TOWN OF BROOKHAVEN

Mill Road Culvert Preliminary Hydraulic Analysis Report

April 6, 2018

Highway Engineering
Gregg G Kelsey P.E.

Executive Summary

Mill Road Culvert, Willow Lake Dam, aka Upper Lake Report

In November of 2012, Milone & MacBrook, Inc, a Connecticut engineering firm prepared a Dam Evaluation Report on the existing spillway and earthen dam located approximately 50 feet north the existing Mill Road culvert. The report was used to evaluate the dam, the existing and proposed spillway and request approval from NYSDEC and Dam Safety for the installation of a new spillway and fish passage project. The existing NYSDEC permit is in place and construction of that project is near completion, with only bulkhead replacement, pedestrian bridge and walkways construction remaining.

Provided in the report are the 100-year frequency flood flow estimated at 176 cfs, see attached.

Based on this report and information, the existing culvert was analyzed to determine the height of the 100-year frequency flood traveling through the existing culvert. This was calculated at 2'-4" deep across the 16' wide culvert. The current underside of the culvert is 3' – 10" above the stream bed. The existing culvert can pass the 100-year frequency flood with some factor of safety.

The proposal is to install a 20-foot-wide pre-cast concrete culvert, with a 3' wide rock path along one side with 1' transition area to allow wildlife to cross under the road safely. The rock path will only impact the flow of water during large flows, but the increased width of the culvert will account for the restriction. The original channel dimensions will be maintained under the culvert for fish and water passage. The completed structure with the rock path will pass the 100-year frequency flood with some factor of safety.

Mill Road Culvert Preliminary Hydraulic Report

April 6, 2018

November 2012 Report:

In November of 2012, Milone & MacBrook, Inc, a Connecticut engineering firm prepared a Dam Evaluation Report on the existing spillway and earthen dam located approximately 50 feet north the existing Mill Road culvert. The report was prepared for Dam ID Number NY 252C-4519, a classified small dam as the height of the embankment is 7.8 feet.

The report was used to evaluate the dam, the existing and proposed spillway and request approval from NYSDEC and NYS Dam Safety for the installation of a new spillway and fish passage project. The existing spillway was replaced with a 15' wide ogee crest spillway sized to accommodate the 100-year frequency flood. Applications were submitted, reviewed and approved for the replacement of the spillway and the installation of the new fish passage.

The existing NYSDEC permit is in place and construction of that project is near completion, with only bulkhead replacement, pedestrian bridge and walkways construction remaining. The winter of 2017-2018 suspended the work until the weather improves. The new culvert is functioning fully, as is the fish passage.

Provided in the report are the 100-year frequency flood flow estimated at 176 cfs, see attached. We will use this flood flow in our calculations of the existing and future capacity of the Mill Road Culvert.

Existing Culvert Capacity

The measurements of the existing culvert were obtained by the Suffolk County Department of Public Works, Bridge Division in September 2016. As a check, I verified the dimensions, most recently on April 2nd, 2018, to verify the width and heights recorded. It was determined that the measurement of the culvert width, given along the center road line, was skewed from the perpendicular cross section by 23 degrees. The width of the culvert has been calculated to be 16'-0" wide, Cosine 23 degrees times 17'-4". Attached is a revised sketch showing the calculation and the opening height, also measured.

The existing topographic information we have from the 2010 design plans and the recent measurements of the channel bottom reveal elevation changes between the stream bottom at the upstream side of the culvert and the downstream side of the culvert to be 30.88 and 30.68 respectively. Over the length of the culvert, 65 feet, the slope is calculated at .0031 or 0.31%

We also measured the culvert openings, with the upstream side being 3' – 10" high and the downstream side being 2' – 3" high.

