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WILLETT POND DAM MA 00169

NEPONSET RIVER BASIN NORWOOD/WALPOLE, MASSACHUSETTS

PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00169 Name of Dam: Willett Pond Town: Norwood and Walpole County and State: Norfolk County, Massachusetts Stream: Hawes Brook - Tributary of the Neponset River Date of Inspection: December 5 and 12, 1978

The impounding structures at Willett Pond include a 900-foot long, 25-foot high main dam with a spillway and an outlet, and a 1,900-foot long, 13-foot high dike. The structures were built in 1913. According to the available specification and drawings, both the dam and dike contain a concrete core wall with the embankments made of earth fill. The crest of the main dam varies from elevation (El) 143.7 to 144.6, and the crest of the dike varies from El 142.0 to 142.8. An asphalt-paved street (Brook Street) is on the crest of the main dam. The spillway is located at the south abutment of the dam, and consists of a three-bay concrete box culvert beneath the roadway. The combined width of the culvert openings is 24.9 feet, and the openings are each 5.1 feet high. Stoplogs are mounted at the upstream end of the spillway. The crest of the stoplogs is at El 139.0 and the crest of the spillway is El 137.7. Water discharges into a 220-foot long discharge channel lined with stone and concrete. The outlet consists of two 20-inch diameter, cast-iron conduits which discharge at the toe of the dam. The pipes are located about 270 feet from the south abutment of the dam. A gatehouse on the downstream slope of the dam contains gate valves to control flow. Discharge from the outlet flows through a Parshall flume and into a flat swamp at the toe of the dam.

There are deficiencies which must be corrected to assure the continued performance of this dam. This

conclusion is based on the visual inspection of the site, a review of available data, a review of the 1911 and 1913 plans and specifications, and a review of operating and maintenance procedures. Generally, the dam is in fair condition.

The following deficiencies were observed at the main dam: seepage at several locations along the downstream toe, erosion on the upstream face of the dam which has caused undermining of the crest, erosion on the upstream and downstream slopes due to surface runoff from the road on the crest, trees and brush on the upstream and downstream slopes, cracking and spalling of gunite and concrete on the spillway, debris lodged on the stoplogs of the spillway, erosion in the floor and in the north side of the spillway channel, trees on the sides of the spillway discharge channel, and standing water in the foundation of the gatehouse. Also, the earth dike is eroded locally on the upstream slope and contains trees and brush on the upstream and downstream slopes.

Based on Corps of Engineers' guidelines, the dam has been classified as "intermediate" and in the "high" hazard category. Accordingly, a test flood equal to the full probable maximum flood (PMF) was used for this analysis. Hydraulic analyses indicate that the spillway (without stoplogs) can discharge 740 cubic feet per second (cfs) with the pond at El 142.1, which is the average low point on the crest of the dike. A test flood outflow of 4,380 cfs (the full Probable Maximum Flood (PMF)) with the pond at El 143.6 will not overtop the main dam, but will overtop the dike by a maximum of 1.5 feet. The spillway (without stoplogs) can discharge 17 percent of the test flood outflow before the dike is overtopped. With the stoplogs in place, the spillway can discharge 440 cfs or 10 percent of the test flood before the dike is overtopped.

It is recommended that the Owner employ a qualified consultant to evaluate the seepage which is occurring through the embankment of the main dam. The consultant should also conduct a more detailed hydraulic/ hydrologic study to evaluate raising the crest of the dike or increasing the discharge capacity of the spillway at the main dam. The Owner should immediately remove the stoplogs in front of the spillway and lower the pond by an arbitrary 2.7 feet (to El 135) below the crest of the spillway to reduce seepage pressure through the dam. The pond should be maintained

at El 135 until the above recommendations and the following remedial measures are completed: repair erosion on the upstream slope of the dam and dike, construct surface drainage control on both sides of the crest of the dam; selectively clear trees and brush from the dam, dike, and spillway discharge channel; repair concrete/gunite on the spillway; repair erosion in the floor and a breach in the side of the spillway discharge channel; and dewater the foundation of the gatehouse and determine the location and magnitude of the leakage. The Owner should also implement a regular program of inspection and maintenance and a warning system for the dar

The remedial measures outlined above and in Section 7 should be implemented by the Owner within a period of one year after receipt of this Phase 1 Inspection Report. There are no recommended alternatives.



Elwar Chen

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

Connecticut Registration No. 08365

Approved by:

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

Massachusetts Registration No. 19703



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

CHARLES G. TIERSCH, Chairman Chief, Foundation and Materials Branch Engineering Division

FRED J. RAVENS, JR., Member Chief, Design Branch Engineering Division

SAUL C. COOPER, Member Chief, Water Control Branch Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in <u>Recommended Guidelines for Safety Inspection of Dams</u>, 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 willbe detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

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WILLETT POND DAM

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OVERVIEW WHLET POND DAM NORWOOD, MASSACHUSETTS

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NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

WILLETT POND DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. <u>Authority</u>. Public Law 92-367, dated August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Divison of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-79-C-0016, dated November 28, 1978, has been assigned by the Corps of Engineers for this work.

b. Purpose:

- Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
- (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
- (3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam is located on Hawes Brook, a tributary of the Neponset River. The town line

between Norwood and Walpole crosses the axis of the dam (see Location Map). Most of the main dam is located in the Town of Norwood and the southern end of the main dam and the dike are in the Town of Walpole. These towns are located in Norfolk County, Massachusetts.

 b. Description of Dam and Appurtenances. The impounding structures at Willett Pond Dam consist of the main dam, including a spillway and outlet, and an earth dike (see Figures B-1 through B-5 and photographs in Appendix C).

The main dam is a 900-foot long earth embankment with a maximum height of 25 feet at the gatehouse. According to the specifications and drawings for the dam, the embankment contains a concrete cutoff wall extending 4 to 10 feet below the base of the embankment (see Figures B-4 and B-5). An asphalt-paved street is on the crest of the dam, which is 23 to 27 feet wide. The crest of the dam varies from El 143.7 to 144.6. The section of the road located in Norwood is called Brook Street, and the section in Walpole is called Bullard Street. The upstream face slopes at 2:1 (horizontal to vertical) and is covered with riprap. The downstream face slopes at 2.0:1 to 2.5:1 and is covered with grass and vegetation. There is an area of rock and earth fill on the downstream face of the dam about 250 feet north of the gatehouse. This may have been the site of a tannery which was originally located at the dam.

The spillway, located at the south abutment of the dam, is a three-bay concrete box culvert which extends under Bullard Street. The approach to the spillway has vertical, concrete sidewalls extending 11 feet upstream. Wooden stoplogs are set at the entrance to the spillway, with the top at El 139.0. The invert of the culvert forms a broad-crested weir at El 137.7 at the upstream edge, sloping to El 136.6 at the downstream edge. The culvert openings are 5.1 feet high and have a combined width of 24.9 feet (effective length of spillway). The discharge channel below the spillway is about 220 feet long and 20 to 24 feet wide. The

sides are concrete walls for a distance of about 40 feet downstream. Below that, the sides are made of earth which are covered with boulders that are grouted in place. The floor of the discharge channel slopes at about 8 percent.

The low-level outlet for the dam consists of two 20-inch diameter, cast-iron conduits, extending from the upstream toe of the dam to the downstream toe. The outlet pipes are located about 270 feet north of the south abutment of the dam. The downstream invert of the pipes is at El 118.7. A brick gatehouse is located on the downstream slope of the dam and contains a manually operated gate valve and a gated bypass for each outlet pipe. The outlet pipes discharge into a Parshall flume used to measure the volume of flow (see Figures B-6 and B-7). A device to record flow is located inside the gatehouse. Below the flume is a stream bounded by trees and a swamp.

The dike is a 1,900-foot long earth embankment located along the southeast shore of Willett Pond (see Location Map). The dike has a maximum height of 14 feet. According to the specifications and drawings for the dike, the embankment contains a concrete core wall about 15 feet high. The crest of the dike is about 15 feet wide and varies from El 142.0 to 142.8. The upstream face slopes at about 2:1 and is covered with riprap. The downstream face slopes at 2.4:1 and is covered with vegetation.

