SHOE POND DAM

the east for "a short section". The low-level outlet was constructed adjacent to the spillway at the same time. The construction was completed in 1942.

Subsequent changes have been made periodically. In 1954, permission was granted by the County to raise the elevation of the weir by 8 inches using stoplogs. In 1956, the low-level outlet was repaired. In 1970, a concrete cap wall was placed on both walls near the weir and low-level outlet to cover spalled concrete.

1. Normal Operating Procedures. Personnel from United Shoe Machinery Corporation reportedly visit the dam daily. The stoplogs, although removable, are intended to remain in place permanently. The low-level outlet was repaired in 1956. Since that time it reportedly has not been operated. Maintenance work is performed on the dam twice a year and at that time debris is removed from the trash rack.

Measurements of the depth of the reservoir are made when the water is below El 16.0 (invert of 14-inch intake). The United Shoe Machinery Corporation will not supply irrigation water to the golf course when the water level is below El 16.0.

A 14-inch intake pipe discharges water to a concrete holding tank. This water is used for cooling the turbines in the powerhouse. The static water level in the holding tank is the same as the water surface in the reservoir. The gate valves in the gate house and in the holding tank are both kept open under normal operating conditions.

1.3 Pertinent Data

- a. Drainage Area. The approximately 1,056-acre (1.65 square mile) drainage area includes the drainage area of the Bass River (See Location Map). The McKay Street embankment is a restriction to direct drainage into the pond. There is a 36-inch culvert that discharges water into the pond from the west side of McKay Street.

SHOE POND DAM

The topography of the watershed is gently rolling. About 2.5 percent of the drainage area is swamps. The remaining land is about one-quarter wooded and three-quarters cleared, partially for residential use.

- b. Discharge. Normal discharge is over a 33-foot long weir formed by the spillway and the top of the outlet gate. The crest of the weir with stoplogs in place on the spillway is at El 20.5. The water flows downstream into a concrete-lined chute which is 33 feet wide at the weir and narrows to 15.0 feet at the exit. The chute is 165 feet long and discharges into Lower Pond. The outlet for the lower pond is a concrete arch culvert about 11 feet wide with a 30-inch sluice gate at the entrance. The bottom of the sluice gate is at El 8.6.

The test flood inflow (one-half PMF) was estimated to be 800 cfs, after adjusting for the restriction caused by an upstream street embankment (see McKay Street shown on Location Map). The peak test flood outflow is estimated to be 800 cfs with the pond at El 23.7 and would overtop the low area near the dam by a maximum of 0.8 feet. The spillway with stoplogs can discharge 475 cfs or 59 percent of the peak test flood outflow before the low area is overtopped. Without stoplogs, the spillway can discharge 660 cfs or 83 percent of the test flood before the low area is overtopped.

Personnel from United Shoe Machinery Corporation stated that the dam has never been overtopped.

- c. Elevation (feet above Mean Sea Level (MSL)). A benchmark was established at El 20.5 on top of the stoplogs. This elevation was estimated from a United States Geological Survey (USGS) topographic map.
- (1) Top dam - 23.7 to 24.0 (El 22.9 low point - east of dam)
 - (2) Test flood pool: 23.7

SHOE POND DAM

- (3) Design surcharge (original design):
unknown
- (4) Full flood control pool: N/A
- (5) Recreation pool: 20.5 top of stoplogs
- (6) Spillway crest (without stoplogs): 19.8
- (7) Upstream portal invert diversion tunnel:
16.0 invert of 14-inch intake to factory
- (8) Streambed at centerline of dam: 7.0
(estimated)
- (9) Tailwater: 11.0 - Lower Pond

d. Reservoir

- (1) Length of maximum pool: 1,500 feet
- (2) Length of recreation pool: 1,500 feet
- (3) Length of flood control pool: N/A

e. Storage (acre-feet)

- (1) Test flood surcharge (net): 24.5 at El
23.7
- (2) Top of dam (El 22.9): 58
- (3) Flood control pool: N/A
- (4) Recreation pool (El 20.5 - Top of
Stoplogs): 38
- (5) Spillway crest (El 19.8): 33

f. Reservoir Surface (acres)

- *(1) Top dam: 7.6
- *(2) Test flood pool: 7.6
- (3) Flood control pool: N/A

*Based on the assumption that the surface area will not significantly increase with changes in pond elevation from 20.5 to 23.7

SHOE POND DAM

- (4) Recreation pool: 7.6
- (5) Spillway crest (with stoplogs): 7.6

g. Dam

- (1) Type - earthfill embankment
concrete core wall
- (2) Length: 250 feet
- (3) Height - maximum: 17 feet
- (4) Top width: 13 to 15 feet
- (5) Side slopes - downstream: 3:1
upstream: 2:1
- (6) Zoning: Concrete core wall with clay
fill
- (7) Impervious core: Concrete core wall
- (8) Cutoff: unknown
- (9) Grout Curtain: none

h. Spillway

- (1) Type - Sharp-crested weir with stoplogs
mounted on weir
- (2) Crest length: 33.0 feet, including 26.3
feet of stoplogs, a 1-foot thick concrete
wall, and 5.7 feet on top of the outlet
gate (see Photograph No. 2, page C-1).
- (3) Crest elevation: 20.5 with stoplogs
19.8 without stoplogs
- (4) Gates: None
- (5) Upstream channel: Vertical concrete
training walls extending 16 feet
upstream, wing wall 5 feet long on
westerly wall, floor covered with riprap.
- (6) Downstream channel: 33 feet wide at
outlet and 15.0 feet at exit. 165 feet
long. Concrete walls and floor entire
length. Trash rack at the foot bridge.

1. Regulating Outlets. The regulating outlet at the dam consists of a slide gate adjacent to the weir. This gate is 5.7 feet wide and has the same top and bottom elevations as the spillway with stoplogs, El 20.5 and El 15.5. The capacity of the gate is 180 cfs with a pond elevation at 20.6. The gate can be raised manually until movement is impeded by the platform above it at El 24.6.

SHOE POND DAM

SECTION 2

ENGINEERING DATA

- 2.1 General. Previous inspection reports and reports on the additional construction in 1941 are available for the Shoe Pond Dam. A sketch showing the concrete core wall and slopes of the dam are on the first inspection form, made in 1917. No record plans of the work done in 1904, 1941 or 1956 were found.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Division of Waterways, the Massachusetts Department of Public Works and the USM Corporation.

- 2.2 Construction Drawings. The only construction records are the reports referred to in Section 2.1 and included in Appendix B. There are no as-built drawings of the dam.

- 2.3 Operating Records. The only operating records kept are when the pond level drops below El 16.0.

2.4 Evaluation

- a. Availability. There is limited engineering data available.
- b. Adequacy. The lack of detailed structural and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on review of available past inspection and construction reports, past performance history and engineering judgment.
- c. Validity. Comparison of the available drawings with the field survey conducted during the Phase I Inspection indicates that the available information is generally valid.

SHOE POND DAM

SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I Inspection of the dam was performed on April 18 and July 6, 1979. A copy of the inspection checklist is in Appendix A. Previous inspections were conducted by the Essex County Engineering Department in March 1917, again in 1923, 1928, and then once every two years through March 1968. A summary of these reports is in Appendix B (see Pages B-3 through B-17).
- b. Dam. The dam consists of a 250-foot long, 17-foot high earth embankment with a weir and low-level outlet at the west abutment (see Photos No. 1 and No. 2). There is a wood and concrete pier extending from the crest of the dam out to a 14-inch intake pipe. A gate house is located on the upstream slope of the dam and contains gate valves for the 14-inch intake.

The main dam is in fair condition. The upstream slope, 2:1 (horizontal to vertical) is riprapped to within 2 feet of the crest of the dam (see Photo No. 3). Some of the riprap is missing and, in one area, it has slipped down the slope. There are several random concrete slabs at the top of the riprap in the middle of the dam.

A chain-link fence located along the upstream edge of the crest of the dam is tilted towards the reservoir. There is some surface erosion under the fence along its entire length. Some bushes are growing on the crest and upstream face of the dam (see photograph No. 3).

There is a gravel pathway on the crest of the dam, and a metal grated foot bridge across the chute. The downstream slope is 3:1 and covered with grass. There is a localized slump midway on the slope located between the gatehouse and east abutment. The approximate dimensions of the slump are 10 feet wide and

SHOE POND DAM

30 feet long. At the toe of the slope there is riprap extending out into the lower pond. This riprap was in good condition.

- c. Appurtenant Structures. The outlet works on the dam consist of a sharp-crested weir adjacent to a low-level slide gate which discharges into a chute on the west abutment of the dam. The approach channel to the weir is formed by two concrete walls extending 16 feet out into the pond. The westerly wall has a wing wall 5 feet long. There is a chain-link fence set on both approach walls. The bottom of the channel is stone covered and in good condition. The concrete approach walls are spalled, especially the easterly wall where the fence has partially fallen into the water due to the deteriorated concrete. The weir is concrete with 0.7 feet of stoplogs added on top. The stoplogs, although removable, are intended to remain permanently. The concrete on the weir has some minor spalling. Water was flowing over the weir at the time of inspection, and it was not possible to conduct a detailed examination. The USM Corporation has not operated the low-level gate since 1956.

The chute has some localized wet areas and some severe spalling near the weir and low-level outlet (see photograph No. 7). The floor of the chute is also spalled at the downstream end for a length of 20 feet. Downstream of the weir, there are two I-beam compression struts to support the concrete walls of the chute. The concrete around the joints at all four locations is in poor condition. A trash rack is located on the upstream side of a foot bridge over the chute. The rack is in good condition, although it contains an accumulation of debris about 3 feet deep. There is one crack that extends across the floor and walls of the chute. This crack is located midway between the footbridge and the downstream end of the chute. Brush and trees are growing along the west side of the chute, and some branches are overhanging the chute.

SHOE POND DAM

There is a 14-inch intake pipe in the pond that discharges into a concrete reservoir near the factory. This water is used for cooling the turbines in the power house. There is a wooden screen around the intake which can be reached by a wood and concrete pier extending from the crest of the dam. The pier is supported on concrete columns which have deteriorated, and the reinforcing bars are exposed and corroded. Tension rods under the pier are also corroded. Gate valves are located in the gatehouse on the crest of the dam. The valves are in good condition and and reported to be operable.

- d. Reservoir Area. The area around Shoe Pond contains two factories, an athletic field and McKay Street. The embankment beneath McKay Street separates Shoe Pond from the golf course upstream and forms a drainage divide. There is a 36-inch culvert through the McKay Street embankment.
- e. Downstream Channel. Immediately downstream of the dam is the Lower Pond. There is an 11-foot wide culvert from the lower pond which discharges under Elliot Street into the Bass River.

- 3.2 Evaluation. The above findings indicate that the dam is in fair condition and that there are several deficiencies which require attention. Recommended measures to improve these conditions are stated in Section 7.3.

SHOE POND DAM

SECTION 4

OPERATING PROCEDURES

- 4.1 Procedures. Personnel from the USM Corporation reportedly visit the dam daily. The normal procedures at the dam consist of keeping the gate valve open to the 14-inch intake pipe. This pipe discharges water into a concrete reservoir which is used to cool the turbines.

The maximum possible capacity is maintained in the reservoir at all times. Water is supplied to the municipal golf course for irrigation when the reservoir level is above El 16.0.

- 4.2 Maintenance of Dam. Maintenance of the dam is reportedly performed twice a year. Brush is cleared and debris removed from the trash rack. About seven years ago, the concrete spillway was repaired. However, in subsequent years, more spalling of the concrete has taken place, and in some areas it is quite severe. Also, erosion is occurring under the fence on the upstream side of the crest, and some bushes are growing on the crest and upstream face of the dam.

- 4.3 Maintenance of Operating Facilities. The low-level outlet adjacent to the spillway was repaired in 1956 and has not been operated according to plant personnel. Debris has accumulated at the trash rack downstream of the outlet.

The valves to the 14-inch intake pipe are kept open and are not operated. These valves are located in the gatehouse which is kept locked. Concrete supporting the pier leading to the intake pipe is in poor condition. The wooden screen structure at the discharge pipe is rotting.

- 4.4 Description of Any Warning System in Effect.
There is no warning system in effect at this dam.

- 4.5 Evaluation. Although maintenance personnel visit the dam regularly, the maintenance program is inadequate. There is no program of technical inspections or any warning system in effect at

SHOE POND DAM

Shoe Pond Dam. A regular program of inspection and maintenance, and a surveillance and warning system for this dam should be implemented as recommended in Section 7.3.

SHOE POND DAM

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. General. Shoe Pond is impounded by a 250-foot long, 17-foot high earth dam. McKay Street, which is located at the northern end of the pond, forms a restriction to 92 percent of the drainage area into the pond. There is a 36-inch diameter culvert under McKay Street to Shoe Pond. The drainage area for the pond is 1,056 acres (1.65 square miles) and is located in suburban communities with sections of dense residential development.

The maximum storage in Shoe Pond is calculated to be 58 acre-feet. The maximum flood level is unknown; personnel at USM Corporation state that the dam has never been overtopped. The pond is used for industrial purposes.