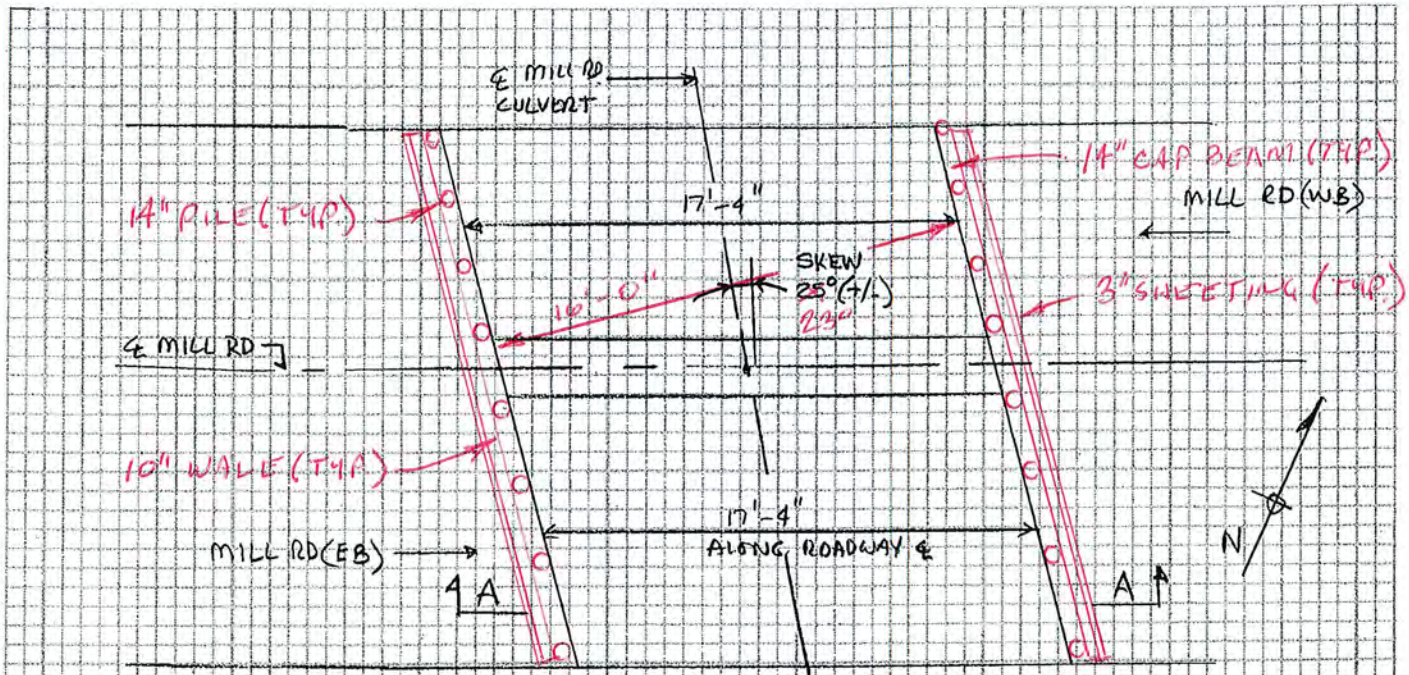
SUFFOLK COUNTY DEPARTMENT OF PUBLIC WORKS
Division of Bridges, Structures and Waterways

By K. SWARINGEN, G. Kelsey
Checked By .....