- c. <u>Size Classification</u>. Willett Pond Dam is classified in the "intermediate" category, since it has a maximum height of 25 feet and a maximum storage capacity of 2,785 acre-feet.
- d. <u>Hazard Classification</u>. The valley downstream of the dam is about 400 to 500 feet wide. An earth dam 5 feet high is located about 800 feet downstream, but it has been breached near the south abutment down to the stream bed. A second dam forming Ellis Pond is located about 3,700 feet downstream of Willett Pond Dam.

Concentrated residential development occurs downstream of the dam along both sides of the valley (see Location Map). Most of the homes are built away from and at least 10 feet above the bed of Hawes Brook. However, some homes are lower and closer to the stream, especially along the south side of the valley on Morningside and Orleans Roads and around Ellis Pond. Below the dam at Ellis Pond, Hawes Brook flows beneath Route 1A, and then through a thickly developed area including an apartment building and a complex of factories.

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The alignment of the dike is parallel to Bullard Street which is a well-traveled road. About 20 residences are located downstream, about 200 and 500 feet from the dike.

Failure of the main dam when the pond is at the crest of the dike would produce a flood wave about 10.5 feet high, 1,500 feet downstream. It is likely that this flood could result in excessive property damage and the loss of more than a few lives. Discharge below the Ellis Pond Dam could also affect the roadway and structures farther downstream. Failure of the dike would produce a flood wave 3.5 feet high and would cause excessive property damage and possible loss of life along Bullard Street. Accordingly, the dam has been placed in the "high" hazard category.

e. <u>Ownership</u>. The dam and dike have been owned since November 1953 by the Neponset Reservoir Corporation, a group of four industrial companies located along the Neponset River. The member companies are: Bird & Son, Inc., East Walpole; Hollingsworth & Vose Co., East Walpole; the Kendall Co., Walpole; and Diamond International, Hyde Park. The current chairman of the corporation is Mr. Malcolm White at Hollingsworth & Vose Co., 112 Washington Street, East Walpole, Massachusetts 02032 (telephone: (617) 668-0295). Mr. White granted permission to enter the property and inspect the dam.

The pond originally was referred to as New Pond but is now known as Willett Pond, out of respect for George F. Willett, former president

of Winslow Brothers & Smith Company, under whose administration the man-made pond was constructed.

- f. Operators. The dam is operated by personnel from Bird & Son, Inc., East Walpole.
- g. <u>Purpose of Dam</u>. Willett Pond was originally used by Winslow Brothers and Smith Co. to provide water for processing at a tannery. Later, the water was reportedly used to dilute industrial effluent from Hollingsworth & Vose Co. and Bird & Son, Inc., but who now recycle their industrial wastewater.

At the present time, water in Willett Pond is primarily used to maintain a flow of 3 mgd (million gallons per day) in the Neponset River as measured at a gaging station located about 2 miles downstream. The water is released as needed, usually during July and August. The pond is also drawn down in the fall to provide storage for spring runoff. The pond is also used for swimming and boating by the abutting residents.

Design and Construction History. The dam and h. dike at Willett Pond were constructed in 1913 for Winslow Brothers and Smith Co. A drawing and construction specifications were prepared in 1911 by Lucian A. Taylor, consulting engineer (drawing shown on Figure B-5). later drawing of the dam was prepared by A. L. Maddox, engineer, in 1913 (see Figure B-4). These drawings show that both the dam and dike were to be constructed with a concrete core wall extending below the bottom of the embankment. The base of the core wall is described as carried to bedrock or to a "watertight foundation". The specifications state the embankment was to be constructed of "good gravel and sand such as may be procured from the neighboring land". The spillway was to be constructed of concrete with the crest four feet below the top of the embankment of the dam. The outlet pipes are shown as two 20-inch diameter, cast-iron pipes encased in concrete and having gate controls at the toe of the dam.

During the period 1953 to 1970, several plans were proposed for diverting water from Willett Pond and Hawes Brook to ponds near the Hollingsworth & Vose and the Bird & Sons factories. None of these plans was ever implemented.

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In 1971, a Parshall flume was constructed below the outlet pipes for measuring discharge into Hawes Brook. Construction drawings prepared by Metcalf & Eddy, Inc. are shown on Figures B-6 and B-7.

Spalling and cracking of the concrete had been described in inspection reports dated May, 1968 and July, 1973. Therefore, in about 1975, the concrete walls of the spillway were reportedly reconstructed by the Owner.

Normal Operating Procedures. Personnel from 1. Bird & Son, Inc. reportedly visit the dam three to four times a week. The stoplogs on the crest of the spillway are permanently mounted; therefore, operation of the dam consists of opening and closing the gates on the outlet The gates are operated in summer and pipes. early fall, as required, to maintain a flow of 3 mgd at a gaging station located 2 miles downstream on the Neponset River (see Location Map). Personnel from Bird & Son, Inc. have keys to the gaging station and check the flow periodically during dry months. The pond is also drawn down by 2 or 3 feet in the fall to provide storage for runoff in the spring. Maintenance personnel measure discharge through the Parshall flume and record the discharge using an instrument located in the gatehouse. The gatehouse is kept locked.

1.3 Pertinent Data

a. <u>Drainage Area</u>. The approximately 3,555-acre (5.55 square mile) drainage area includes the drainage areas of Bubbling Brook and Mill Brook which flow into Willett Pond from the north (see Figure D-1 in Appendix). The topography is gently rolling. About 12 percent of the drainage area is ponds and swamps. The remaining land is about half wooded and about half cleared, mostly for residential development. There is moderate to thick residential

development, especially north of Willett Pond into Westwood and along the southwest shore of the pond. There are over 200 residences in the drainage area.

Discharge. Normal discharge is over the spillb. way and into a stone-lined channel leading to Hawes Brook. The spillway is a three-bay concrete box culvert with an effective length of 24.9 feet. There are wooden stoplogs mounted just upstream of the culvert, and the top of the stoplogs is at El 139.0. This discharge channel is about 220 feet long and 20 to 24 feet wide and discharges into Hawes Brook downstream of the toe of the dam. The valley below the dam is a 400- to 500-foot wide swamp, heavily overgrown with brush and trees. Pools and streams of water are present at several locations below the dam, so that the bed of Hawes Brook is not clearly defined until farther downstream.

Discharge also occurs from the two 20-inch outlet pipes which discharge into a Parshall flume and then into the swamp. This discharge is controlled by gate valves which are opened in the late summer and fall for flood control.

Hydraulic analyses indicate that the spillway without stoplogs can discharge an estimated 750 cfs with the pond at El 142.1, which is the average low point on the crest of the dike. The test flood outflow (full PMF) is estimated to be 4,380 cfs with the pond at El 143.6. During the test flood, the main dam would not be overtopped, but the dike would be overtopped by a maximum of 1.5 feet. The pond could also flow out through a low area just south of the south abutment of the main dam and discharge down Bullard Street. The low area is about 10 to 30 feet wide and about 1.5 feet below the crest of the main dam. The spillway without stoplogs can discharge 17 percent of the test flood before the dike is overtopped. With the stoplogs in place, the spillway can discharge 440 cfs or 10 percent of the test flood before the dike is overtopped.

Flood levels at the gaging station located downstream on the Neponset River have been recorded since October 1939. The maximum discharge recorded on August 19, 1955 was 1,490 cfs for the 35.2 square mile watershed including Willett Pond. The dam at Willett Pond was reportedly not overtopped or damaged in this storm.