The low-level outlet is a manually operated slide gate adjacent to the weir. The spillway and outlet are separated by a concrete wall 1 foot wide and 7 feet long. The slide gate is 5.7 feet wide and 5.0 feet high and has an invert at El 15.5. The top of the gate can be raised only to El 24.6, which is the bottom of the platform from which the gate mechanism is operated. This raises the bottom of the gate to El 19.6, leaving an opening 5.7 feet wide by 4.1 feet high. The gate has a capacity of 180 cfs with a water surface at El 20.6. Assuming no inflow, the pond can be lowered 2 feet in about 2 hours starting with the water level at the spillway crest.

- b. Design Data. There are no hydraulic/hydrologic computations available for the design of the spillway at Shoe Pond Dam.
- c. Experience Data. Personnel employed at USM Corporation stated that the dam has never been overtopped.
- d. Visual Observations. Water discharges over stoplogs and over the top of the outlet gate.

SHOE POND DAM

The effective width of the spillway is 33.0 feet, and the crest is at El 20.5. The discharge channel is a concrete chute with an invert at El 15.5 at the weir. The chute curves around the dam at the west abutment and narrows down to 15.0 feet wide at the exit. The chute is 165 feet long and discharges into the lower pond. The floor slopes at 2 percent. The chute has a concrete floor and vertical concrete walls 6 feet high at the weir, 10 feet high at the trash rack and then tapers down to 2 feet high at the downstream end (See Figure B-2).

The concrete of the chute is spalled and cracked in places, and debris has piled up 2 to 3 feet deep at the trash rack. Trees and bushes are growing along the west side of the chute.

A more detailed discussion of the condition of the dam and appurtenances is given in Section 3, Visual Inspection.

- e. Test Flood Analysis. Shoe Pond Dam has been placed in the "small" size category and in the "significant" hazard category. Based on the Corps of Engineers' guidelines, a test flood ranging from a 100-year storm to a one-half PMF should be used to evaluate the capacity of the spillway. A one-half PMF was used in this analysis.

The one-half PMF rate for Shoe Pond Dam was determined to be 775 cfs per square mile of drainage area. This calculation is based on the average slope of the drainage area of 1.1 percent, the pond-plus-swamp to drainage area ratio of 2.5 percent, and the U.S. Army Corps of Engineer's guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). Applying the one-half PMF rate to 1.65 square miles of drainage area results in a calculated peak flow of 1,180 cfs as the test flood inflow. However, 92 percent of the drainage area drains to the golf course pond on the north side of McKay Street and then flows through a 36-inch diameter culvert to Shoe Pond. Because of the attenuating effect of the McKay Street embankment, the test flood inflow for Shoe Pond was reduced to 800 cfs.

SHOE POND DAM

Hydraulic analyses indicate that the spillway with stoplogs (they are removable but are intended to be permanent) can discharge 475 cfs with the pond at El 22.9, which is the low point on the ground adjacent to the east abutment of the dam. This discharge is 59 percent of the test flood outflow. Overtopping would occur in a 150-foot wide low area just upstream of the east abutment of the dam (see Figure B-1). The maximum discharge rate in the low area is estimated to be 1.8 cfs per foot of length. The depth at critical flow would be 0.47 feet with a velocity of 3.9 feet per second.

With the stoplogs removed, the spillway can discharge 660 cfs or 83 percent of the test flood outflow before the low area is overtopped. With the gate open and the stoplogs removed, the spillway can discharge all of the test flood without overtopping the low area.

- f. Dam Failure Analyses. The peak discharge rate due to failure of the dam was calculated to be 5,500 cfs. The discharge would flow directly into the lower pond with an outlet assumed to be a 30-foot wide weir at El 11.0. The weir is approximately 3 feet below the top of the dam at the lower pond. Assuming that the outlet from the lower pond would cause flow to back up and raise the lower pond to El 14, then discharge from Shoe Pond would be reduced to 3,600 cfs.

The dam failure would result in a 500 cfs flow through the conduit at the lower pond and 1,500 cfs over land. This water would go through parts of some factory buildings and the main parking lot and out across Elliot Street. The wave height would be about 3 feet. Failure of the dam could cause appreciable damage to the factory and possibly cause the loss of a few lives.

For these reasons, the dam has been placed in the "significant" hazard category.

SHOE POND DAM

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations. The evaluation of the structural stability of the dam at Shoe Pond is based on a review of the available data, a review of previous inspection reports and visual inspections conducted on April 18, and July 6, 1979.
- b. Design and Construction Data. The dam was built in 1903-04. According to the 1917 inspection report by the Essex County Engineering Department, the dam was constructed with a "heavy concrete core wall". The height of the dam from stream bed to crest was 14.0 feet. A sketch submitted with the report shows both embankment slopes at 2:1 (horizontal to vertical). Presently, the height is 17.0 feet and the downstream slope is 3:1.
- c. Operating Records. There is no instrumentation of any type in the embankment at Shoe Pond and no instrumentation was ever installed at this site. The performance of the embankment under prior loading can only be inferred by physical evidence at the site.
- d. Post-Construction Changes. Reports by the County inspectors on the new construction in 1941 and 1942 state that the dam was raised. They do not state the amount of additional height that was added. However, in the 1940 report of inspection to the County Commissioner, it states that the dam may be raised 2 or 3 feet. The raising of the core wall was accomplished by tying a new section into the existing core wall.

Counterforts, extending to undisturbed old backfill below the top of the old wall, were added for safety against overturning according to the November 5, 1941 report. The length of the dam was increased 15 feet at the easterly end when this construction was taking place.

SHOE POND DAM

In 1954, 8 inches of 2-inch by 4-inch stoplogs tied together were added to the top of the weir. In 1956 the low-level outlet gate was repaired. However, since that time it has not been operated.

The chute walls were repaired about 10 to 12 years ago. At the present time the concrete floor and walls of the spillway are spalled and the concrete at the ends of the compression struts is in poor condition.

- e. Seismic Stability. Shoe Pond is located in Seismic Zone No. 3, which indicates that there is a potential for major damage due to earthquakes in this area. This classification is based on past earthquakes of intensity VII and VIII on the Modified Mercalli Scale which occurred in 1727 and 1755, respectively. This is no record of any major earthquake since the dam was completed.

The construction reports state that the embankment is a "clay material, hard and compact". This material is not susceptible to liquefaction. However, since no test results are available on the soil and no computations are available on the design of this dam, a seismic analysis could not be done at this time. Considering that the dam is in the "significant" hazard category, a seismic investigation should be conducted as recommended in Section 7.2.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. Based upon a review of available data, the visual inspection of the site, and limited information on operation and maintenance, there are deficiencies which must be corrected to assure the continued performance of the dam. There was a localized slump mid-way on the downstream slope near the east abutment. Several other signs of distress were also observed: riprap missing from sections along the upstream face of the dam, erosion along the crest of the dam causing undermining of the chain-link fence, and spalled concrete on the walls and floor of the chute. The concrete at the joints with the I-beam struts is in poor condition. There is a continuous crack across the walls and floor of the chute. Trees and bushes are growing along the west side of the chute, and bushes are growing on the crest and upstream face of the dam. There is debris at the trash rack downstream of the spillway. The concrete columns supporting the pier out to the 14-inch intake are also deteriorated.

A test flood equal to a one-half PMF was used to evaluate the capacity of the spillway. The test flood inflow was estimated to be 800 cfs, after adjusting for the attenuating effect of the street embankment upstream. The test flood outflow is estimated to be 800 cfs due to the delay in arrival of the peak outflow from upstream of the street embankment. The outflow would result in the pond at El 23.7, which is 0.8 feet above the low area near the east abutment of the dam. The spillway with stoplogs can discharge 475 cfs which is 59 percent of the test flood outflow without overtopping the low area. With the stoplogs removed, the spillway can discharge 660 cfs or 83 percent of the test flood before the low area is overtopped.

SHOE POND DAM

- b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on review of the available data, the 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 receipt of this Phase I Inspection Report.
- d. Need for Additional Investigations. Additional investigations to further assess the static and seismic stability of the dam are needed, as discussed below in Section 7.2.

7.2 Recommendations. In view of the concerns over the continued performance of the dam, it is recommended that the Owner employ a qualified engineering consultant to evaluate the localized slump on the downstream face of the dam and to investigate the static and seismic stability of the embankment. The Owner should implement the recommendations of the consultant.

7.3 Remedial Measures

- a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:
 - (1) Repair the concrete at the junction of the I-beam compression struts and the walls of the chute.
 - (2) Repair the spalled concrete on the walls and floor of the chute and repair the crack located below the trash rack.
 - (3) Repair the erosion and dislodged sections of fence on the crest of the dam.
 - (4) Replace riprap missing from the upstream face of the dam.
 - (5) Remove all the bushes on the crest of the dam and initiate selective clearing of trees and roots adjacent to the west side of the chute. Backfill where required with selected material.

SHOE POND DAM

- (6) Maintain the low-level gate in operating condition and provide access to the gate stem.
- (7) Have the proper tools readily accessible so that the stoplogs can be removed and the gate opened if required.
- (8) Repair the deteriorated concrete on the columns supporting the pier out to the 14-inch intake.
- (9) Conduct a program of monthly maintenance inspections of the dam and appurtenances. This should include monthly clearing of debris from the trash rack in the chute below the outlet works. Additional inspections should be conducted during and after severe storms. All repairs and maintenance should be undertaken in accordance with all applicable State regulations.
- (10) Conduct periodic technical inspections of this dam on an annual basis.
- (11) Institute a plan for surveillance of the embankment during and after periods of unusually heavy runoff and a plan for notifying nearby residents in case of an emergency at the project.

7.4 Alternatives. There are no recommended alternatives.

SHOE POND DAM

APPENDIX A
PERIODIC INSPECTION CHECKLIST

SHOE POND DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT UNITED SHOE POND DAM

DATE 4/18/79

TIME 1:00-5:00 PM

WEATHER SUNNY-50°

W.S. ELEV. 20.6 U.S. DN.S.

PARTY:

- | | |
|-----------------------|--------------------------------|
| 1. <u>M. LARSON</u> | 6. <u>H. LORD</u> |
| 2. <u>M. GILBERT</u> | 7. <u> </u> |
| 3. <u>A. S. NAGEL</u> | 8. <u> </u> |
| 4. <u>L. BRANAGAN</u> | 9. <u> </u> |
| 5. <u>W. CHECCHI</u> | 10. <u> </u> |

PROJECT FEATURE

INSPECTED BY

REMARKS

- | | | |
|--------------------------------|-----------------------------|--|
| 1. <u>DAM</u> | <u>GILBERT & LARSON</u> | |
| 2. <u>HYDRAULICS</u> | <u>BRANAGAN</u> | |
| 3. <u> </u> | <u> </u> | |
| 4. <u> </u> | <u> </u> | |
| 5. <u> </u> | <u> </u> | |
| 6. <u> </u> | <u> </u> | |
| 7. <u> </u> | <u> </u> | |
| 8. <u> </u> | <u> </u> | |
| 9. <u> </u> | <u> </u> | |
| 10. <u> </u> | <u> </u> | |

PERIODIC INSPECTION CHECK LIST

PROJECT UNITED SHOE POND DAM DATE 4/18/79
 PROJECT FEATURE Dam Embankment NAME M.Larson
 DISCIPLINE GEOTECHNICAL NAME M.Gilbert

M.G.=Million Gallons

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	24.0
Current Pool Elevation	20.6
Maximum Impoundment to Date	35.5 Acre-ft (11.6 M.G.)
Surface Cracks	None
Pavement Condition	Gravel-tire ruts (1"-2" deep)
Movement or Settlement of Crest	Light poles-vertical Fence tilting towards pond
Lateral Movement	Fence
Vertical Alignment	O.K.
Horizontal Alignment	O.K.
Condition at Abutment and at Concrete Structures	Abutment O.K. Outlet concrete spalled
Indications of Movement of Structural Items on Slopes	Slight localized bulge midway on D/S slope between gate house and the east abutment
Trespassing on Slopes	None
Sloughing or Erosion of Slopes or Abutments	Some erosion under fence on upstream side of crest
Rock Slope Protection - Riprap Failures	Some localized failures of riprap, another area where riprap is missing
Unusual Movement or Cracking at or near Toes	No
Unusual Embankment or Downstream Seepage	Not visible - D/S toe is inundated by lower pond
Piping or Boils	No
Foundation Drainage Features	Lower pond toe of dam
Toe Drains	No
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT UNITED SHOE POND DAM

DATE 4/18/79

PROJECT FEATURE Outlet Works

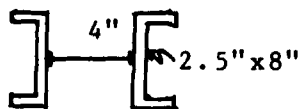
NAME M. Gilbert

DISCIPLINE GEOTECHNICAL

NAME M. Larson

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	No
Floor of Approach Channel	Submerged-good
b. Weir and Training Walls	
General Condition of Concrete	Fair (west) Poor (east) spalling, fence fell in on east side
Rust or Staining	Yes, staining
Spalling	Heavy on top of east wall
Any Visible Reinforcing	heavy spalling Compression struts(2)@wall conn.
Any Seepage or Efflorescence	Minor efflorescence @ or below high water, minor seepage
Drain Holes	None
c. Discharge Channel	
General Condition	Fair
Loose Rock Overhanging Channel	No
Trees Overhanging Channel	Yes
Floor of Channel	Some cracking of concrete-1 crack continuous 2 walls+floor-Very poor last 20 feet
Other Obstructions	Some concrete missing @ water line