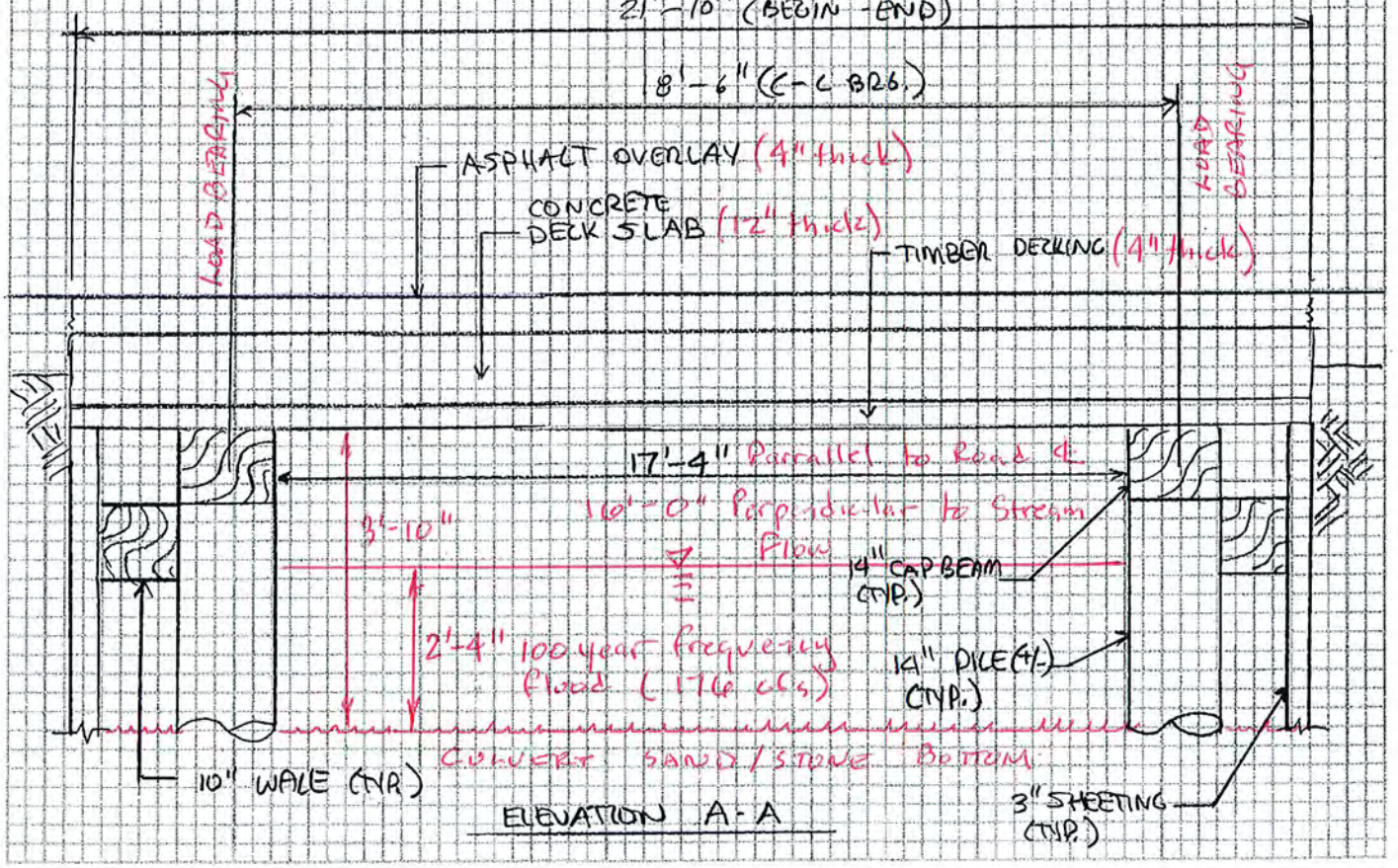
MILL RD CULVERT GEOMETRY

Sheet No. 1 OF 1
Date 9/22/16 4/2/18

42-0138: 2/97cg



PLAN VIEW (MILL RD CULVERT)
(N.T.S.)



ELEVATION A-A

Calculation of Existing Culvert at the 100-year flow:

The existing 100-year frequency flood (Q) is 176 cfs.

The existing slope in the culvert (S) is approximately .0031 or 0.31%.

The existing width of the culvert is 16'.

The existing coefficient of roughness (n) is 0.025, natural channel in good condition.

The area of the channel (A) is 16'y.

The wetted perimeter (R) is 16'y/16' + 2y

Using Manning's formula:

$$Q = \frac{1.49}{n} \times A \times R^{2/3} \times S^{1/2}$$

Setting Q = 176 cfs

Solve for y = 2' – 4", the depth of flow during the 100-year frequency flood.

Since the depth of flow during the 100-year frequency storm is generally less than the height of the culvert, the culvert can be treated like an open channel flow, with no additional head losses at the entrance.

2' – 4" depth of flow < 3' – 10" height of culvert at upstream opening.

The existing culvert will pass the 100-year frequency storm event.

Proposed Culvert Capacity

The proposed culvert is 20 feet wide by 4 feet high, 4 feet wider than the existing culvert and includes a 3-foot-wide rock path for wildlife to pass. The rock path will be 1 foot higher than the stream bed and 1 foot off from the existing 16-foot-wide channel. The area of the rock path will remove approximately 3.5 square feet from the increased cross section area of the new culvert.

Calculation of Proposed Culvert at the 100-year flow:

The proposed 100-year frequency flood (Q) is 176 cfs.

The proposed slope in the culvert (S) is approximately .0031 or 0.31%.

The proposed width of the culvert is 20'.

The proposed coefficient of roughness (n) is 0.025, natural channel in good condition.

The proposed area of the channel (A) is 20'y – 3.5 sq. ft..

The proposed wetted perimeter (R) is 20'y/20' + 2y

Using Manning's formula:

$$Q = \frac{1.49}{n} \times A \times R^{2/3} \times S^{1/2}$$

Setting Q = 176 cfs

Solve for y = 2' – 1", the depth of flow during the 100-year frequency flood.