- c. <u>Elevation (feet above Mean Sea Level (MSL)</u>). A benchmark was established at El 139.0 on top of the stoplogs at the spillway. This elevation was estimated from a United States Geological Survey (USGS) topographic map.
 - (1) Top dam Main dam: 143.7 to 144.6 Dike section: 142.0 to 142.8
 - (2) Test flood pool: 143.5
 - (3) Design surcharge (original design): Unknown

 - (5) Recreation pool: 139.0 top of stoplogs
 - (6) Spillway crest (without stoplogs): 137.7
 - (7) Upstream portal invert diversion tunnel: N/A
 - (8) Streambed at centerline of dam: 118.7
 - (9) Tailwater: 119.0 swamp below dam
- d. <u>Reservoir</u>
 - (1) Length of maximum pool: 6,000 feet
 - (2) Length of recreation pool: 6,000 feet
 - (3) Length of flood control pool: N/A

e. <u>Storage</u> (acre-feet)

(1) Test flood surcharge (net): 1,227 at El 143.6

- (2) Top of dam (El 142.1, average low point on dike): 2,785
- (3) Flood control pool: N/A
- (4) Recreation pool (El 139.0, top of stoplogs): 2,140
- (5) Spillway crest (El 137.7): 1,870
- f. <u>Reservoir Surface (acres)</u>
 - *(1) Top dam: 208
 - *(2) Test flood pool: 208
 - (3) Flood control pool: N/A
 - (4) Recreation pool: 208
 - (5) Spillway crest (without stoplogs): 208
- g. <u>Dam</u>

 (1) Type - Main dam: earthfill embankment, concrete core wall, asphalt pavement on crest
 Dike section: earthfill embankment, concrete core wall

- (2) Length Main dam: 900 feet - Dike section: 1,900 feet
- (3) Height Main dam: (maximum) 25 feet - Dike section: (maximum) 14 feet
- (4) Top width Main dam: 23 to 27 feet
 Dike section: 13 to 16 feet
- (5) Side slopes Main dam: downstream 2:1 to 2.5:1; upstream 2:1
 - Dike section: downstream 2.4:1; upstream 2:1

^{*}Based on the assumption that the surface area will not significantly increase with changes in pond elevation from 137.7 to 142.1.

- (6) Zoning (dam and dike): Concrete core wall with embankment of pervious fill
- (7) Impervious core (dam and dike): Concrete core wall
- (8) Cutoff (dam and dike): Concrete core wall extends 4 to 10 feet below embankment to bedrock or impervious material.
- (9) Grout curtain: None
- h. Spillway
 - Type: Broad-crested three-bay concrete box culvert with stoplogs mounted at upstream end
 - (2) Crest length: 24.9 feet

 - (4) Gates: None
 - (5) Upstream channel: Vertical concrete side walls extending 11 feet upstream, floor covered with sand and boulders
 - (6) Downstream channel: 20 to 24 feet wide, 220 feet long; vertical, concrete side walls extending 40 feet downstream, then earth sides lined with stone and concrete; floor is lined with stone and concrete
- 1. <u>Regulating Outlets</u>. The regulating outlet at the dam consists of two 20-inch diameter, cast- iron conduits extending from the upstream toe of the dam to the downstream toe. The invert of the conduits at the downstream toe is at El 118.7. Flow is controlled by gate valves in a gatehouse on the downstream slope. The gates are operated several times a year. Discharge is into a Parshall flume for measuring flow, and then into the swamp downstream.

SECTION 2

ENGINEERING DATA

2.1 General. Several drawings, specifications and previous inspection records are available for the Willett Pond Dam. A drawing, showing generalized sections through the dam and dike (see Figure B-5) and a 10-page specification, both prepared in 1911 by Lucian A. Taylor, were obtained from the Massachusetts Department of Public Works. A drawing dated 1913 showing a plan and section of the main dam (see Figure B-4) was obtained from the Town Engineer's Office in Norwood. A drawing dated 1952 showing a plan of the dike and property abutting the southern half of the pond was obtained from Bird & Sons, Inc. Four sheets of drawings dated 1971 for construction of the Parshall flume (see Figures B-6 and B-7) were prepared by Metcalf & Eddy, Inc. Previous inspection notes and an inspection report dated July 13, 1973 (see pages B-8 through B-13) were also obtained from the Massachusetts Department of Public Works. No other plans, specifications, or computations are available from the Owner, County, or State agencies relative to the design, construction or repair of this dam.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Division of Waterways, the Massachusetts Department of Public Works, and the Norwood Town Engineer's Office; Mr. Malcolm White, representing the Neponset Reservoir Corporation; and Messrs. Jim Moylon and John Hays of Bird & Son, Inc.

- 2.2 <u>Construction Records</u>. The only construction records are the drawings referred to in Section 2.1 and included in Appendix B. There are no as-built drawings for the dam, dike or appurtenant structures.
- 2.3 <u>Operating Records</u>. No operating records are available, and there is no daily record kept of the elevation of the pool or rainfall at the dam site.

2.4 Evaluation

- a. <u>Availability</u>. There is limited engineering data available.
- b. <u>Adequacy</u>. 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 drawings and specifications, review of past inspection reports, visual inspection, past performance history, and engineering judgment.
- c. <u>Validity</u>. Comparison of the available drawings with the field survey conducted during the Phase I inspection indicates that the available information is valid. There were minor discrepancies between the 1911 and 1913 drawings concerning the height and top elevation of the core wall in the main dam. This could not be checked in the field.

SECTION 3

VISUAL INSPECTION

3.1 Findings

- a. <u>General</u>. The Phase I Inspection of the dam at Willett Pond was performed on December 5, 1978. The inspection of the dike was conducted on December 12, 1978. A reinspection of the dam and dike was done on March 21, 1979. A copy of the inspection checklist is in Appendix A. Previous inspections were conducted by Norfolk County in August, 1945, September, 1945, and May, 1968. An inspection report prepared by the Massachusetts Department of Public Works in July, 1973 is given in Appendix B (see pages B-8 through B-13).
- b. Dam. The dam consists of a 900-foot long, 25-foot high earth embankment, with a spillway at the south abutment and with an outlet and gatehouse located about 270 feet north of the south abutment. Also impounding the pond is an earth dike about 1,900 feet long and 13 feet high located just south of the main dam.

The main dam is in fair condition. The area near the downstream toe is wet and soft. Several locations of seepage were observed along the toe from the spillway to the fill area north of the gatehouse. In March, 1979, two streams of seepage were also flowing from the base of the fill area, as shown on Figure B-1. A rectangular, stone-lined hole is located just downstream of the fill, and may be an abandoned outlet. A stream of orange water is flowing from this opening southward into Hawes Brook. Much of the area below the dam is a swamp which extends downstream and appears to be a natural feature. The toe of the embankment may have been constructed on or adjacent to organic material, however, the core wall probably extends below the swamp level.

The most obvious deficiency at the main dam is the severe erosion of the upper portion of the upstream face near the crest. This erosion has undermined portions of the roadway, caused

tilting of the fence along the edge of the road and washing of soil down over the riprap. Other than wave action, this erosion is probably due to surface runoff from the road, which has no curb or drainage system. The surface of the road is cracked, irregular, and patched in places. The riprap on the upstream slope of the dam is mostly intact. A few pieces are missing, but there is no filling or chinking between the stones. Small trees and brush are growing along the entire length of the upper upstream slope.

The downstream slope of the dam contains a moderate growth of brush and small oak trees, except in the vicinity of the gatehouse. Surface runoff from the road has eroded gullies locally and one section of the fence along the downstream edge of the crest is tilted downstream.

The embankment of the dike is in fair condition. The upstream slope is covered with riprap, but footpaths and wave erosion have caused local sloughing. Birch trees are growing along most of the upstream edge of the crest. The downstream slope is covered by a moderate to thick growth of trees and brush. No seepage was observed along the dike.

c. <u>Appurtenant Structures</u>. The spillway for the main dam is a three-bay box culvert beneath the road on the crest. Although the concrete walls were recently resurfaced with gunite, cracking and erosion has occurred on the lower portion of the approach walls upstream of the spillway and on the invert of the box culvert (see photographs 7 and 8 in Appendix C). During a subsequent visit to the dam in March 1979, a tree stump and other dead wood were caught on the stoplogs of the spillway.

The outlet for the dam is two 20-inch diameter cast-iron pipes which discharge at the downstream toe into a Parshall flume. A gatehouse is located on the downstream slope and contains manually operated valves to control flow. The gatehouse is in good condition and kept locked. The outlet pipes in the foundation of the gatehouse are submerged in standing water. The

outlets were discharging at the time of inspection and could not be examined closely. The flume is in good condition, although some erosion and spalling has occurred on the inside of the concrete walls. Water is seeping out of the flume through a construction joint on the upstream wall, forming a pool of water outside the wall.