X-Section on Compression strut



PERIODIC INSPECTION CHECK LIST

PROJECT UNITED SHOE POND DAM

DATE 4/18/79

PROJECT FEATURE Bridge to intake

NAME M. Gilbert

DISCIPLINE GEOTECHNICAL

NAME M. Larson

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SERVICE BRIDGE</u>	(Pier and platform to 14-in. intake) Wood-satisfactory
a. Super Structure	
Bearings	Concrete columns (4) spalled rebars exposed and corroded
Anchor Bolts	Very poor condition @ platform
Bridge Seat	Fair
Longitudinal Members	2 steel tie bars under bridge- corroded below water line
Under Side of Deck	Fair
Secondary Bracing	-
Deck	Wood-fair to good-Cover on 14" intake is missing
Drainage System	-
Railings	None
Expansion Joints	-
Paint	None
b. Abutment and Piers	
General Condition of Concrete	Poor
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

PERIODIC INSPECTION CHECK LIST

PROJECT United Shoe Pond Dam

DATE 4/8/79

PROJECT FEATURE Gate House

NAME M. Gilbert

DISCIPLINE Geotechnical

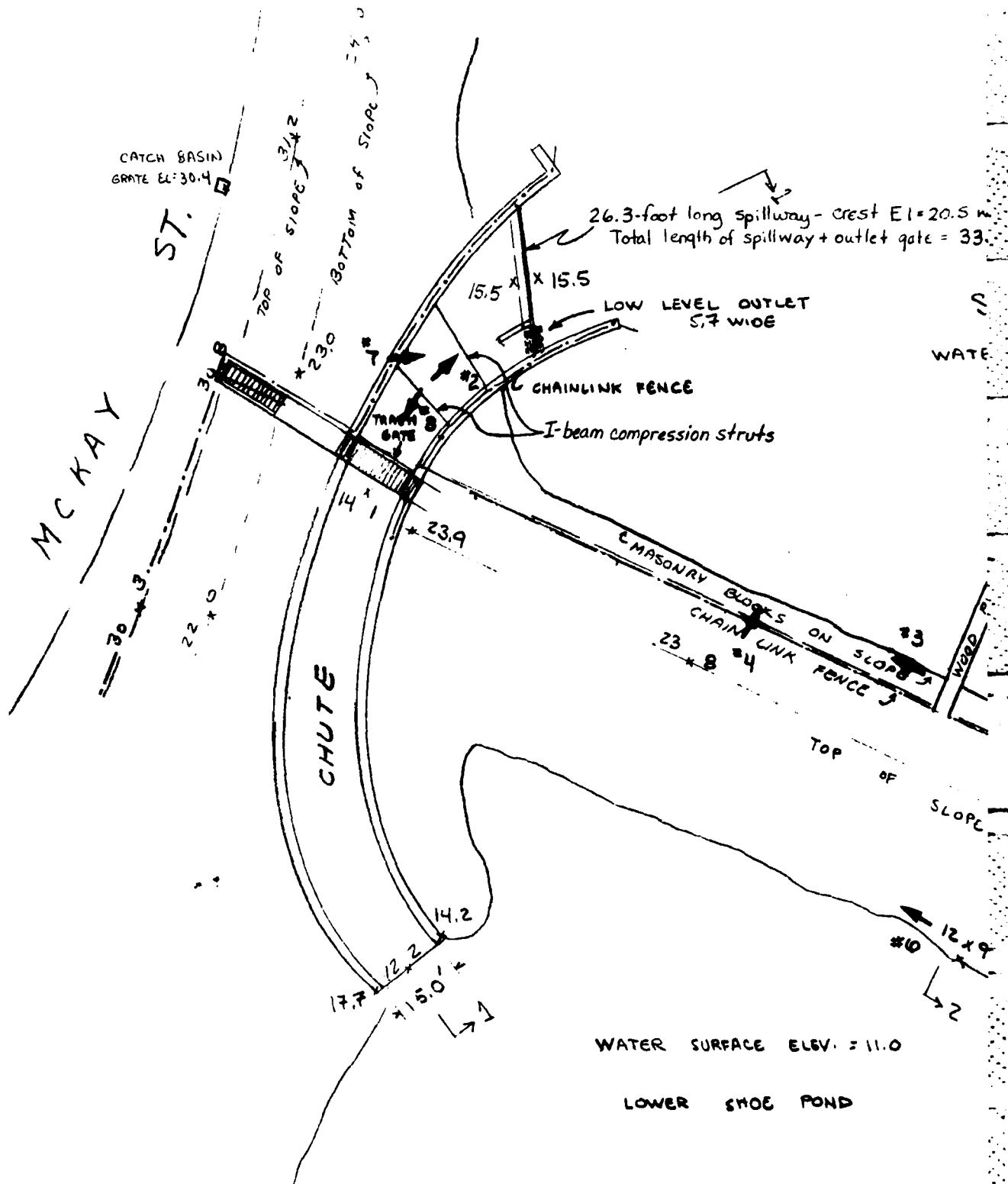
NAME M. Larson

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - CONTROL TOWER</u>	Gate house on upstream face of dam
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	None
Visible Reinforcing	None
Rusting or Staining of Concrete	None
Any Seepage or Efflorescence	None Observed
Joint Alignment	Good
Unusual Seepage or Leaks in Gate	None
Cracks	None
Rusting or Corrosion of Steel	None
b. Mechanical and Electrical	
Air Vents	N/A
Float Wells	N/A
Crane Hoist	Good
Elevator	N/A
Hydraulic System	N/A
Service Gates	Stated by owner to be in good condition
Emergency Gates	N/A
Lightning Protection System	N/A
Emergency Power System	N/A
Wiring and Lighting System in Gate Chamber	N/A

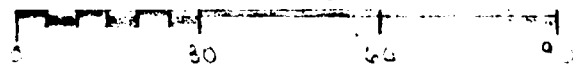
APPENDIX B
PLANS OF DAM AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1, Plan of Dam from field survey, April 18, 1979	B-1
Figure B-2, Plan of McKay Street and Sections through Dam and McKay Street from field survey, April 18, 1979	B-2
Dam Inspection Report, Essex County Engineering Department, 1917	B-3
Letter Reports, Essex County Engineering Department	B-4

SHOE POND DAM



PLAN SCALE
in feet

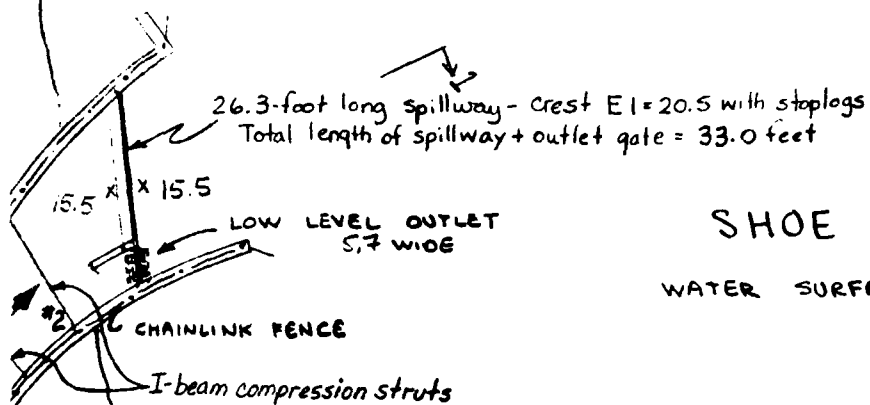


METCALF & EDDY, INC



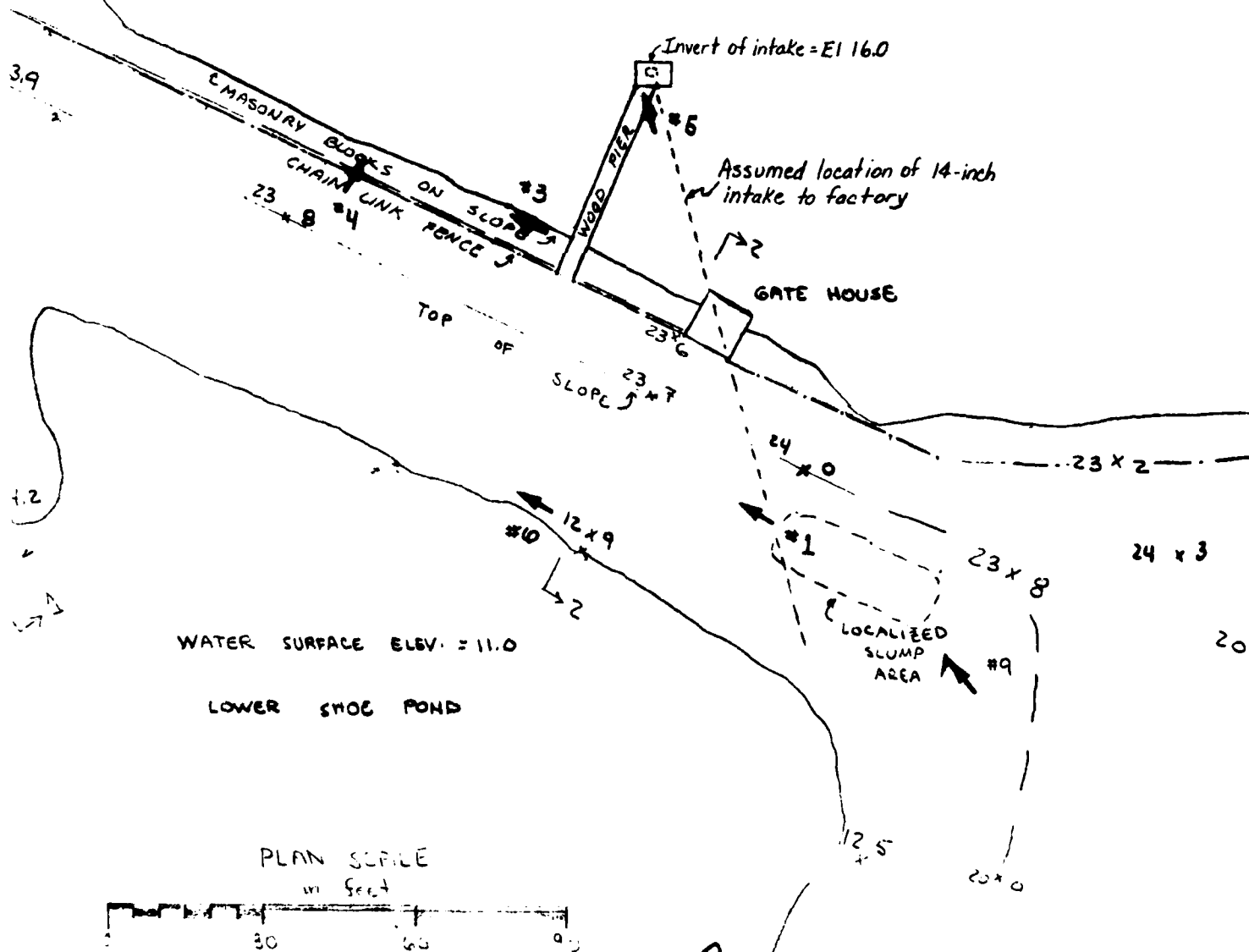
NOTES:

1. ELEVAT
2. INFORM
3. OF AC



SHOE POND

WATER SURFACE ELEV. = 20.6



2

NOTES:

1. ELEVATIONS SHOWN BASED ON ASSUMED STILLWATER CREST ELEV = 20.5 (MSL)
2. INFORMATION SHOWN BASED ON FIELD SURVEY OF APRIL 18, 1979
3. #1 INDICATES LOCATION AND DIRECTION OF VIEW FOR PHOTOGRAPHS