Since the depth of flow during the 100-year frequency storm is less than the height of the culvert, the culvert can be treated like an open channel flow, with no additional head losses at the entrance.

2' – 1" depth of flow < 4' – 0" height of proposed culvert opening at both ends.

The proposed culvert will pass the 100-year frequency storm event.

The original channel dimensions will be maintained under the culvert for fish and water passage. The completed structure with the rock path will continue to pass the 100-year frequency flood with some factor of safety.

References

R.K. Linsley and J.B. Franzini, Water-Resources Engineering. 1979 McGraw-Hill Inc.

Attachments

Dam Evaluation Report, Willow Lake Dam on Carmens River, November 2012, Milone & MacBroom, Inc.

Prepared by Gregg G Kelsey, P.E.

DAM EVALUATION REPORT

WILLOW LAKE DAM

Yaphank, New York

MMI #4791-01

November 16, 2012

Prepared for:

Town of Brookhaven
One Independence Hill
Farmingville, New York 11738

Prepared by:

Milone & MacBroom, Inc.
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Cheshire, Connecticut 06410
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MILONE & MACBROOM®

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LIST OF ADDENDICES

1.0 DAM DATA

Dam ID Number:	NY 252C-4519
Dam Type:	Earthen Embankment
Embankment Crest Elevation:	39.0 feet
Embankment Height:	7.8 feet
Spillway Type:	concrete ogee-crested weir w/concrete apron
Spillway Channel:	natural channel, boulder and cobble
Spillway Crest Elevation:	36.4 feet
Normal Pool Elevation:	37.0 feet
Impoundment Size:	***Area:*** 26.2 acres ***Volume:*** 58 acre-feet
Contributing Watershed Area:	70 square miles

Note: All elevations in NAVD88

2.0 INTRODUCTION

Milone & MacBroom Inc. (MMI) was contracted by the Town of Brookhaven to evaluate existing conditions at the Willow Lake Dam. The existing dam was evaluated on June 26, 2012 by W. Andrew Greene and Elsa Loehmann. Flow depth over crest was approximately six inches on the day of inspection. Weather was sunny, 80° F.

This report describes the dam and spillway structures as observed during the field visit. Right and left bank are so named when facing downstream.

3.0 DAM OVERVIEW

The Willow Lake Dam is an earthen embankment dam located at the downstream end of Willow Lake (Photo 1). The dam consists of an earth embankment, spillway, and a low level outlet. The dam is within a municipal park with extensive public access and use. The Carmans River watershed upstream of the dam is approximately 70 square miles.

3.1 Earth Embankments

The Willow Lake Dam is an 250 foot long earthen embankment dam. The height of the dam, measured from the nominal embankment crest to the downstream natural channel bed elevation is 8.5 feet.

The embankment extends toward Yaphank Middle Island Road with flat topography. The toe of the dam is located at the natural channel downstream of the spillway. The dam does not have a traditional crest and toe, but rather is supported on the downstream side along most of its length by Yaphank Island Road.

The earthen embankment is separated in to two embankments by the spillway channel. These embankments are herein named left and right when facing downstream. The right embankment is a low earth berm reinforced with vertical 12 inch wide concrete bulkhead, which extends thirty feet to the west. The crest of the concrete bulkhead is generally at elevation 38.6, 1.6 feet above normal pool level.

The right section of the dam embankment and reservoir is located immediately adjacent to the gravel parking lot for the Millhouse Inn. Sections of the parking lot sit lower than the dam embankment, such that flood flows would first flow through the parking lot before overtopping the embankment crest. The parking lot elevation is just under 38.0 feet at its highest point along the flood flow path.

The left embankment is earth reinforced with wooden bulkhead, which extends for 200 feet to the east. A 2 inch by 8 inch wood board caps the bulkhead along its length. The crest of the wooden bulkhead is generally at elevation 38.1, 1.1 feet above normal pool level. There is a significant seepage through a hole in the wooden bulkhead at the left corner transistion from the timber sheeting to the spillway channel (Photo 2).

Steel tie-backs anchor the bulkhead to the embankment. Embankment erosion has exposed the tie-backs in numerous places (Photo 3). The embankment is used as a public park, with regularly mowed turf grass. The embankment is eroded as a result of drainage in a number of places. Holes in the wooden bulkhead drain through sink-holes on the top of the embankment.