- d. <u>Reservoir Area</u>. The area around Willett Pond contains sections of moderate and thick residential development. There are about 50 residences around the pond. It is possible that future development could occur, especially along the northwest portion of the shoreline. The land is about half wooded and about half cleared, with slopes ranging from 4 to 10 percent.
- e. <u>Downstream Channel</u>. The discharge channel below the spillway is lined with stone and voids are filled in with concrete. Several large holes 1 to 3 feet deep have been eroded in the floor of the discharge channel (see photograph / in Appendix C). On both sides of the channel, trees are growing which could fall and partially block the channel during a flood. Near the downstream end of the channel, the north side has been eroded and, during the March 1979 visit, water was discharging through the side and flowing upstream toward the toe of the dam.

Water discharging from the Parshall flume flows into a swamp, although some water pools around the outside of the flume. Around and downstream of the flume, the area is flat, swampy and thickly wooded.

3.2 <u>Evaluation</u>. The above findings indicate that the dam is in fair condition and that there are several deficiencies which require attention. It is evident that the dam is not adequately maintained. Recommended measures to improve these conditions are stated in Section 7.3.

SECTION 4

OPERATING PROCEDURES

- 4.1 <u>Procedures</u>. Personnel from Bird & Son, Inc. reportedly visit the dam three to four times a week. Normal procedures at the dam consist of seasonally operating the outlets to maintain a downstream discharge and to provide storage for spring runoff. A minimum flow of 3 mgd is maintained as measured at a gaging station located about 2 miles downstream on the Neponset River. To accomplish this, personnel check the flow at the gaging station periodically during dry months. The outlets are opened as required, usually in July and August. The pond is also reportedly drawn down by 2 or 3 feet in the late fall.
- 4.2 <u>Maintenance of Dam</u>. Periodic maintenance of the dam has been conducted in the past. Trees and brush have been kept cleared from the downstream slope in the vicinity of the gatehouse. There is also evidence of past clearing of trees and brush in other areas on both the upstream and downstream slopes. However, subsequent growth has occurred. About two or three years ago, the concrete on the spillway and side walls of the downstream channel was repaired and resurfaced with gunite.

Present conditions at the dam indicate that it has not been adequately maintained. Seepage was observed at several locations along the downstream toe of the embankment. Erosion has occurred on the upstream edge of the dam, causing undermining of the road, loss of some riprap and tilting of the fence along the road. Trees and brush are growing on the upstream and downstream slopes of the dam. The gunite and concrete on the spillway is cracked and eroded below the level of the stoplogs. The floor and north side of the discharge channel are eroded, and trees are lining both sides of the channel. The dike contains localized erosion on the upstream face and growth of trees on the upstream and downstream slopes.

4.3 <u>Maintenance of Operating Facilities</u>. The outlet pipes are operated regularly. The control valves are located inside a building which is kept locked

and in good condition. The outlet pipes are submerged below standing water in the foundation of the gatehouse. There is some erosion and spalling of the inside walls of the flume located below the outlet pipes.

- 4.4 <u>Description of Any Warning System in Effect</u>. There is no warning system in effect at this dam.
- 4.5 <u>Evaluation</u>. 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 Willett Pond Dam. This is extremely undesirable considering the dam is in the "high" hazard category. A regular program of inspection and maintenance and a surveillance system for this dam should be implemented as recommended in Section 7.3.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. <u>General</u>. Willett Pond is impounded by a 900foot long, 25-foot high earth dam and by a 1,900-foot long earth dike. The crest of the dike was found to be 1 to 2 feet below the crest of the main dam. The drainage area for the pond is 5.55 square miles and is located in suburban communities with sections of thick residential development. Bubbling Brook and Mill Brook drain into the pond. The valley below the dam is wide and swampy. A low, earth dam, which has been breached, is located 800 feet downstream. Ellis Pond Dam is located 3,700 feet downstream, and the pond is surrounded by housing.

The maximum storage in Willett Pond is calculated to be 2,785 acre-feet. The maximum flood level is unknown; there is no mention in the County records of the dam being overtopped. The pond has been used for industrial purposes in the past. It is now used to control flow in the Neponset River and for recreation.

- b. <u>Design Data</u>. There are no hydraulic/hyrologic computations available for the design of the spillway at Willett Pond Dam.
- c. Experience Data. Records for the gaging station downstream on the Neponset River indicate that the maximum flood discharge since 1886 was a rate of 1,490 cfs (42.3 cfs per square mile) on August 19, 1955. Personnel employed at the time at Hollingsworth & Vose Co. state that the dam was not overtopped or damaged in that storm.

It was noted that during the December 1978 inspection, the pond had been drawn down and, with a relatively dry fall, the level was at El 132.8. During a return visit in March 1979, water was flowing over the stoplogs of the spillway (El 139.0), indicating a seasonal fluctuation of over 6 feet for the pond.

d. Visual Observations. Water discharges over stoplogs at the upstream edge of the crest of the spillway. The spillway is a three-bay concrete box culvert with an invert at El 137.7 and an effective weir length of 24.9 feet. The discharge channel is 20 to 24 feet wide, 220 feet long and the floor slopes at 8 percent. The sides of the channel are vertical, concrete walls, 5.4 feet high at the spillway and tapering down to less than 1 foot high were they end about 40 feet downstream. Below this, the sides of the channel are 1 or 2 feet high and made of earth, lined with boulders and The floor is lined with boulders and concrete. concrete.

A tree stump and a few other pieces of dead wood were caught on the stoplogs of the spillway. Large holes 1 to 3 feet deep have been eroded in the floor of the discharge channel. Trees are growing along both sides of the channel and could fall down during a flood. The lower 20 feet of the north side of the channel has been eroded, allowing some water to discharge through the side and flow upstream toward the toe of the dam.

The outlet for the dam consists of two 20-inch conduits which discharge into a Parshall flume and then into the swamp below the dam. Flow is controlled by gate valves which are located in a gatehouse and are operated several times a year. The outlets were discharging at the time of inspection. Some water was pooled around the foundation of the flume.

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

e. <u>Test Flood Analysis</u>. Willett Pond Dam has been placed in the "intermediate" size category and in the "high" hazard category. In accordance with the Corps of Engineers' guidelines, the full PMF was used to evaluate the capacity of the spillway.

The PMF rate for Willett Pond Dam was determined to be 1,000 cfs per square mile of drainage area. This calculation is based on

the average slope of the drainage area of 1.5 percent. The pond- plus-swamp area to drainage area ratio of 12 percent, and the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Rates (dated December 1977). Applying the full PMF rate to the 5.55 square miles of drainage area results in a calculated peak flood flow of 5,550 cfs as the test flood inflow. By adjusting the test flood inflow for surcharge storage, the maximum discharge rate was established as 4,380 cfs (790 cfs per square mile) with the level of the pond at El 143.6.

Hydraulic analyses indicate that the spillway (without stoplogs) can discharge a maximum of 740 cfs with the pond at El 142.1, which is the average low point on the crest of the dike. This discharge is 17 percent of the test flood outflow. During the test flood, the main dam would not be overtopped, but the dike would be overtopped by a maximum of 1.5 feet. The pond could also flow out through a low area just south of the south abutment of the main dam and discharge down Bullard Street. The low area is about 10 to 30 feet wide and about 1.5 feet below the crest of the main dam. During the test flood, discharge over the crest of the dike is estimated to be 3,320 cfs with a maximum head of 1.5 feet. The depth at critical flow would be 0.91 feet with a velocity of 5.41 feet per second. With the stoplogs in place, the spillway can discharge 440 cfs or 10 percent of the test flood before overtopping the dike.

The two 20-inch outlet pipes can discharge a flow of 96 cfs when the level of the pond is at the crest of the spillway without stoplogs. Starting at that elevation, the outlets can lower the pond by 1 foot in about 25 hours.

f. Dam Failure Analysis. The peak discharge rate due to failure of the main dam was calculated to be 24,000 cfs, assuming a breach 154 feet wide and a head of 20 feet. Failure of the main dam would produce a flood wave obout 10.5 feet high about 1,500 feet downstream. This flood could result in excessive damage to residential and commercial property downstream of

both Willett Pond and Ellis Pond Dams. The failure could also cause loss of more than a few lives in residences between Willett Pond and Ellis Pond Dams.