POND

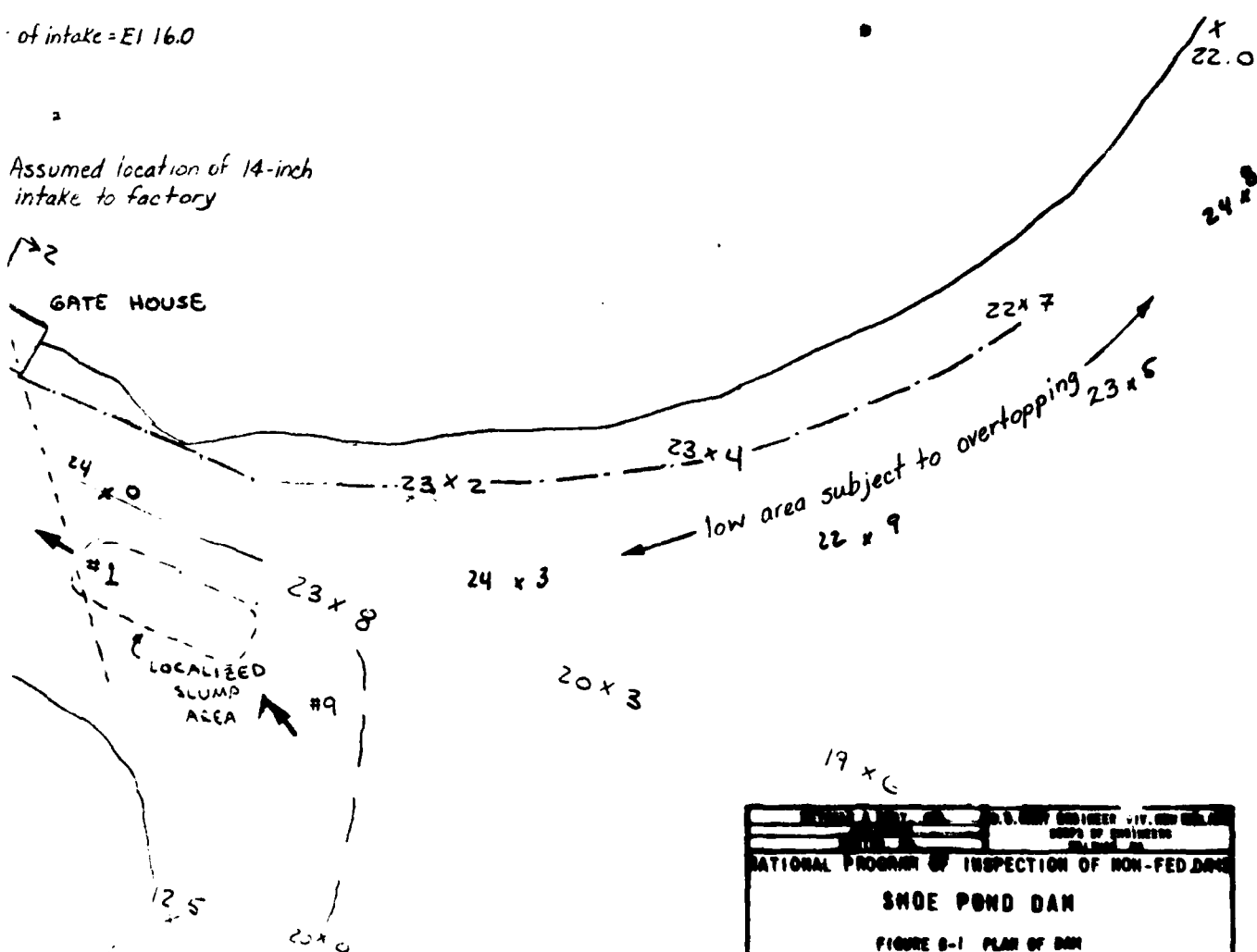
FACE ELEV. = 20.6

of intake = EI 16.0

Assumed location of 14-inch intake to factory

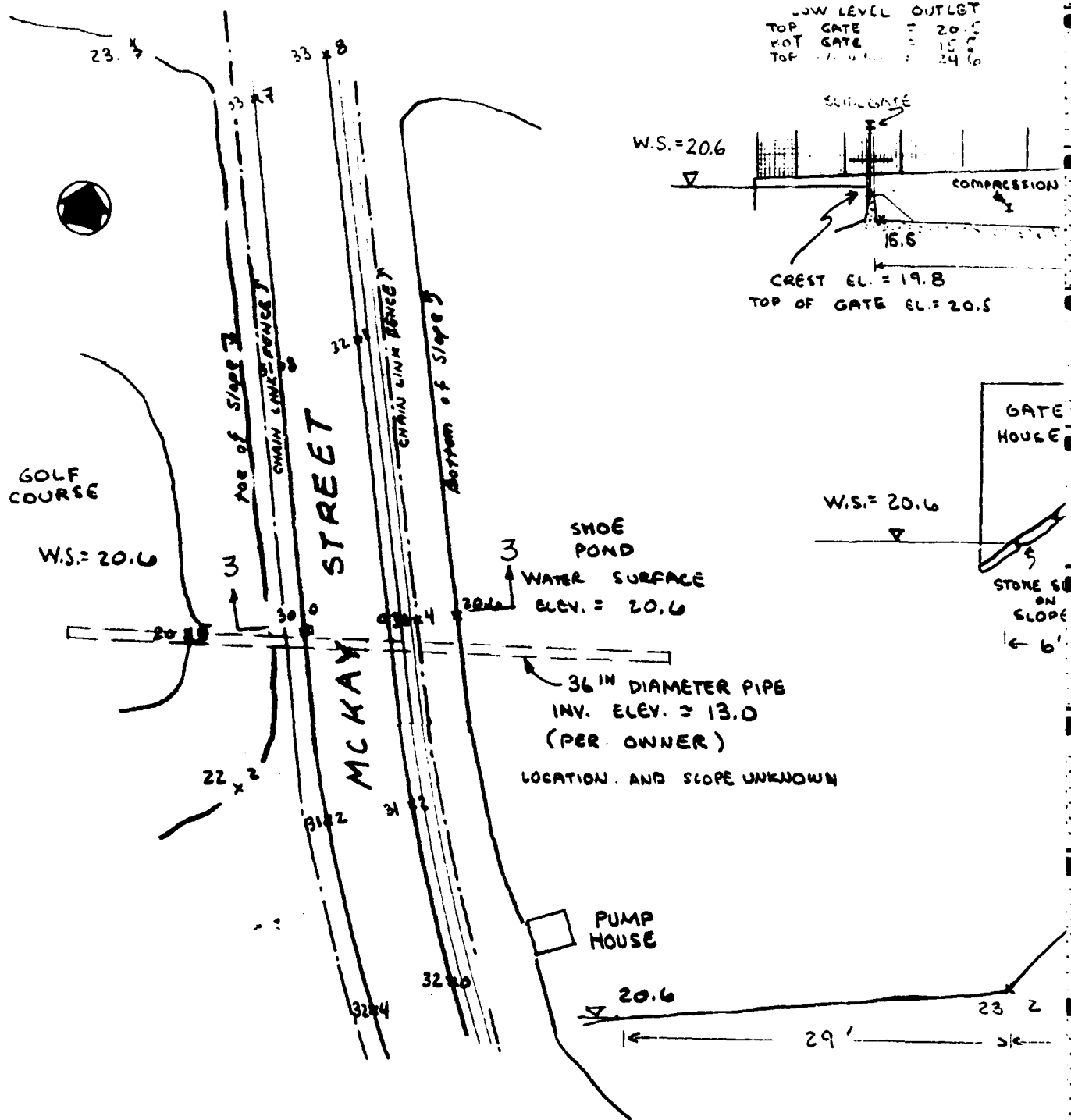
1/2

GATE HOUSE



U.S. ARMY ENGINEER CIVIL WORKS	
CORPS OF ENGINEERS	
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS	
SHOE POND DAM	
FIGURE 8-1 PLAN OF DAM	
TRIBUTARY DARVERE RIVER	MASSACHUSETTS
SCALE: 1" = 50'	DATE: APRIL, 1979

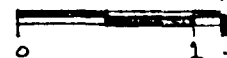
3



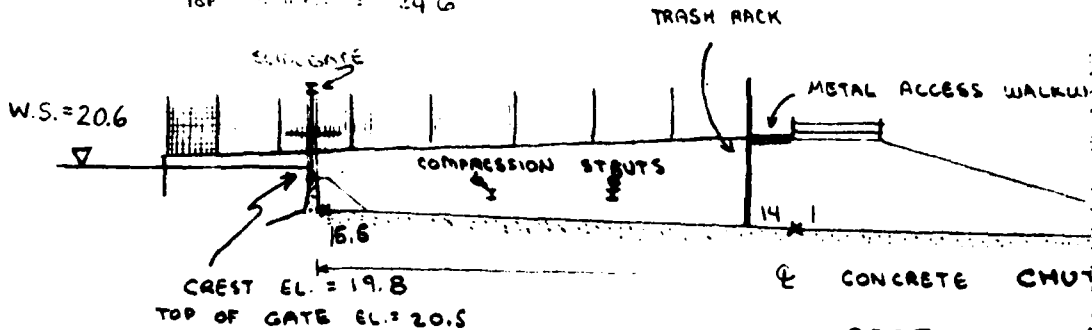
DETAIL PLAN
OF
MCKAY STREET

SCALE 1 in = 50 FT

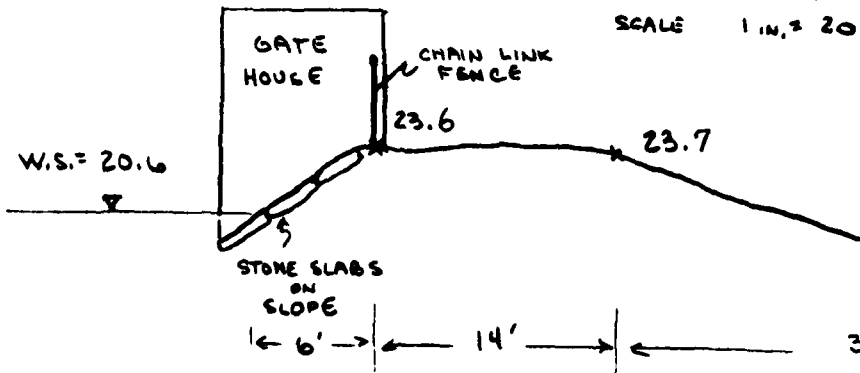
METCALF & EDDY, INC.



LOW LEVEL OUTLET
 TOP GATE = 20.6
 BOT GATE = 19.8
 TOP OF CHUTE = 24.6



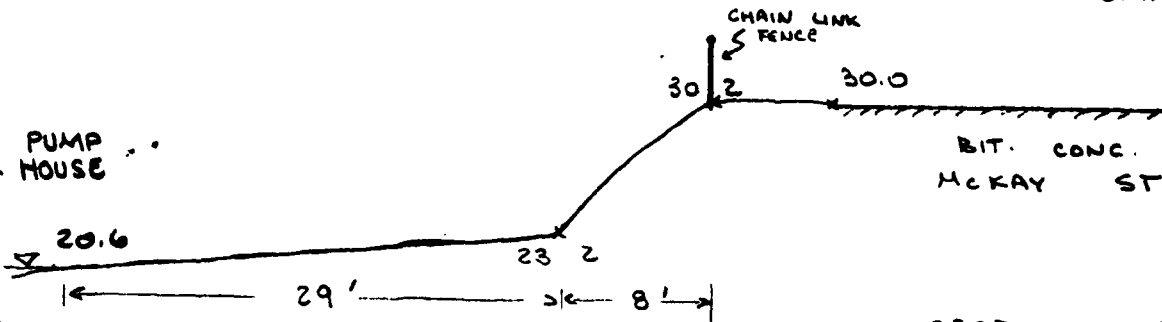
SECTION 1
 SPILLWAY
 SCALE 1 IN. = 20'



SECTION 2
 DAM EMBANKMENT
 SCALE 1 IN. = 10 FT.

SHOE POND
 WATER SURFACE
 ELEV. = 20.6
 36 IN DIAMETER PIPE
 INV. ELEV. = 13.0
 (PER OWNER)
 LOCATION AND SLOPE UNKNOWN

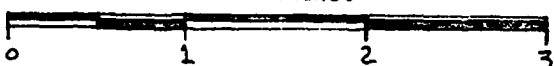
PUMP HOUSE

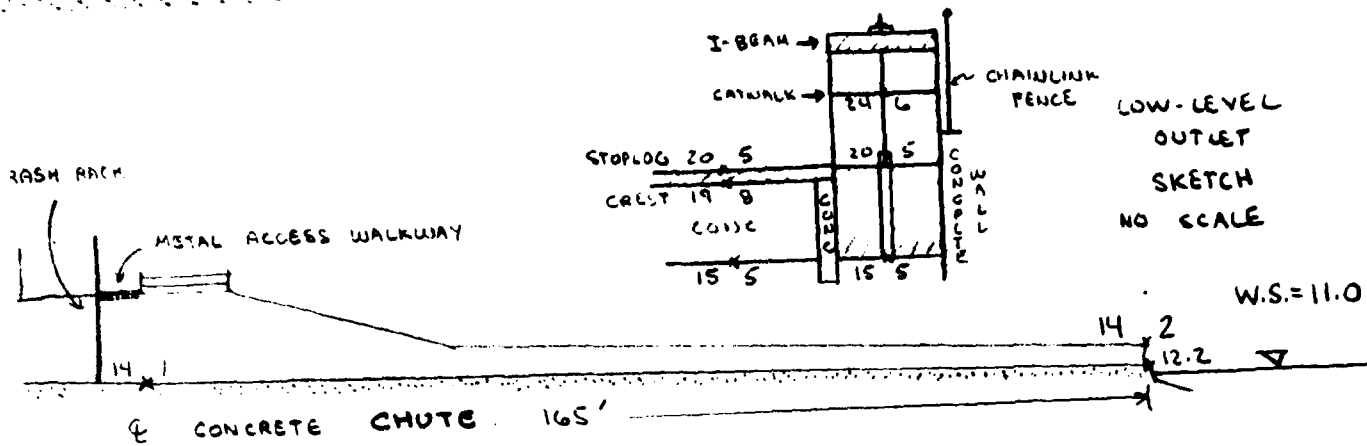


SECTION 3
 MCKAY ST. EMBANKMENT
 SCALE 1 IN. = 10 FT.

AIR PLAN
 OF
 MCKAY STREET
 SCALE 1 IN. = 50 FT.