3.2 Spillway

The Willow Lake spillway is a 7.5 foot wide concrete ogee crest with a concrete apron (Photo 4). The crest elevation is 36.4 feet NAVD88. The concrete apron extends 15.5 feet downstream of the spillway, and transitions to large boulder and cobble in the downstream natural channel. There is a large deterioration hole in the upstream face of the concrete spillway. The hole extends from approximately three feet below the spillway crest to the pond bottom. It was not determined if flow was going through the hole in the spillway.

The concrete at the downstream end of the apron is jagged and deteriorated; there is a scour hole at the intersection of the apron and the natural channel.

The spillway channel is a 15 foot long chute between two training walls. A wooden pedestrian bridge sits on top of the training walls and spans the width of the spillway. The training walls are constructed of a 12 inch wide concrete wall waterward of a stone

masonry wall. The training walls are leaning inward; three painted screw jack posts are resisting the inward lean (Photo 5). The training walls are heavily scoured at and below the water line along the apron.

There is significant tree growth around the downstream channel at the end of the spillway, as well as a number of trees on the toe of embankment. There is a significant seepage in this area. The root zone of the trees is saturated with seepage, and a root wad has pulled out.

The following deficiencies were observed at the spillway:

1. The spillway apron is jagged and deteriorated at the downstream end; there is a scour hole a the toe of the apron in the natural channel.
2. The training walls are heavily scoured at the water line.
3. The training walls are braced and leaning inward.
4. Significant seepage is evident at the toe of the embankment near the natural channel.

3.3 Low Level Outlet

An old 24" steel pipe discharges to the right of the spillway in a concrete stepped headwall with 45° wingwalls. A steel plate is bolted over the downstream face. Water was jetting out of a 1-1/2" hole in the center of the steel plate on the day of inspection (Photo 6). No control works were evident. The pipe is therefore under hydraulic pressure through the dam. The area downstream of low level outlet is a pool and flow joins downstream channel just upstream of bridge.

On the upstream side, the outlet pipe intersects the concrete bulkhead. The pipe is approximately half full of sediment.

3.4 Impoundment

Willow Lake is a long, narrow impoundment located in the Brookhaven, Long Island, New York. Both the eastern and western edges of the reservoir are developed as residential; the western edge is more heavily developed. There is currently very little development immediately upstream and downstream of the reservoir.

The normal pool surface area and impoundment volume of Willow Lake is estimated as 26 acres and 58 acre-feet, respectively. Impoundment surface area was determined from GIS mapping; impoundment volume was determined from bathymetric survey conducted by P.W. Grosser Consulting, Inc. in 2008.

3.5 Downstream Channel and Inundation Area

The channel downstream of Willow Lake is a natural channel with a sand, gravel, and boulder bottom. Flow discharges from the spillway apron to a pool associated with the low-level outlet. The channel then flows under Yaphank Middle Island Road.

3.6 Size Classification

The size classification of a dam is based upon its height and volume of of water in the impoundment. Based upon the field survey, the elevation downstream is 31.2 feet NAVD88, and the crest of the earth embankment elevation is 39.0 feet NAVD88. The dam height is thus 7.8 feet. The volume of the reservoir is estimated to be 58.10 acre-feet. The size of the structure is classified as "small", as per Table 1 of the New York DEC "Guidelines for Design of Dams".

3.7 Hazard Classification

The Willow Lake dam has been previously classified as a Class A Low Hazard dam, as defined by 6 NYCRR Subpart 673.5(b). This definition is repeated for reference below:

(1) Class "A" or "Low Hazard" dam: A dam failure is unlikely to result in damage to anything more than isolated or unoccupied buildings, undeveloped lands, minor roads such as town or county roads; is unlikely to result in the interruption of important utilities, including water supply, sewage treatment, fuel, power, cable or telephone infrastructure; and/or is otherwise unlikely to pose the threat of personal injury, substantial economic loss or substantial environmental damage.

The most likely mode of failure of the Willow Lake dam is failure of the spillway and subsequent embankment erosion. Fair weather failure usually assumed to have the most potential for loss of human life due to the element of surprise. Under the "fair weather" scenario, water levels in the reservoir would be at the normal pool level.

A commercial area is located immediately downstream of the dam, across Yaphak Middle Island Road. Downstream of the commercial area, the potential inundation area consist of mostly undeveloped wooded areas extending to Lower Lake. The majority of the flood wave asosociated with failure of the Upper Lake dam would likely be attenuated by the undeveloped area between the Upper Lake dam and the Lower Lake dam.