The peak discharge rate due to failure of the dike along Bullard Street was calculated to be 4,600 cfs, assuming a breach 56 feet wide and a head of 13.4 feet. Failure of the dike would produce a flood wave about 3.5 feet high and 200 feet wide. Failure of the dike could result in excessive damage to residences along Bullard Street and cause the loss of a few lives.

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

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. <u>Visual Observations</u>. The evaluation of the structural stability of the dam and dike at Willett Pond is based on a review of the available data, a review of previous inspection reports, and visual inspections conducted on December 5 and 12, 1978, and on March 21, 1979.

As discussed in Section 3, Visual Inspection, the dam and dike are in fair condition. Seepage was observed at several locations along the downstream toe of the dam. Lo seepage was observed at the toe of the dike. There were no visible signs of significant settlement of either structure. However, erosion of slopes and growth of trees and brush is occurring at both sites.

Design and Construction Data. The dam and dike b. were constructed in 1913. A specification dated 1911 by Lucian A. Taylor describes the methods and materials proposed for construction. Both embankments were to contain a core wall made of Portland cement mixed with clean sand and gravel, less than 2-1/2 inches in diameter. The core wall at the main dam is 2 feet thick at the top, which is 1.5 feet above the crest of the spillway (about El 139). The drawing dated 1913, however, shows the top of the core wall at 3.5 feet above the "floor of the wasteway" (about El 141). The thickness of the core wall increases 1 foot for each 10 feet vertically to the level of the outlet pipes (20 feet on 1911 drawing, 17.5 feet on 1913 drawing). The core wall is then extended downward at the same thickness for 4 to 10 feet into bedrock or other "watertight" material. The core wall for the dike is constructed in a similar way, with its top 1 foot above the crest of the spillway (about El 139). The wall increases thickness to a height of 15 feet, and then is trenched into a "hard, water-tight" foundation with a thickness of 3 feet.
The embankments are described as being made from local sand and gravel, with no stones more than 6 inches in diameter and no vegetable matter. The embankments were to be laid in 8-inch layers and "thoroughly rolled" to prevent settlement. The specification calls for the ground beneath the embankments to be cleared, grubbed, and all vegetable matter and mud removed to a "firm" foundation, except beneath the lower half of the downstream slope. The area along most of the downstream toe of the dam is a swamp. The toe of the embankment may have been constructed on or adjacent to organic material, although the core wall probably extends below the swamp level.

- c. <u>Operating Records</u>. There is no instrumentation of any type in the embankment at Willett Pond Dam, 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. <u>Post-Costruction Changes</u>. During the period 1953 to 1970, several plans were proposed to divert water from Willett Pond and Hawes Brook to ponds near the Hollingsworth & Vose and Bird & Sons factories. None of these plans was ever implemented.

The Parshall flume below the spillway was constructed in 1971. Copies of the design drawings are shown in Appendix B. An instrument to record the discharge is located inside the gatehouse. About 1975, the concrete on the spillway was repaired and resurfaced with gunite.

e. <u>Seismic Stability</u>. The dam is located in Seismic Zone No. 2. Because of its configuration and the low head of water retained, a seismic analysis is not considered warranted.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

Condition. Based upon a review of available a. data, the visual inspection of the site, and limited operational or maintenance information, there are deficiencies which must be corrected to assure the continued performance of the dam. Seepage was observed at several locations along the downstream toe of the main dam. Several other signs of distress were also observed: wave erosion on the upstream slope of the dam causing undermining of the crest, erosion on the upstream and downstream slopes due to runoff from the road on the crest, trees and brush on the upstream and downstream slopes, cracking and spalling of gunite and concrete on the spillway, debris lodged on the stoplogs of the spillway, erosion of the floor and the north side of the spillway discharge channel, trees on the sides of the spillway discharge channel, and standing water around the outlet pipes in the gatehouse. The earth dike is eroded locally on the upstream slope and contains trees and brush on the upstream and downstream slopes.

Hydraulic analyses indicate that the spillway (without stoplogs) can discharge an estimated flow of 740 cfs with the pond at El 142.1, which is the average low point on the crest of the dike. An outflow test flood (full PMF) will not overtop the main dam, but will overtop the dike by a maximum of 1.5 feet. The pond could also flow out through a low area just south of the south abutment of the main dam and discharge down Bullard Street. The spillway can discharge 17 percent of the test flood before the dike is overtopped. With the stoplogs in place, the spillway can discharge 440 cfs or 10 percent of the test flood before the dike is overtopped.

b. <u>Adequacy</u>. 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 a review of the available data, the visual inspection, past performance and engineering judgment.

- c. <u>Urgency</u>. The recommendations and remedial measures outlined below should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.
- 7.2 <u>Recommendations</u>. In view of the concerns over the continued performance of the dam, it is recommended that the Owner employ a qualified consultant to: conduct a subsurface investigation to evaluate the seepage through the main dam, and conduct a more detailed hydraulic/hydrologic study to evaluate raising the dike, increasing existing spillway capacity and/or adding an emergency spillway.

Recommendations on repairs and maintenance procedures are outlined below under Section 7.3, <u>Remedial</u> <u>Measures</u>.

- 7.3 Remedial Measures
 - a. <u>Operating and Maintenance Procedures</u>. The dam and appurtenant structures are not adequately maintained. It is recommended that the Owner accomplish the following:
 - (1) immediately remove the stoplogs on the spillway and lower the pond by an arbitrary 2.7 feet (to El 135) below the crest of the spillway to reduce seepage pressure through the dam. The pond should be maintained at El 135 until the above recommendations and the following remedial measures have been completed.
 - (2) repair erosion on the upstream slopes of the dam and dike, replacing any missing riprap,
 - (3) construct a curb or drainage ditch along both sides of the roadway on the crest of the main dam to control surface drainage,
 - (4) initiate a program of selective clearing of trees and brush from both slopes of the main dam and dike, and from the sides of the spillway discharge channel,

- (5) repair damaged gunite and concrete on walls and crest of spillway,
- (6) repair erosion in the floor and in the north side of the spillway discharge channel,
- (7) dewater the foundation of the gatehouse and determine the location and magnitude of the leakage,
- (8) implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam, dike and appurtenances, supplemented by additional inspections during and after severe storms. Maintenance should include clearing of debris from the spillway and discharge channel, clearing of trees and brush from the slopes, and repair of erosion to slopes or to the concrete on the spillway. All repairs and maintenance should be undertaken in accordance with all applicable State regulations.
- (9) periodic technical inspections of this dam should be continued on an annual basis,
- (10) institute a definite plan for surveillance and a warning system during periods of unusually heavy rains and/or runoff.
- 7.4 <u>Alternatives</u>. There are no recommended alternatives to implementing the recommendations and remedial measures listed above.

APPENDIX A

PERIODIC INSPECTION CHECKLIST

PERIODIC INSPECTION

PARTY ORGANIZATION

PHOJECT WILLETT POND DAM	DATE 5 DEC. 1978
	TIME 8:30 AM
	WEATHER Clear, Breezy
: <u>an17</u> :	W.S. ELEV. <u>132.8*</u> U.C. <u>119*</u> II *based on assumed benchmark at E1.139. on top of stoplogs on spillway.
	6. S. Pierce
D. Cole	7
. J. Komisarek	8
M. Larson	9
5. H. Lord	10
PROJECT FEATURE	INSPECTED BY REMARKS
. Dam Embankment	Larson/Komisarek
2Spillway	Larson/Komisarek
3. Dike Embankment	Komisarek
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page<u>A-1.56</u>