SCALE
 IN INCHES

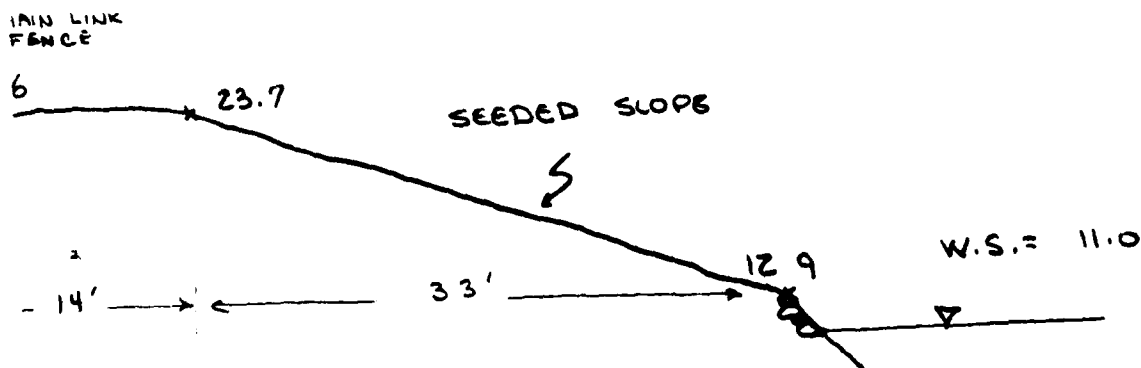




SECTION 1-1

SPILLWAY

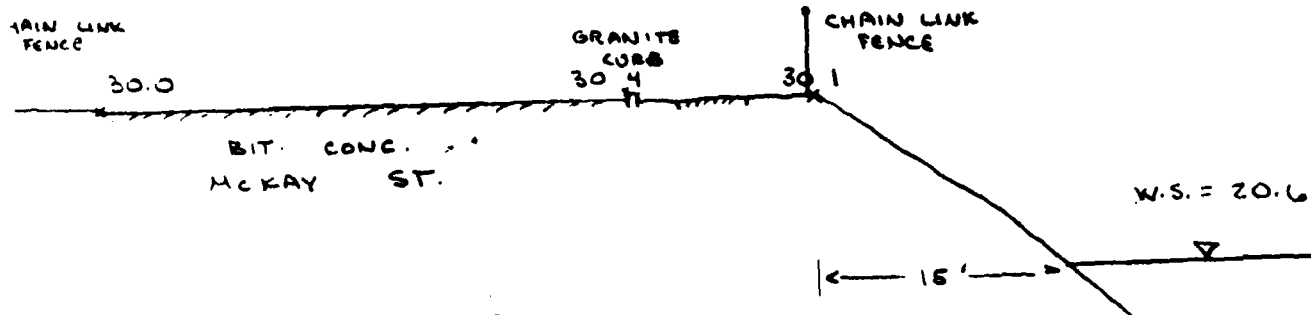
SCALE 1 in. = 20 FT.



SECTION 2-2

DAM EMBANKMENT

SCALE 1 in. = 10 FT.



SECTION 3-3

MCKAY ST. EMBANKMENT

SCALE 1 in. = 10 FT.



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
MOE POND DAM	
FIGURE D-2	
ADDITIONAL DETAILS AND SECTIONS	
TRIMBLE ENGINEERING, INC.	DATE: APRIL, 1972
SCALE: AS SHOWN	

2

3

COUNTY OF ESSEX, MASSACHUSETTS
ENGINEERING DEPARTMENT

Inspection of Dams, Reservoirs, and Stand Pipes

O 103-51

SUB NUMBER

D. 6 R. S. P.

Neg. No. 7191

Inspector *A. E. Woodbury* Date *Mar. 23, 1917* *Classification *2*

City or Town *Beverly* Location *Beast River, M^{rs} Kay St.*

(off Pt.)
Owner *United Shoe Machinery Co. Inc. Use Manufacturing*

Include such details as core, cut off walls, paving, sodding, etc. of masonry, kind of cement, (nat. or port.) etc.

Material and Type *Earth with heavy concrete core wall.*

Elevations in feet: above (+) or below (-) full pond or reservoir level. (Cross out what does not apply.)

For Dam
Bed of stream below *7.2* Bottom of pond *-12* Bottom of spillway *0* Top of dam *+2* Top of flash boards *7.6*

For Res. or S. P.
Ground surface below *Bottom of sea* Level of over flow pipe *Top of sea*

For dam
Length in ft. *250* Top width in ft. *13* Pond area *11.0 acres* Area of watershed *15.5 sq. mi.*

For Res. or S. P.
Inside dimensions Capacity *22 million gals.* covered - open

Length of overflow or spillway *33.5* Outlet pipes (size and nature) *14 in. pipe*

Stand pipe, thickness at base *diam. of rivet head* Pitch *from*

Foundation and details of construction *Core wall to solid bottom.*

Constructed by and date *1903-4*

Recent repairs and date *None*

Evidence of leakage *Go None*

Condition *Good* *Good (1917)* S. P. when painted *inside*

Topography of country below *Pond & dam small & pond & tide gate.*

Nature, extent, proximity, etc. of buildings, roads or other property in danger if failure should occur *Might wash*

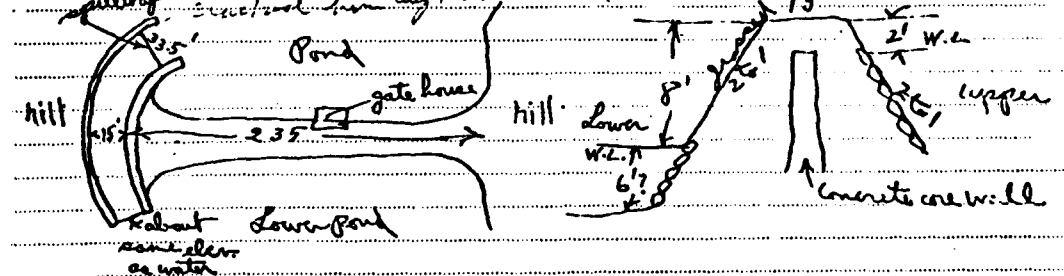
Elliott St

Plans and data secured or available

Use separate sheet for sketches if necessary.

Notes, sketches, sections, etc. *2 dams below this one one of which is a tide gate dam of 1917*

(Water not held at site now or condition is poor.)



*Classify as to probable damage in case of failure. 1 slight. 2 moderate. 3 serious.

SHOE POND DAM

Beverly D. 6

1917, March 26. Watershed 1.5 sq. m. Max. Ht. 12.0 ft. Apparent condition, Good.

1928, Aug. 1. C. C. Barker, Insp. Dam on Bass River, east of McKay Street, is owned by the United Shoe Machinery Company, and is used for manufacturing purposes. I gave a notice to P. R. Bosworth who is in charge and who inspected the dam with me. Below this dam is a small basin at the end of which is a concrete dam which acts as a spillway. Below this spillway is a wide concrete covered channel which leads to the tide water, and in case of failure there would probably be no damage or loss of life. The conditions are the same and there have been no changes except that the old tide gate at Eliot Street has been removed. The northwest wall of the spillway is cracked and there is a slight leakage there. The lower basin has been raised about six inches and they intend to raise the slope paving in this basin and will probably repair the spillway at the same time. Otherwise this dam is in good condition. The water level today is elevation 4.

1928 Report to Co. Comm. Bass River Dam east of McKay Street, is owned by the United Shoe Machinery Company, and is in fair condition, except that some repairs at the spillway are contemplated by the owners and there seems to be no possibility of damage through failure.

1930, Sept. 15. C. C. Barker, Insp. Dam on Bass River east of McKay Street, is owned by the United Shoe Machinery Company, and is used for manufacturing purposes. I gave a copy of the notice to P. R. Bosworth, who is in charge. He inspected the dam with me. The conditions below the dam are the same and in case of failure, there would probably be no damage or loss of life. The lower slopes are in good condition and is well paved at the water level of the lower basin. The paving on the upper slope is somewhat irregular. The northwest wing wall of the spillway on the upper side is cracked, and in rather poor shape. Mr. Bosworth intends to make some repairs around the spillway this fall. The water is low.

1930 Report to Co. Comm. A small dam on Bass River east of McKay Street is owned by the United Shoe Machinery Corporation, and is so situated that there would probably be no damage in case of failure. The paving on the upper slope is somewhat out of shape and the northwest wing wall of the spillway is cracked and in rather poor condition.

1932, Aug. 1. C. C. Barker, Insp. I gave the notice to P. R. Bosworth, who went to the dam with me. The dam is in good condition except the crack in the northwest wing wall which is in rather poor shape. This will probably be repaired this fall and some of the paving on the upper side put in better shape. There has been no change.

1932, Nov. 1. R. R. Evans, Insp. Drove to site to note conditions but did not inspect dam. Heavy rain at the time. Probability of damage below does not seem to justify requiring of anything to be done, although repairs, stated to be in contemplation in C.C.B. report, should of course be made.

1932 Report to Co. Comm. Little importance, not in good condition.

SHOE POND DAM

Beverly D. 6

1934, Sept. 27. C.C.Barker, Insp. I gave a copy of the notice to Mr. Bosworth, who sent Mr. Robert Chalmers to the dam with me. The spillway has been repaired and the paving on the upper slope has been put in good condition. This dam is now in good condition.

1934 Report to Co. Comm. Structure is of little importance.

1936 Aug. 8, C.C.Barker Insp. I saw Mr. Bosworth. There has been no change; this dam is in good condition.

1936 Report to Co. Commissioners. Safe and in reasonably good condition.

1938 Oct. 25, C.C.Barker, Insp. I gave a copy of the notice to Mr. Bosworth, who sent one of his men to the dam with me. This dam is apparently in good condition and the same as when last inspected. The water is just splashing over the spillway.

1938 Report to Co. Comm. Safe and in reasonably good condition.

1940, Oct. 1, C.C.Barker, Insp. I gave a copy of the notice to Mr. Bosworth, who went to the dam with me. The dam is in good condition. There is some disintegration in the concrete at the spillway also slight leakage. Mr. Bosworth intends to have repairs made. The water level is at the bottom of the spillway. Mr. Bosworth says they are contemplating raising this dam 2 or 3 feet.

1940 Report to Co. Comm. The dam on Bass River east of McKay Street was found in fairly good condition, but some repairs are in contemplation, and it is stated that the dam may be raised two or three feet.

1942 July 31, C.C.Barker, Insp. I saw Mr. Bosworth. Since the last inspection this dam has been raised. Plans were approved by the County Commissioners, but a few changes were made and now Mr. Bosworth will furnish the county with a plan of the dam as actually rebuilt. This dam is in good condition and the work is complete except for a little loaming and seeding at the easterly end. The pond is partly full.

1942 Report to Co. Comm. No report.

1944 July 19, S.W. Woodbury, Insp. Mr. Ernest DiPaolo went to the dam with me. I gave him a copy of the notice for Mr. Bosworth, who is in charge of construction and maintenance. Repairs have been made, according to plans filed in this office, since the last inspection. An iron pipe has been laid from the inlet to the dam and a 24" concrete pipe from the dam to the foundry along the shore. Repairs are made on the dam every spring and fall. Water level is 19.0 ft. The dam is in very good condition.

SHOE POND DAM

Beverly D. 6

1944 Report to Co. Comm. Safe and in reasonably good condition.

1946 Oct. 1, S.W. Woodbury, Insp. I gave a copy of the notice to Mr. Bosworth who went to the dam with me. No repairs since last inspection. Water level today 19.7 on gauge. Condition of the dam is the same.

1946 Report to Co. Comm. Safe and in reasonably good condition.

1948 September 22, S. W. Woodbury, Insp. Gave a copy of the notice to Mr. Ernest Dipaolo for Mr. Bosworth. Mr. Depaulo went to the dam with me. No repairs since last inspection. Water level today: 15.0' on gauge. Condition of the dam is the same.

1948 Report to Co. Comm. Safe and in reasonably good condition.

1950 Sept. 29, S.W. Woodbury, Insp. Gave a copy of the notice to Mr. Ernest Dipaolo for Mr. Bosworth. Mr. Dipaolo went to the dam with me. No repairs since last inspection. Water level today: 10.5 feet on gauge. Condition of the dam is the same.

1950 Report to Co. Comm. Safe and in reasonably good condition.

1952 E.H. Page, Insp. Gave a copy of the notice to Mr. Gardner for Mr. Baldus who was out. Mr. Gardner went to the dam with me. No repairs since last inspection. Water level today: El. 18.6 ft. Some leakage through the conc. sidewall of the spillway on the downstream side. Condition of the dam is the same.

1952 Report to Co. Comm. Safe and in reasonably good condition.

1954, May 20, E.H. Page and J.O. Harmaala, Insp. Owner's Agent Mr. Baldus. 8" of flashboards have been added as requested by owner. These boards are more or less permanent. Elev. of water or distance above or below spillway: 2". Height of flashboards etc. in place: 8". Minimum freeboard with all possible stop logs etc. in place 3.0" $\pm$. Condition of dam: Reasonably good. The drawoff gate at the spillway is not in working condition. This should be remedied.

1954 Report to Co. Comm. Safe and in reasonably good condition.

1956 Sept. 12, E.H. Page, Insp. Owner: United Shoe. Owner's Agent: Mr. Baldus. Elev. of water: 3". Height of flashboards: 8" No obstructions. Drawoff gate was repaired and is now in working condition.