Failure of Upper Lake dam is likely to result in damage to isolated buildings, undeveloped lands, and county roads. Failure is unlikely to result in interruption of utilities. Consequently, it is our opinion that the dam is "Class A".

4.0 SPILLWAY DESIGN FLOOD

The *New York State Guidelines for Design of Dams, Revised January 1989* specify the magnitude of spillway design floods (SDF) based upon the dam's size and hazard classification. For a hazard classification "A" small dam, the SDF is that with an average return frequency of 100 years. For existing dams that are being rehabilitated, the spillway shall have the capacity to pass the SDF without overtopping.

MMI has estimated the 100-year frequency flood to be 176 cfs. This was determined by using the U.S. Army Corps of Engineers Statisical Software Pacakge (HEC-SSP). HEC-SSP performs statistical analyses of hydrologic data based on Bulliten 17B, "Guidelines for Detemining Flood Flow Frequency" (1982), which recommends a Log Pearson Type III distribution as a base method for flood flow frequency studies. The Log Pearson Type III distribution is similar to normal distributions with a standard deviation and mean but also includes skew. Annual peak flows from USGS gage 01305000 Carmans River at Yaphank, NY were used to conduct this analysis. The gage gives peak discharges between 29 and 165 cfs for sixty-eight years of record, from 1943-2010.

Based upon field survey and spillway measurements, the crest of the normal spillway is elevation 36.4 feet (NAVD88). The dam and reservoir are located immediately adjacent to the gravel parking lot for the Millhouse Inn. Sections of the parking lot are at a lower elevation than the dam embankment crest, such that floods flows overtop the parking lot before overtopping the dam embankment. The elevation of the parking lot is just less than 38.0 feet at the highest point along the flood flow path.

Using a weir coefficient of 3.3, the maximum spillway flow capacity before overtopping is 50 cubic feet per second (cfs), 28 percent of the spillway design flood.

The NY DEC *Guidelines for Design of Dams* requires that spillways for existing dams have adequate capacity to pass the design flood without overtopping. The Willow Lake spillway does not currently have the capacity to pass the design.

There are multiple means of achieving the desired spillway design flood capacity. These options are addressed separately.

5.0 RECOMMENDATIONS

5.1 Spillway

The following recommendations are given for the spillway:

1. Monitor and/or repair leaning training walls.

2. Monitor and/or repair spalling and surface cracks on the wingwall.

3. Repair scourhole at bottom of training walls where it intersects with spillway channel.

4. Repair hole near pond bottom from middle to left about three feet below spillway crest.

5.2 Embankment

1. Monitor and/or repair earth erosion through holes in timber.

2. Repair seepeage at spillway left corner transistion from timber sheeting to spillway channel.

3. Remove trees on the embankment around the spillway channel. The roots for these trees prodive seepage paths for water through the dam. Install a drain to collect seepage water through the dam.

5.3 Low Level Outlet

1. Repair steel pipe and plate that is bolted over the downstream face which should be on the upstream face of the dam.

6.0 REFERENCES

NYDEC, 1985. Revised 1989. Guidelines for Design of Dams. New York State Department of Environmental Conservation, Division of Water, Bureau of Flood Protection, Dam Safety Section. Albany, NY.

NYDEC, date unknown. Guidance for Dam Hazard Classification, Draft. New York State Department of Environmental Conservation, Division of Water, Bureau of Flood Protection, Dam Safety Section. Albany, NY.

Interagency advisory committee on water data, Hydrology Subcommittee, 1981. Guidelines for determining flood flow frequency, Bulletin 17B, Washington, D.C.

Brunner G.W. and M.J. Fleming, 2010. HEC-SSP Statistical Software Package User's Manual.

APPENDIX A

PHOTO LOG

Photo # 1: Willow Lake Dam and Impoundment

Photo # 2: Seepage through wooden bulkhead

Photo # 3: Exposed steel tie-backs

Photo # 4: Willow Lake spillway

Photo # 5: Screw jack posts

Photo # 6: Low level outlet

Photos provided by - Suffolk County Department of Public Works
Bridges, Structures & Waterways Division

W. Abutment, N. Culvert

W. Abutment, S. Culvert

W. Abutment, N. Culvert

Between Culverts from below

Mill Road Culvert

(Town of Brookhaven, Suffolk County)