PROJECT WILLETT POND DAM	DATE 5 DEC. 1978		
PROJECT FEATURE Dam Embankment	NAME_Komisarek		
DISCIPLINE <u>Geotechnical</u> u/s=upstream d/s=downstream	NAME Larson lt.=left rt.=right		
AREA EVALUATED	CONDITIONS		
DAM EMBANKMENT			
Crest Elevation	Varies from El. 143.7 to 144.6		
Current Pool Elevation	132.8		
Maximum Impoundment to Date	Unknown		
Surface Cracks	Longitudinal cracks in road on crest		
Pavement Condition	Alligator cracking, asphalt patches		
Movement or Settlement of Crest	Settlement of road on both sides		
Lateral Movement	None visible		
Vertical Alignment	Numerous small dips in road		
Horizontal Alignment	Straight		
Condition at Abutment and at Concrete Structures	Lt.abut.good-v.few trees, rolling ground;rt.abut.good-many trees,rock butcrop		
Indications of Movement of Structural Items on Slopes	Fence on u/sedge of crest leaningu/s fence&telephone poles on d/sedge of prest leaning d/s		
Trespassing on Slopes	Footpaths on d/sslope, rt. abut.		
Sloughing or Erosion of Slopes ¹ or Abutments	i/s slope-consid.erosion&sloughing of road edge, also at one point on I/s edge.		
Rock Slope Protection - Riprap ^u Failures	/sriprap full length,minor pieces dislodged,eroded near top of slope, slump at ctr of lt u/s slope.no fill		
Unusual Movement or Cracking at or near Toes	material None visible		
Unusual Embankment or Downstream Seepage	Seepage along toe from spillway channel to fill area north of gate		
Piping or Boils	None		
Foundation Drainage Features	None		
Toe Drains	None visible		
Instrumentation System	None		

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PROJECT	WILLETT	POND DAM
PROJECT	FEATURE Di	ke Embankment
DISCIPLI	NE Geotec	chnical

Mark Ste

DATE 12 DEC. 1978 NAME Komisarek

NAME_____

AREA EVALUATED	CONDITION		
DIKE EMBANKMENT			
Crest Elevation	Varies from El.142.0 to 142.8		
Current Pool Elevation	132.8		
Maximum Impoundment to Date	linknown		
Surface Cracks	None visible		
Pavement Condition	None		
Movement or Settlement of Crest	Undulating with minor dips		
Lateral Movement	None apparent		
Vertical Alignment	Minor dipping		
Horizontal Alignment	Follows curved shoreline		
Condition at Abutment and at Concrete Structures	Good to fair-Joins natural knolls		
Indications of Movement of Structural Items on Slopes	None		
Trespassing on Slopes	Major footpaths, piers and landings sandboxes, fireplaces		
Sloughing or Erosion of Slopes or Abutments	None at abut., some on u/s slope at landings and paths		
Rock Slope Protection - Riprap Failures	Good condition-some scattered sloughing		
Unusual Movement or Cracking at or near Toes	None visible		
Unusual Embankment or Downstream Seepage	None visible		
Piping or Boils	None visible		
Foundation Drainage Features	None		
Toe Drains	None visible		
Instrumentation System	None		

page A-3 of 6

PROJECT WILLETT POND DAM	DATE 6 DEC. 1978
PROJECT FEATURE Spillway at Dam	NAME <u>Komisarek</u>
DISCIPLINE <u>Geotechnical</u>	NAMELarson

AREA EVALUATED	CONDITION			
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Concrete side walls, floor covered with sand, gravel, boulders			
a. Approach Channel				
General Condition	Fair to good-cracking & erosion of lower portion of side walls			
Loose Rock Overhanging Channel	None			
Trees Overhanging Channel	Some trees & brush			
Floor of Approach Channel	Sandy with boulders, spit island on u/s. side			
b. Weir and Training Walls	Triple box culvert			
General Condition of Concrete	spalling&erosion below water line, numerous cracks			
Rust or Staining	Some staining			
Spalling	severe below water line, especially on invert			
Any Visible Reinforcing	None			
Any Seepage or Efflorescence	Minor seepage, extensive efflorescence			
Drain Holes	None			
c. Discharge Channel	Rock rubble with concrete matrix			
General Condition	Very poor-several extensive holes due to scour, breach in left side			
Loose Rock Overhanging Channel	Loose boulders rt.side, some natural rock outcrop in floor			
Trees Overhanging Channel	Large trees and brush each side			
Floor of Channel	Badly eriorated, severe pitting erosion, and scour			
Other Obstructions	Channel discharges into swamp area			

page **A.4** of <u>6</u>

PROJECT WILLETT POND DAM	DATE 5 DEC. 1978		
PROJECT FEATURE Control Tower	NAMEKomisarek		
DISCIPLINE Geotechnical	NAMELarson		
AREA EVALUATED	. CONDITION		
UTLET WORKS - CONTROL TOWER a. Concrete and Structural	Brick building with concrete founda- tion, windows bricked on d/s. side, locked door.		
Jeneral Condition	Good, vine-covered side		
Condition of Joints	Good		
Spalling	Minor amount, some due to vines		
Visible Reinforcing	None		
Rusting or Staining of Concrete	Algae stained concrete		
Any Seepage or Efflorescence	None		
Joint Alignment	Not applicable		
Unusual Seepage or Leaks in Gate	None visible-outlet pipes submerged beneath standing water		
Cracks	None visible		
Rusting or Corrosion of Steel	Steel door sheathing rusted		
b. Mechanical and Electrical	Two gate valves, hand operated, partially submerged in standing water		
Air Vents	None		
Float Wells	None		
Crane Hoist	None		
Elevator	None		
Hydraulic System	None		
Service Gates	None-two gate valves, one closed, one partially open		
Emergency Gates	None		
Lightning Protection System	None		
Emergency Power System	None		
Wiring and Lighting System in Gate Chamber	No lighting, chart recorder present to measure&record flow through flume		

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PROJECT WILLETT POND DAM	DATE 5 DEC. 1978
PROIECT FEATURE Discharge Flume	NAME Komisarek
DISCIPLINE Geotechnical	NAMELarson

AREA EVALUATED	CONDITION		
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Parshall-flume-combined poured concrete &cinder blocks. Fair to good, some spall on inside		
Rust or Staining	Minor		
Spalling	Minor spalling above water line- interior walls.		
Erosion or Cavitation	Noted on cinder blocks and concrete-interior walls		
Visible Reinforcing	None		
Any Seepage or Efflorescence	Minor efflorescence on cinder		
Condition at Joints	Minor at concrete cinder block		
Drain Holes	None		
Channel	Natural, boulders visible with		
Loose Rock or Trees Over- hanging Channel	Trees and brush in and at channel edge		
Condition of Discharge Channel	Poor to fair_natural, with minor trash present		

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APPENDIX B

PLANS OF DAM AND PREVIOUS INSPECTION REPORTS

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	Page
Figure B-1, Plan of Main Dam	B-1
Figure B-2, Sectons through Main Dam	B - 2
Figure B-3, Plan and Sections of Dike	B - 3
Figure B-4, Plan and Profile of Dam dated April 1913	B-4
Figure B-5, Sections of Dam and Dike, dated August 1, 1911	B-5
Figure B-6 and B-7, Drawings of Willett Pond Gage, dated April 1971	B-6
Inspection Report by Massachusetts Department of Public Works, dated July 13, 1973	B-8





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NATIONAL	PROGRAM OF IN	SPECTIC	N OF	NON-FED.DAM
	WILLETT	POND	DAM	
	FIGURE 8-1	PLAN OF	DAM	
: TREBUTARY	NEPONSET RIVER			MASSACHUSETTS
SCALE: AS	SHOWN	DATE:	MARCH,	1973

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FIGURE B 2 SECTIONS THROUGH DAM

TRTHUTANY NEPON'LT RIVER MASSACHUSETTS SCALE: 1" 10' DATE: MARCH, 1979



WILLETT P

ICE SURFACE EVEN.