1956 Report to Co. Comm. Safe and in reasonably good condition.

1959, Jan. 6, E.H. Page & K.M. Jackson, Insp. No repairs since last inspection. Elev. of water: just lapping over flashboards. Height of flashboards 8" Minimum freeboard: 3' $\pm$ Obstructions: Clear. Condition: good.

1958 Report to Co. Comm. Safe and in reasonably good condition.

SHOE POND DAM

Beverly D. 6

1960, Dec. 28, E.H. Page & P.D. Killam, Insp. Conditions below dam: Good. Elev. of water: Top of flashboards. Small leak in river wall below dam. Height of flashboards: 10" above conc. No obstructions in spillway. Condition of dam: Good. Check height of flashboards. Frozen over - skating. Permission granted for 6" to 8".

1960 Report to Co. Comm. United Shoe Pond on Bass River. Permission was granted to raise height 6" or 8", but height has been raised 10".

1962, January 2, 1963, K.M. Jackson, Insp. Owner: United Shoe Machinery Corp. Conditions below dam: Good. Elev. of water: Top flash boards. Height of flashboards: 8' of flashboards. No obstructions in spillway. Condition: good. Frozen over.

1962 Report to Co. Comm. Safe and in reasonably good condition.

1964, January 4, 1965. P.D. Killam and K.M. Jackson, Insp. Bass River. Conditions are the same.

1964 Report to Co. Comm. Safe and in reasonably good condition.

1966 March 3, 1967, P.D. Killam and K.M. Jackson, Insp. Bass River. Condition the same.

1966 Report to Co. Comm. Safe and in reasonably good condition.

1968 March 25, 1969, P.D. Killam and J. Fitzgerald. Stop planks have been removed and about 0.5 ft. water going over dam. Condition good.

SHOE POND DAM

01032-C
October 27, 1941.

Dam at United Shoe Machinery Corporation, Beverly

I was at the dam at about 11:00 A.M. with Mr. Barker, and saw work in progress and talked with Mr. Bosworth. The top of the concrete core wall has been uncovered for its full length and a short section of new wall has been built on top of the northeasterly end of this core wall and extending beyond it where there was previously no wall. The bottom of the new wall in this area beyond the old wall is about two feet below the top grade of the old wall. The material on the upstream side of the old core wall is a clay material, hard and compact, and the new wall overlaps it on the upstream side as called for in the plans to a depth of about eight inches below the top.

Mr. Bosworth states that the top of the wall was roughened by using an air hammer and neat cement paste was worked into it followed by about two inches of one to two mortar before placing the concrete which is from the Lynn Sand and Stone Company, and was mixed in the truck after arriving at the site. This concrete, which was deposited Saturday, is a one to four mix and forms have been removed this morning showing a very good surface. A section of the top of the wall which had been roughened near the gate house is also exposed this morning and shows that a very good job was done. Holes for dowels have been drilled, the reinforcing is being assembled and wired together, and forms have been built and are loose in place so that it is expected that the remainder of this wall will be built about Wednesday of this week.

It is now Mr. Bosworth's intention to complete the fill on the other side, also the spillway walls and dam, so as to raise the level of the pond to increase the storage, after which he plans to draw down the lower pond and extend the pipe by about two lengths so as to have better opportunity

ity to complete the downstream slope.

Apparently a very good job is being done, closely supervised by Mr. Bosworth.

U-2

01035-C

1941

Dam at United Shoe Machinery Corporation, Beverly

I visited the site of the work with Mr. Barker on November fifth. The forms have been stripped from the core wall of the dam and forms are in place and reinforcing rods within them are being wired up for the extension of the side walls of the spillway. Counterforts, extending below the top of the old wall, are provided, running back into the proposed fill to strengthen the wall against overturning from the earth pressure: (2) They do not extend to the bottom of the old wall, or, so far as I observed, to ledge, but rest in the undisturbed old back fill. The trench on both sides of the core wall of the main dam has been backfilled and is said to have been thoroughly ramed in place during the wet weather of the last weekend, and looks to be thoroughly compacted. All work seems to be done well and requirements of plans and specifications are being fully followed, except as to spillway wall.

Since November fifth this matter has been taken up with Mr. Bosworth and with his assistant Mr. Depaulo. Instead of building the wall with a batter on the back as shown on the plans it was built of substantially the same thickness as the wall on which it rests. The counterforts have a heavy rectangular base of concrete under their ends which acts as a counterweight, so that the resultant pressure is back near the rear face of the wall, but the horizontal reinforcing in the wall does not seem sufficient to transfer the pressure by beam action to these counterweights or counterforts, and in any event this construction does not strengthen the original wall against overturning under the pressure of the added height of fill. Examination on the ground does not disclose that there is any ledge, at least down to a point nearly as low as the original foundation, although Mr. Bosworth feels very

SHOE POND DAM

certain that ledge was encountered. It is agreed now (November 13) that I-beam struts will be placed across the spillway channel at about the level of the old top of the wall at intervals not exceeding about sixteen feet on the longest side to take up this thrust.

0-2

SHOE POND DAM

B-11

1025-c

1941

1941. Nov. 12, L. B. Barker Insp. I met Mr. Ernest DePauls Engineer, at the United Shoe Machinery Co. Plant at McKay Street, to locate ledge in back of the western side wall of the spillway. We made several punchings in back of the wall along the higher part for about 30 feet and did not find any ledge eight feet below the top of the new wall. One hole at the highest part of the wall between the old stairway walls was punched down nine and one-half feet below the top of the new wall and no ledge was found. The old stairway walls are solid against the old spillway wall and may be they were cast together. The bar could be worked down into the old earth about two feet and the earth was very hard at the bottom of the hole.

SHOE POND DAM

0103-5-2

United Shoe Machinery Corporation Dam, Beverly

Visited the work with Mr. Barker on November 21, 1941.

The fill on the upstream side of the wall, and enough of it on the downstream side to meet the slope, has been completed nearly to finished grade. It has been rolled and shows in places marks of tractor, and seems to be very hard and compact. Filling behind the walls of the outlet channel is well along and forms are being set for the return at the end of the wall on the McKay Street side upriver. Also concrete has been added in the bottom of the channel and workman is cutting recess in the McKay Street wall to take the end of the strut. A layer of broken stone about one inch size has been deposited on the upstream slope and the slope paving of large stone is being laid on it and is about finished for a part of the length of the dam.

1941

60 3-3-2

United Shoe Machinery Corporation dam, Beverly, Massachusetts

1941

Visited the dam at about 11 A.M. November twenty seventh. The concrete walls have been completed. The portion at the new gate is surrounded with tarpaulins and there is an oil heater inside to keep the concrete from freezing. The temperature is well above freezing now. The added concrete in the floor of the wasteway channel extends from the upstream end down to about the position where the rack will be placed and the old concrete below that point is being roughened up with pneumatic hammers preparatory to completing the work there. The slope paving on the upstream side of the dam is complete. The fill seems to be up to grade, but little or no fill has been added on the downstream slope. The earth fill on the McKay Street side of the outlet is being placed and not much more remains to do. Both steel struts, each composed of two channels separated by short sections of I-beam rivatted between the backs of the channels, are in place and well anchored in recesses cut in the walls.

0-2

SHOE POND DAM

03-5-C

1941

United Shoe Machinery Co. Dam, Beverly
Dec. 15, 1941. L. B. Barker Insp. I was at the
dam this morning. The up stream slope of
the dam is all paved, except on the western
side of the spillway, also there is no any
riprap on the upper and lower sides of the
spillway wall. The floor of the spillway
channel has been resurfaced with concrete.
All concrete has been poured.

The sluice gate in the spillway is in place
also the steel tie beams between the spillway
walls.

To day men are placing the riprap along
the bottom of the down stream slope, except
in front of the outlet pipe, which has to
be extended when the lower pond can
be drawn down, and they are nearly ready
for the earth fill to form the lower
slope, which will be made soon.

Down stream slope is being widened
fill

2103-5-2

1941

1941, Dec. 31, L. L. Barker Ins. I visited the United Shoe Machinery Co. Dam this afternoon.

Men were grading on the upper side of the dam west of the spillway and compacting the earth with a tractor. The down stream side of the dam has been widened and the gravel fill has been well compacted by trucking over it and using the tractor. The outlet pipe on the lower side has not been extended as yet to the toe of the new slope, but a riprap wall has been laid along the toe of the slope and in around the present end of the pipe to protect the fill, which cannot be completed at this point until the pipe is extended. I saw Mr. Brownth who said that he does not intend to extend the present outlet pipe to the toe of the new slope until next spring, so for that reason has laid the riprap wall around the end of the present pipe to protect the earth slope.

The top of the dam is up to grade and the earth is well compacted. The slope has not been loamed yet. The dam is in good condition as far as completed.

The water level in the lower pond is about 3 feet below normal.

Mr. Brownth will send a plan of the dam as as built some time.

SHOE POND DAM

1942

United Shoe Machinery Co. Dam, Beverly.
 June 4, 1942, L. B. Barker Insp. Mr. Brownorth and
 Mr. Kiss was at the dam with me. The dam is
 nearly completed except for a little grading at
 the easterly end of the dam and west of the spillway
 on the up stream side. The slopes are partly
 loamed. The dam is in good condition. The
 pond is nearly full.

Mr. Brownorth says a very large amount of
 stone was placed in the toe of the down
 stream slope and the base is wider than
 called for on the plan much more material
 being used.

The draw off pipe that was to be extended to
 the toe of the new down stream slope was not
 done, but a concrete box was built so that
 from the end of the pipe there is a clear opening
 to the toe of the slope.

A bad leak developed recently below the dam
 in the pipe leading from the gate house on the
 dam to the boiler plant. They now intend to
 replace the 14 inch pipe leading into the gate
 house from the upper pond with a 24" pipe
 and lay a new 24" pipe from the gate house
 easterly through the dam on the down stream
 side of the cut off wall and then at about
 45° to a new concrete chamber, the same as
 the gate house on the dam, at the boiler plant.
 The pumping will be done from this
 chamber in which the water will stand
 at the same level as that of the upper pond.

APPENDIX C
PHOTOGRAPHS

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

SHOE POND DAM

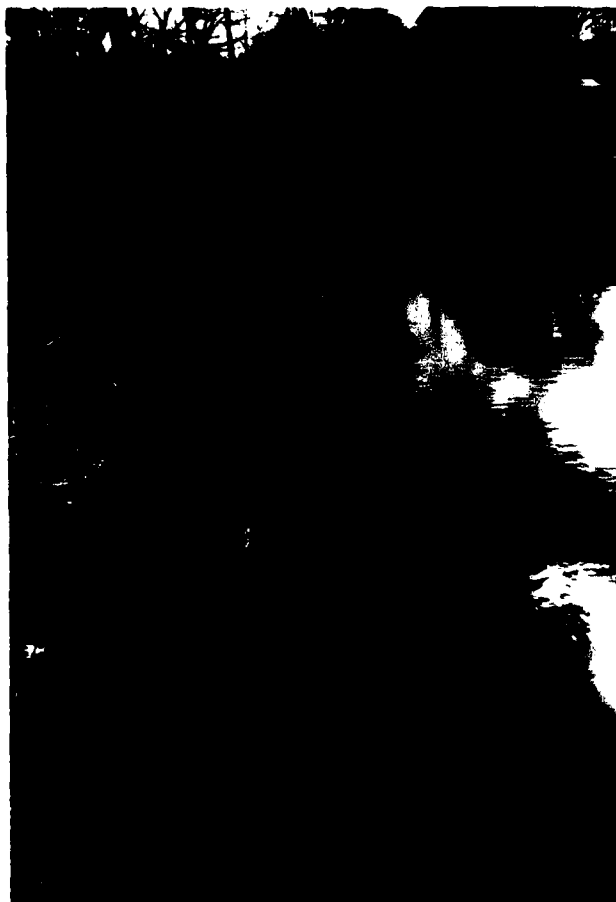


NO. 1 DAM CREST AND DOWNSTREAM EMBANKMENT



NO. 2 SHARP CRESTED WEIR AND LOW LEVEL GATE

SHOE POND DAM



NO. 3 UPSTREAM RIPRAP



NO. 4 MISSING RIPRAP ON UPSTREAM CREST OF DAM

C-2

SHOE POND DAM



**NO. 5 DETERIORATED CONCRETE SUPPORT
AT PIER AND PLATFORM - 14 INCH INTAKE**



NO. 6 DOWNSTREAM RIPRAP

SHOE POND DAM



NO. 7 LOW LEVEL GATE AND CHUTE COMPRESSION STRUT



NO. 8 TRASH RACK AND CHUTE

SHOE POND DAM

APPENDIX D
HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

SHOE POND DAM

I General

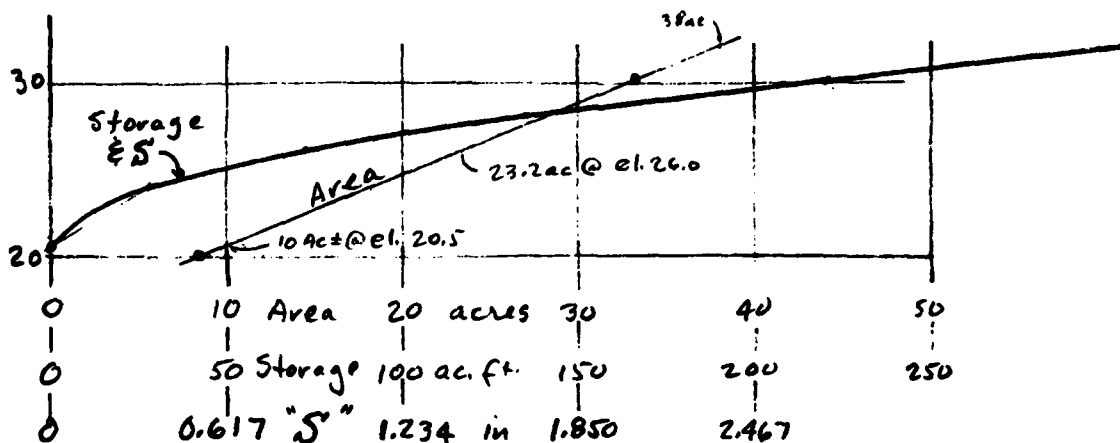
United Shoe Pond has a drainage area of 1.65 mi², however 1.52 mi² are separated from the pond by McKay St. The connection under McKay St. consists of a 36 inch diameter culvert originating in a pond in a golf course. About 10 feet of storage upstream of the McKay St. embankment would be required to develop flow over the street.

Peak flow from the Golf Course storage area will be developed & added to the estimated peak direct flow to United Shoe Pond to estimate the peak discharge from that pond.

II Golf Course Storage

El. 20 - Area = 8.3 ac. ; El. 30 - Area = 33.2 acres

$$S = \left(\frac{\text{Storage Vol. in ft}^3}{\text{Drainage Area in ft}^2} \right)^{1/2}$$



III Test Flood, Storage & Storage Functions - Golf Course Pond

1 - Total Drainage Area - 1.52 mi² (Golf Course Pond)

2 - Pond(s) Area:

Swamp(s) Area: $.016 + .022 = .038$

Total Area Pond(s) & Swamp(s): .038

% Ponds & Swamps = $\frac{.038}{1.52} = 2.5\%$

3 - $\frac{140 - 20}{10600} = .0132$ } Say Ave Slope = 1.1%

4 - Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be nearer to "Flat & Coast." than "Rolling" and taken at 1550 c.f.s./mi²
 Size Class: Small ; Hazard Pot.: Signif. ; Spill. Des. Flood: 100yr to $\frac{1}{2}$ PMF
 Use: Test Flood = $\frac{1}{2}$ PMF

5 - Test Flood Inflow = $\frac{1}{2} (1550) 1.52 = 1180$ c.f.s.

6 - Pond Storage - Varies - see II

~~The pond area is 50. mi. at elev.
 Based on a const. area, storage increases
 at ac. feet per foot of depth increase.~~

7 - Spillway crest elev. is 20.5 (Intake floats - use Un. Sh. PM as control)

8 - Storage Functions are based on $Q_{out} = Q_{in} [1 - \frac{S_{out}}{R}]$

S_{out} = Storage Vol. in Reservoir related to final Q_{out}
 in terms of inches of rain over the drainage area.

~~S (in inches) = $12 D (\frac{1}{R}) = D$; $R = 6$ hr rain of storm.
 D = Storage depth in feet above spillway crest in reservoir~~

9 - Storage Functions: (Test Flood & $\frac{1}{2}$ PMF - if needed)

$F_{TF} = 1180$	$- 124.2 S$	$=$	$-$	D
$F_{\frac{1}{2}PMF} = F_{TF}$	$-$	S	$=$	D

Project Nat. Review of Non Fed Dams Acct. No. 0356 Page 3 of 9
 Subject Essex County, Mass. Comptd. By LEB Date 5/31/79
 Detail UNITED SHOE POND Ch'd. By LEB Date 6/1/79

④ Discharge Rating - Golf Course Pond

A - 36 inch culvert

$$Q = (1.5)^2 \pi \sqrt{\frac{2g}{K}} H_A ; K = 0.5 + 0.2 + 0.2 + 1.0 + \frac{215}{3} (.015) \approx 3.0$$

$$\therefore Q = 32.75 \sqrt{H_A}$$

Golf Pd El. 22 24 26 28 30 32

Disch. w/ Un Shoe Pd

@ El. 21	30	60	70	90	100	110
@ El. 22	—	50	70	80	90	100
@ El. 23	—	30	60	70	90	100
@ El. 24	—	—	50	70	80	90

B - Crest Flow

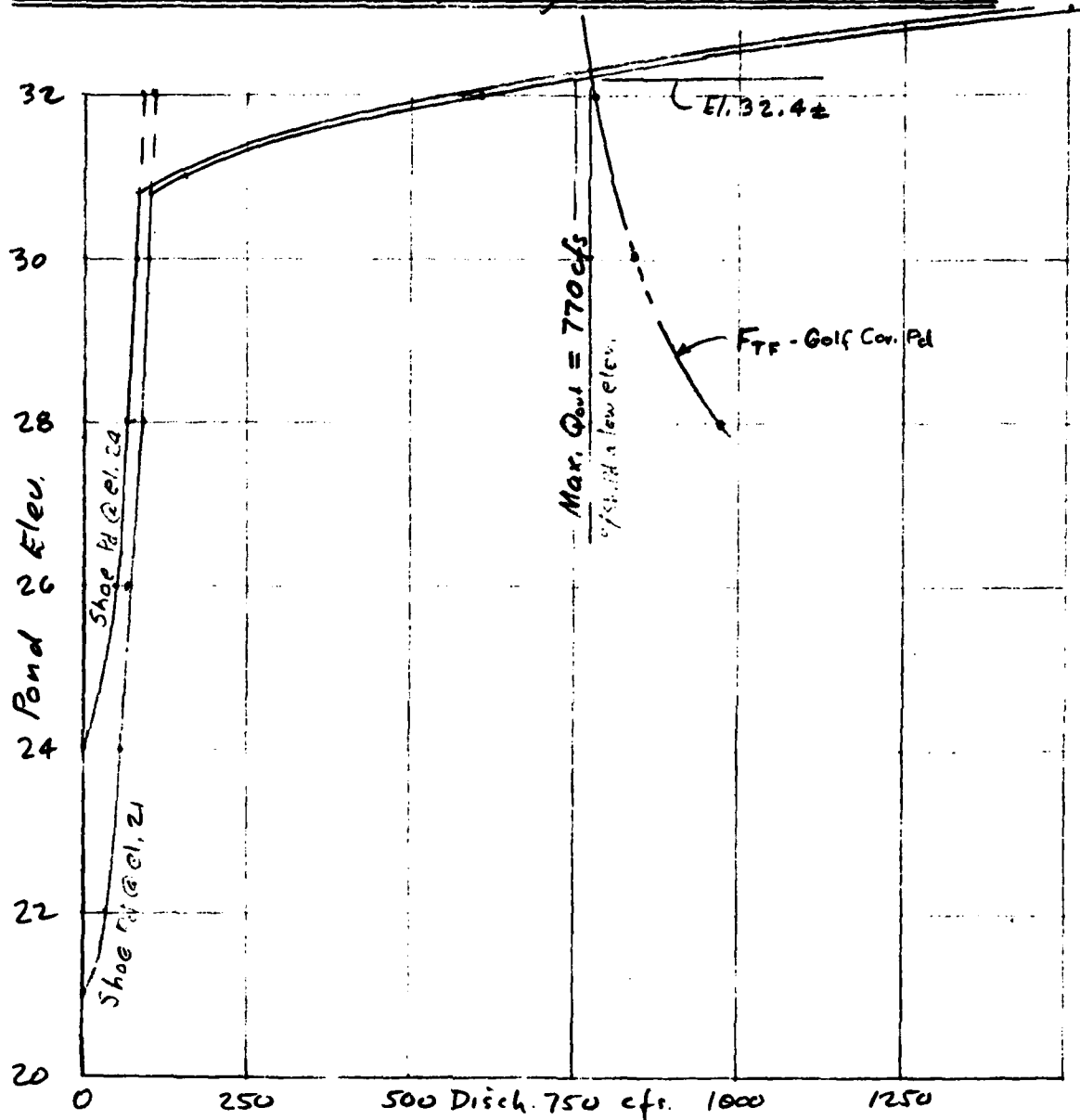
Use $g = 2.55 H_A^{1.5}$ [Ref.: V.T. Chow pg 52-53]

43' @ 30.4 ; 88' @ 31.0 ; 70' @ 31.5

Pond El.	31	32	33
Q ₁	50	220	460
Q ₂	—	220	630
Q ₃	—	60	330
ΣQ_B	50	500	1420

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 4 of 9
 Subject Essex County, Mass. Comptd. By LEB Date 5/31/79
 Detail UNITED SHOE POND Ch'd. By ... Date 6/1/79

V Golf Course Pond - Disch., Storage & Stor. Funct. vs Pd. Eleu.



VI Direct Inflow to United Shoe Pond.

Slope = $\frac{80-20}{1500} = 4\%$; Max Inflow Rate = 2850 cfs/mi²
 Max Direct Inflow : $\frac{1}{2}(2850) \cdot 1.3 = 185 \text{ cfs}$

VII Peak Inflow Rate to United Shoe Pond

A - Time of Conc. to Golf Course Pond = $T_c = \left[\frac{11.9 L^3}{H} \right]^{.375}$ [Ref: "Des. of Sw. Dam" pg 71]

$T_c = 0.918$ - Say 0.75 hours

B - Time of Conc. from direct inflow is short - say 0.1 hours

C - Combine flows - use max peak - use S.C.S. Tech. Rel. No. 55 Table 5-3 to relate peaks

① $185 + \frac{98}{388} (770) \approx 380 \text{ cfs}$

② $770 + \frac{132}{791} (185) \approx 800 \text{ cfs}$ ← Max. Peak for Test Flood

VIII Crest Flow

Max. T.F. Pond Level = 23.7 (Stoplogs in & gate shut)

L.P. Crest = 22.9

Max Head = 0.8 ft.

Disch. - $q = 2.55 (0.8)^{1.5} = 1.82 \text{ cfs}$

As "critical" flow:

$y_c = \left[\frac{q^2}{g} \right]^{1/3} = 0.47 \text{ ft.}$

$V_c = 3.9 \text{ fps}$

(IX) United Shoe Pd. Discharge Relations

A - Weir

33' long w/ semi-permanent stoplogs
 crest weir: 19.8, crest stoplogs 20.5
 Use Williams & Hazen "Hydr. Tables", $p = 30$

With Stoplogs

Pond El.	21	22	23	24	25
h	1.20	6.09	13.01	21.60	31.47
Q_A	40	200	430	710	1040

Without Stoplogs - Lower above pond elev. by 0.7 ft.

B - Gate - Shut

Low level gate, when shut provides generally
 unobstructed weir, taken as 5.7' wide at el. 20.5

Pond El.	21	22	23	24	25
h	1.20	6.09	13.01	21.60	31.47
Q_B	10	30	70	120	180

C - Gate - Open

Low level gate when fully open provides 5.7' wide by
 4.1' high opening, Invert el. 15.5. [Ref: V.T. Chow Fig. 17-29]

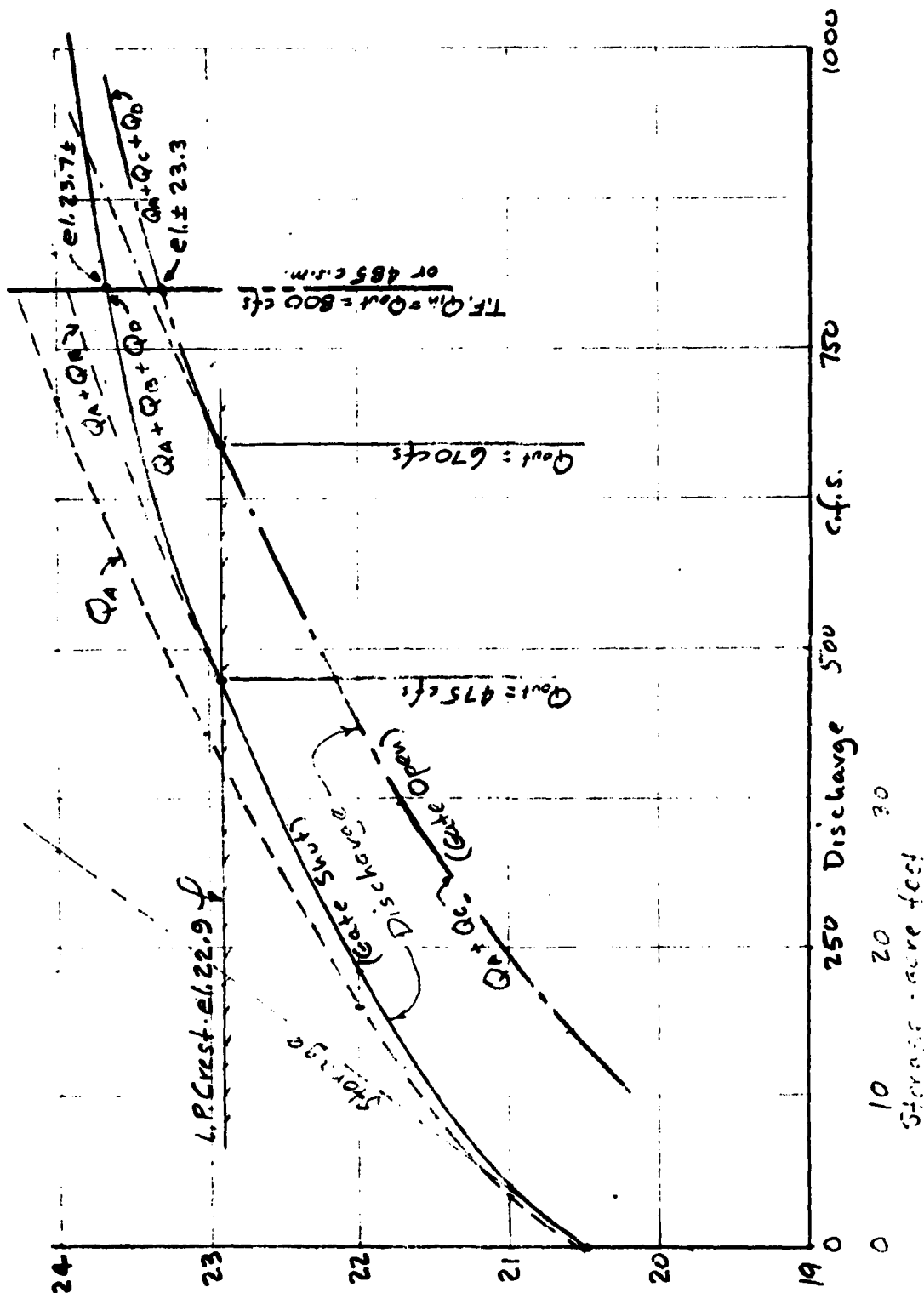
H/d	1.25	1.50	2.0	3.0
g	31	39	47	61
Q_C	180	220	270	350
Pond El.	20.6	21.7	23.7	27.8