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"15×3' T POND 4247 ACE EUE .= .33.2 14225 12.8 142×7 14211 1-12 × 3 ,37× G : .? .5 12347 L .2 411 NOTE : FΤ A 1 300 N ELEVATIONS SHOULD ARE REFLICINGED TO Paranto souchers and to chart PT TOP OF STORUSSE OF CREAT OF SOLLARY

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NATIONAL PROGRAM OF IN	SPECTION OF NON FED. DAMS
NILLETT POND DAM	
FIGURE B-3 PLAN OF DIKE	AND SECTIONS THROUGH DIKE
TRIBUTARY NEPONSET RIVER	MASSACHUSETTS
SCALE: AS SHOWN	DATE: WARCH, 1979







EARTH ENCAMENTENT ic Marille Serve Sections of Proposed Dam and Dike for Winslow Bro's and Smith Co. Norwood, Mass Scale 4 fact to an inch. July, 1911. Scale of Consulting Engineer. 904 Fromont Building, Deston. Water level Filed with and approved by County Countries wiss aug 1. 1911. attest: RBWortheugton deutent terning. 1 F N # 164 . . f 1911 ETITION REC COMMISSIONERS COUNTY NOTE: PLAN REDUCED FOR WILLETT POND DAM THIS REPORT FIGURE B-5





INSPECTION REPORT - DAMS AND RESERVOIRS NORWOOD . Dam No. 6-11-220-2 Location: City/Town Jame of Dam WILLETT POND INSPECTED BY: A.It. Lounsbur Date of Inspection July 13 1973. والمراجع Contact & Barries 2. . Prev Inspection___ Qwner/s: Per: Assessors Reg. of Deeds_____. Pers. Contract_____ 1 Neponset Reservoir Corp. elo Bud & Son East Walpale Wass. Name St. & No. City/Town State Tel No. and the second **A**. man in the second second 2._____ .St. & No. Name City/Town State Tel No. A Latence Long **N** 1 Name St. & No. City/Town State Tel No. and the second - 4- 4 - 4 3. Caretaker(if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners. States and the the furnitual minimum for the country of Name St. & No. City/Town State Tel. No. يتي تو و No. of pictures taken_ 5. Degree of Hazard: (If dam should fail completely)? and the second states a 1. Minor . 2. Moderate -3. Severe 「「「別につったい」 1. N. S. A. S. *This rating may change as land use changes (Future development) _____ Outlet Control: Automatic______ Manual____ ΰ. Operative UNC. No. Comments: 7. Upstream Face of Dam: Condition? 1. Good_____. 2.Minor Repairs_/ /3. Major Repairs 4. Urgent Repairs Comments: Reinive Tree Growth Grout Rip Rop 10.11 art.

DAI 110. 6-11-220-2 unstroau Face of Dan: Condition: 1. Good_____. 2. Manor Repairs____ . 4. Urgent Romairs_ . Compate: Tree Growth Considerable poison iny growth on Slope (downstroom) clise inspection. DINENTS Apprars fair 9. I a special build a starting a science of a second special spe Emergency Spillway: Condition: 1. Good . 2. Far 3. Fajor Ropairs . 1. 2. Minor Repairs_ . 4. Orgent Repairs Coments: · · · · · . . . · · . :0. Particular and the state of 0.10 adora Water level @ time of inspection: ft. ___ below . top of dam_____. principal spillway___ other 1 . . . الد و مغار 1. Summary of Deficiencies Noted: "Growth (trees and bruch) on Elibantant Consider shie 2" to 10" tro. Animal Burrows and Mashouts none Damage to slopos or top of dam Time Cracked or Damager Hasonry Some deterioration at Structure well (Spille Evidence of Saepage Trone Evidence of Piping Trank me Erosion_ 17. mone · -Leaks Trash and/or debris impoding flow NO Clogged or blocked suillysy Ma Other_ 2.2. WILLETT POND DAM

DAM NO. 6-11-220-2 And C. H. H. S. L. Station the state of the s Remarks & Recommendations: (Fully Explain) Note several locations where Surface water runutt from road has caused minor slope erosion - No evidence of a drainage system. l'insideration should be given to prevent surtaire water from roadway from flowing over slopes. (13. Overall Condition: -1- <u>- -</u> -1. Safe V 2. Minor repairs needed 3. Conditionally safe-major repairs needed 4. Unsafe

5. Reservoir impoundment no longer exists(explain)

Recommend removal from inspection list.

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WILLETT POND DAM

man Dane Callon DESCRIPTION OF DAM DISTRICT <u>6</u> Date No. <u>6-11-220-2</u> Uiter/Town <u>Norwood</u> Name of Dua <u>W. 11c IT</u> wand tred by A.H. Lounsbury Date 1424 11,1973 Pond 201 incation; Topo Sheet No. 324 _ 4 Grovide 84" x 11" in clear copy of topo map with location of Dam clearly indicated. · · · • . 1 Pay 14 Year built (Prise to 19.15). Tear/s of subsequent repairs UNK. Tar See Hands and the 4. 1 The second and a second second second second er en antal de la de . Recreational . . . Surpose of Dama -Ustar Supply instructional International Drainage Area: 2.85 59.01. [B26.5 acresa server and a server server a server server server a ser 210 Acres ; Ave Depth 10-12 FT. Harmal Fording Area: <u>210</u> Acres ; Ave Depth <u>10-12 FT</u> Acres ; Ave Depth <u>10-12 FT</u> The pointment <u>760 Million gals</u>; <u>2332</u> acres ft. من منها با الحال الحال والذي يا حدود المائين الديني الأر مدام بالالتحويل والأوقف الجومي وفوقهما في يواقو s. and type of dwellings located adjacent to pond or reservoir - and Lee summer homes etc. Estimals 24 430 year round Length 850 . Rux, Seight 20 Manasions of Dam: Length in italiya Ali italiya Slopes: Upstream Face <u>10-15</u> (R.p. $R_{\ge p}$) Downstream Face <u>25 b Au</u> (Eagree) Width across top <u>27</u> lassification of Can by Haterial: Timber______ Stone Masonry______. Stone Masonry______. Other A. Description of present land usage domedings of dama 100 formal; hirhan. d. In there a stongy area or flood plain downstream of dam which could accompdate the imposidaent in the event of a complete dam failure YES_____. 30. • . 4. WILLETT POND DAM

Uam- 6-1+620 re i fait a f 1 1:10 1 ومراجع والمتعود والمعالي والم 6-11-220-2 DAM NO. - to life and property in event of complete failure. No. of people <u>Virc</u>. and the second second second second No. of Businesses <u>Nonc</u> No. of Industries <u>Nonc</u> No. of Utilities <u>Nonc</u> Railroads <u>None</u> Collect Dama<u>G-W-220-4</u> G-W-220-3 er contra a la -142 ومداد والمروا 2.4 -1.1 1. Attach Sketch of dam to this form showing section and plan on $8\frac{1}{3}$, x.11" sheet.)) · · · · · · ۰. ۰. · 9-13 and the particular and the 1 ς. 13.20 . ۱۰ میلیست میلا ۱۰ میلیست میلا . : . ٠, ١ •..? 4 11 $e_1 \leq e_2$ · 2. . Atrip



APPENDIX C PHOTOGRAPHS

WILLETT POND DAM

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NO. 1 CREST OF DAM FROM SOUTH ABUTMENT





NO. 3 UPSTREAM SLOPE AT SOUTH ABUTMENT



NO. 4 DOWNSTREAM SLOPE OF DAM

WILLETT FOND DAM

C-2



NO. 5 VIEW OF GATE HOUSE AND DISCHARGE FLUME



NO. 6 VIEW OF PARSHALL DISCHARGE FLUME



NO. 7 UPSTREAM VIEW OF SPILLWAY WITH FLASH BOARDS



NO. 8 INVERT OF BOX CULVERT

WIL STT POND DAM

C-4



NO. 9 UPSTREAM VIEW OF DISCHARGE CHANNEL



NO. 10 VIEW OF DIKE SOUTH OF DAM

WILLETT FOND IAK

C-5

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Contraction of the local distance of the loc

NO. 11 VIEW OF UPSTREAM SLOPE OF DIKE



NO. 12 VIEW OF DOWNSTREAM SLOPE OF DIKE

WILLETT POND DAM.