D - Crest Flow

45' @ 22.9, 55' @ 23.5, 165' @ 23.75, Use $g = 2.55 H^{1.5}$ [Ref: V.T. Chow pg 52-53]

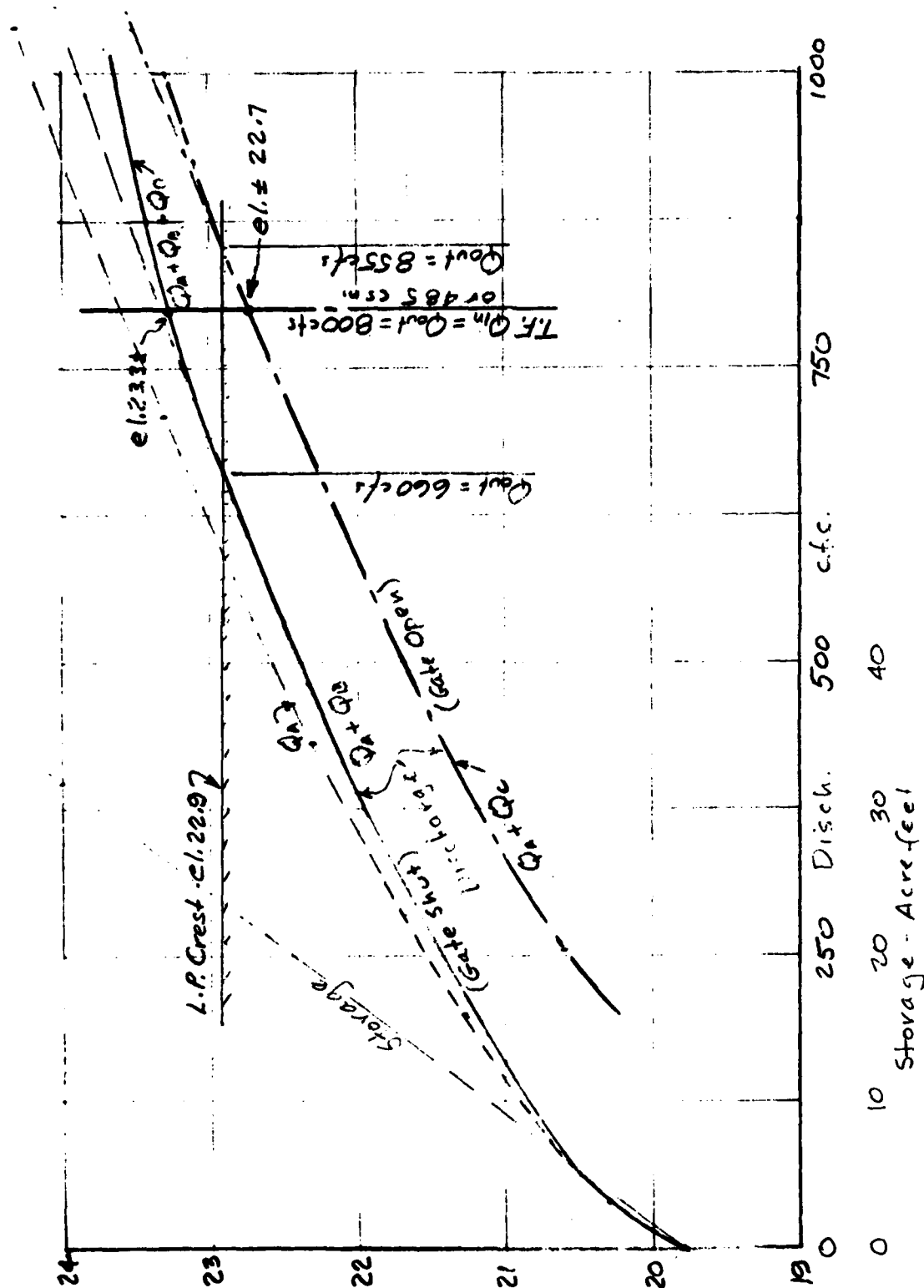
Pond El.	23	24	23.5
Q_1	0	130	50
Q_2	—	50	—
Q_3	—	50	—
ΣQ_D	0	230	50

(X) With Stoplogs - Discharge & Storage vs Pond Elev.



D-7

(XI) Without Stoplogs - Discharge & Storage vs. Pond Elev.



D-8

(XII) Failure of Dam

Peak Failure Flow:

Pond Elevation - 22.9 (L.P. Crest)

Toe Elevation - 11.0 (W.S. Down Pond)

$$Y_0 = 11.9 \text{ ft}$$

Dam Length Subject to Breaching = 200 ft

$$W_0 = 40\%(200) = 80 \text{ ft}$$

$$Q_R = 1.68 W_0 (Y_0)^{1.5} = 1.68 (80) (11.9)^{1.5} \approx 5500 \text{ cfs}^*$$

* This is initial flow - note adjustment below due to down stream conditions

Storage Volume Released:

Storage Above Spillway 7.6 (3.1) = 24 ac. ft.

Storage Below Spillway $(\frac{1}{2}) 7.6 (8.8) = 33 \text{ " "}$

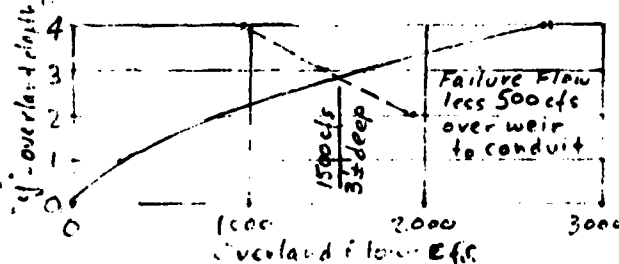
S = Total Storage = 57 " "

Channel Hydraulics:

Failure flow is directed by Lower Shoe Pond with outlet assumed to be $\pm 30'$ wide weir at elev. 11.0. This weir is ± 3 feet below grade. Max. weir disch. is: $17.1 \times 30 \approx 500 \text{ cfs}$. Assume distr. conduit prevents further increase. This raises water level at toe of failed dam to el. 14, reducing failure discharge to $1.68 (80) (18.9)^{1.5} \approx 3600 \text{ cfs}$. The overland flow is about 3100 cfs. Assuming $\frac{1}{2}\%$ grade, $n = .06$ and a 150 ft wide flat flood way ($R \approx y$):

$$V = 1.75 y^{2/3}; Q = 263 y^{5/3}; y = 0.0353 Q^{.6} = 0.0353 (3100)^{.6} \approx 4.4 \text{ ft}$$

Dam failure would result in 500 cfs to conduit to Pass R. & 1500 cfs overland thru parking lot to Base R. Failure flow = 1500 + 500 = 2000 cfs.



Time to Drain:

$$\frac{43560 (57)}{3600 (\frac{1}{2}) (2000)} = 0.69 \text{ Hours}^{**}$$

** This is very approximate

APPENDIX E

INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS

SHOE POND DAM

10

(h)	(a)	(b)	(c)	(d)	(e)
POPULAR NAME	NAME OF IMPONDMENT				
	SHOE POND				
REGION	NEAREST DOWNSTREAM CITY - TOWN - VILLAGE				
01 06	BASS RIVER	BEVERLY	DIST FROM DAM (MI.)	0	POPULATION 37400

(1)	(2)	(3)	(4)	(5)	(6)	(7)
TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FEET)	HYDRAULIC HEIGHT (FEET)	IMPOUNDING CAPACITIES	
					MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)
REGG	1904	SI	17	17	50	30

DIST OWN FED N PRY/FED SCS A VER/DATE:
NED - N' N N , N

(A)		(B)		(C)		(D)		(E)		(F)		(G)		(H)		(I)		(J)		(K)		(L)		(M)		(N)		(O)		(P)		(Q)		(R)		(S)		(T)		(U)		(V)		(W)		(X)		(Y)		(Z)		(AA)		(AB)		(AC)		(AD)		(AE)		(AF)		(AG)		(AH)		(AI)		(AJ)		(AK)		(AL)		(AM)		(AN)		(AO)		(AP)		(AQ)		(AR)		(AS)		(AT)		(AU)		(AV)		(AW)		(AX)		(AY)		(AZ)		(BA)		(BB)		(BC)		(BD)		(BE)		(BF)		(BG)		(BH)		(BI)		(BJ)		(BK)		(BL)		(BM)		(BN)		(BO)		(BP)		(BQ)		(BR)		(BS)		(BT)		(BU)		(BV)		(BW)		(BX)		(BY)		(BZ)		(CA)		(CB)		(CC)		(CD)		(CE)		(CF)		(CG)		(CH)		(CI)		(CJ)		(CK)		(CL)		(CM)		(CN)		(CO)		(CP)		(CQ)		(CR)		(CS)		(CT)		(CU)		(CV)		(CW)		(CX)		(CY)		(CZ)		(DA)		(DB)		(DC)		(DD)		(DE)		(DF)		(DG)		(DH)		(DI)		(DJ)		(DK)		(DL)		(DM)		(DN)		(DO)		(DP)		(DQ)		(DR)		(DS)		(DT)		(DU)		(DV)		(DW)		(DX)		(DY)		(DZ)		(EA)		(EB)		(EC)		(ED)		(EE)		(EF)		(EG)		(EH)		(EI)		(EJ)		(EK)		(EL)		(EM)		(EN)		(EO)		(EP)		(EQ)		(ER)		(ES)		(ET)		(EU)		(EV)		(EW)		(EX)		(EY)		(EZ)		(FA)		(FB)		(FC)		(FD)		(FE)		(FF)		(FG)		(FH)		(FI)		(FJ)		(FK)		(FL)		(FM)		(FN)		(FO)		(FP)		(FQ)		(FR)		(FS)		(FT)		(FU)		(FV)		(FW)		(FX)		(FY)		(FZ)		(GA)		(GB)		(GC)		(GD)		(GE)		(GF)		(GG)		(GH)		(GI)		(GJ)		(GK)		(GL)		(GM)		(GN)		(GO)		(GP)		(GQ)		(GR)		(GS)		(GT)		(GU)		(GV)		(GW)		(GX)		(GY)		(GZ)		(HA)		(HB)		(HC)		(HD)		(HE)		(HF)		(HG)		(HH)		(HI)		(HJ)		(HK)		(HL)		(HM)		(HN)		(HO)		(HP)		(HQ)		(HR)		(HS)		(HT)		(HU)		(HV)		(HW)		(HX)		(HY)		(HZ)		(IA)		(IB)		(IC)		(ID)		(IE)		(IF)		(IG)		(IH)		(II)		(IJ)		(IK)		(IL)		(IM)		(IN)		(IO)		(IP)		(IQ)		(IR)		(IS)		(IT)		(IU)		(IV)		(IW)		(IX)		(IY)		(IZ)		(JA)		(JB)		(JC)		(JD)		(JE)		(JF)		(JG)		(JH)		(JI)		(JJ)		(JK)		(JL)		(JM)		(JN)		(JO)		(JP)		(JQ)		(JR)		(JS)		(JT)		(JU)		(JV)		(JW)		(JX)		(JY)		(JZ)		(KA)		(KB)		(KC)		(	
-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	-----	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	------	--	---	--

OWNER	ENGINEERING BY	CONSTRUCTION BY
UNITED SHOE MACHINERY CO	UNKNOWN	UNKNOWN

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION
	DAY	MO YR
METCALF AND EDDY INC	10APR79	PL 92-367

REMARKS	

END

FILMED

11-84

DTIC