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and a second

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

	Page
Figure D-1, Drainage Area Map for Willett Pond Dam	D-1
Hydrologic and Hydraulic Computations	D-2

WILLETT POND DAM



FIG. D-1 DRAINAGE AREA MAP -- WILLETT POND

Project Nat. Review of Non Fed. Dams Acce No. 6191 _ Page _ 6 of Norfolk County, Mass. compile By -- Date 12/2//78 LEB Subject __ Date 19MANCH 1979 WILLETT POND Chid By BELL (\mathbf{I}) Test Flood, Storage É Storage Functions 1 - Total Drainoge Area - 5.55 mi 2- Pond(s) Area: 0,31+.04 +.02 0.37 Swamp(5) Area : 0.03 +. 10 +.02 + ,12 +.06 = 0.33 0.70 Total Area Pond(s) & Swamp(s): 70 Ponds & Swamps = 0.70 = 12% $3 - \frac{410 - 139}{18,900} = 0.0144$ } Say Ave Slope = 1.5% 4-Using C. of E. Curves for Peak Flow Rules & above guide Values the Peak Flow Rate was estimated to be somewhat above "Flat and Coastal", and taken at 1000 c.f.s./mi` Size class: Interm. ; Hazard Pot.: High ; Spill. Des. Flood: PMF Use: Test Flood = P.M.F. Test Flood Inflow = (1000) 5.55 = 5550 cfs 5-6 - Pond Storage The pond area is 0.31 so, mi, at elev. Based on a const. area , storage incréases at 200 ac. feet per foot of depth increase. 7 - Spillway crest elev. is 137.7 , top stoplogs is 139.0 8- Storage Functions are based on Pour = Qui [1 - 501] Sout = Storage Vol. in Reservoir related to final Quit in terms of inches of rain over the drainage area. $S(m \text{ Inches}) = 12 D(\frac{0.31}{5.55}) = 0.67 D_{3}^{2} R = 6 hr \text{ rain of strum}$ De Storage depth in feet above spillway crest in reservoir 9- Storand Functions : (Test Flood E 1/2 PMF. if needed) $F_{7F} = 5550 - 292 S = 5550 - 196 D$ FK. PMF = 2775 - 292 5 = 2775 - 196 D

METCALF & EDDY.

D-2

Nat. Keview of Non Fed. Dams Acct No. 6191 ___ Page ___ 2 Project Norfolk County, Mass. Comptd. By LEB 1/17 _ Date Subject . WILLETT POND CKd By SEP M 14 march 71 Date Detail I Discharge Ratings A- Spillway (no stoplogs) Gently vounded crest, Use q = 3.12 H^{1.5} Ref. : V.T.Chow, Open Chan. Hydr", pg 360-362 Crest Elev. 137.7, 3 openings-8.25' wide each 141 143 Pond El. 139 140 142 144 138 0.5 4.62 49 Ê, 10,9 18,7 38.1 27,8 10 110 270 460 690 940 1220 B · Spillway (with stoplogs) Use William's & Hazen, "Hydr. Tables", p=30, L=24,75' Fresent top of Stoplogs elev. 139.0, Assume sharp edged Pond El. 140 141 142 143 144 36.84 3,33 9,32 17,1 26.35 Ğ, 80 420 230 650 910 C - Crest Flow Use g= 2.55 H", Ref. : V.T. Chow, "Op chan Hyde" pg 52-53 Q,: 280'@ 142.15; Q2: 670'@142.35 Pond El, 142,5 143,0 143.5 144 560 1120 1800 Ο. 150 Q1 100 2100 3620 900 29, 250 1460 3220 5420 D - Low Level Outlet 2-20" Pipe's ; Lower Elev = Top Pipes = 120.7 ~ due to flume backwole Hp=PondEl.-120.7 = V/0 (2.2) == Enters, Exit =1.0, Value 20.5, for it 20.2 Total Area = 4.36 ft for 201000 Qo - 23.6 140 Pond El. 136 157 138 139 140 HD 17.3 18.3 19.3 16.3 15,3 92 95 98 Q_{0} Time to lower pond 2 fool "Pond @ 137,5 = 200 (47,560) = ±25hr,

METCALF & EDDY. ENGINEERS

D-3



D-4

Project Nath Review of Non Fed. Dams Acct. No. 6191 Page 4 of 6
Subject Norfolk County, Mass. Comptd. By LEB Date 1/17/79
Detail WILLETT POND Chid. By Date 14 munch 79
I Maximum Crest Flow
Max Depth: 143,55 - 142.0 = 1.55' (142.0 is minor low pt.)
$g = 2.55 (1.55)^{1.5} = 4.92 \text{ cf} \text{ / ft}$
As critical flow:
$y_c = 0.91'$, $V_c = 5.4$ fps
B - With Stoplogs
Max, Depth: 143,6 -142,0 = 1.6'
g=2.55(1.6)"= 5.16 cfs/fr
As critical flow
$y_c = 0.94'$, $V_c = 5.5 fps$
I Temporary Pond Lowering
Lower pond before remedial work to allow passage of 100 yr storm, (taken as # PMF) via spillway and low level out let "foot overtopping
$\varphi_{out} = 740 + 95 = 835 \text{ cfs.}; \qquad \varphi_m = \frac{1}{4}(5550) = 1390$
Using Stonage Funct .: Pout = Qin - 196 Dr
835 = 1390 - 196 D, ; D,= 2.8 ft.
$\begin{array}{rcl} \text{Min Crest eleu. = } & 142.1 \\ \text{Less } & \text{D} & \text{= } & 2.8 \end{array}$
Elev. 139.3 - Temporary max. pondekeu,

-- CALI & CDD). ENGINEERS

Project Alat. Poview of Non Fed. Dams Acct No. 6191 5 6 Page County, Mass compid. By Norfolk <u>125</u> 79 Subject POND ex 14 march TO WILLETT Detail Failure of Dam - at Main Dam Peak Failure Flow 142.1 (L.P. on Dike) Pond Elevation -122.0 (Tee Main Dam) Toe Elevation -Yo 20.1 Dam Length Subject to Breaching = 384 Wo = 40% (384) = 153.6 $Q_{P_1} = 1.68 W_0 (Y_0)^{15} = 1.68(153.6)(20.1)^{15} = 23,250 c.f.s.$ Spillway Flow Mond El. 148.1 = 7400. f. Total Flow = 24,000 c.f.s Storage Volume Released: Storage Above Spillway : 4.5 (200) = 900 ac. ft. Storage Below Spillway : 13 (15,6)200 = 1040 -5 = Total Storage = 1940 Channel Hydraulics: h=0.08, 5=10 800, V=2.08 R 7' A= 35 y2, Ry y , V= 1.31 y 3 490'± 12 METCALF ¥55 G 10 875 3.83 3360 3 'n 31 10 3500 609 21310 <u>, 6</u> 6,88 34650 12 5040 2176 5.25 11420 8 140 2.08 291 2 4 560 3.31 1850 10000 20000 30000 Failure from at 10.5' t dep th & velocity of 6.2 t fps. Prior flow at about 3' depth & velocity of 2.6 ± frs. Time to Drain : 43560 (1940) = 2.02 Hours. 3600 (1/2) (23,250) D-6

& EDDY.

Project Alat. Peview of Nom Fed. Dame Acci No _ 6191 Norfolk County Mass compile By _ LEB Subject Date 19 Murch WILLETT POND -ek Detail Failure of Dam - at Dike VI Peak Failure Flow; 142.1 (L.H on Dike) Pond Elevation 126,7 (L.P. on toe of Dife) Toe Elevation 13.4 ft . Yo 75 . Vic. of Toe Life Dam Length Subject to Breaching = 140 (& cront 142.12) Wo = 40% (140) = 56 $Q_{P_1} = 1.68 W_0 (Y_0)^{15} = 1.68(56) (13.4)^{1.5} = 4600 cfs$ Spillway Flow @ And El. 142.12 = 740 40 - NOT ADDITIVE TO FAILURE FLOW Storage Volume Released: Storage Above Spillway: 4.5 (200) - 900 ac. ft. Storage Below Spillway; / (8.9) 200) = 890 5 = Total Storage 119 and battam Discharge Overland Channel Hudraulics; S= 10 ; n=,07 , V= 3.0 R 3 = 3.0 y 1/3 V 200'± As calculated, dike failure produces Q A у flow about 3 1/2 feet deep with a 2 400 1910 steady flow velocity of 6.9 fps 600 6.26 3760 3 3.5 700 numerous residences would 6.94 4869 be affected, Closest about 200 feet from dike Time to Drain : 3600(1/2)(4600) = 9.4 Hours 43560 (1790) D-7

F - LOY. - ...

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

1.1

WILLETT POND DAM