WRIGHT-PIERCE
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December 5, 2011
W-P Project No. 12305A

Mr. Jeff Blaney P.E.
NHDES Dam Bureau
29 Hazen Drive; PO Box 95
Concord, NH 03302-0095

Subject: Pleasant Lake Dam Breach Analysis
NHDES Dam #176.02

Dear Mr. Blaney:

Please find the attached report for the above referenced project for your review. The purpose of this report is to summarize the results of a dam breach analysis conducted on the Pleasant Lake Dam located in New London, NH. Wright-Pierce is submitting this report on behalf of the Town of New London, in response to the letter the Town received from your office dated July 26, 2010, which was a follow-up to a letter dated October 28, 2009.

This dam breach analysis and resultant inundation mapping is intended to assist in understanding the appropriate hazard classification that should be assigned to the dam and for use in the Emergency Action Plan for the dam. The following paragraphs summarize key points of our study findings associated with these two purposes.

Hazard Classification

The Pleasant Lake Dam is currently assigned a hazard classification of "high", as indicated in a letter from your office dated October 28, 2010. This classification was, in part, due to the likely failure of the downstream Mill Pond Dam, caused by failure of the Pleasant Lake Dam. At that time, failure of the Mill Pond Dam was expected to cause the structural failure of an inhabited building which was supported by the Mill Pond Dam. Subsequently, this building was removed. Nonetheless, this dam breach modeling was performed to help determine whether the Pleasant Lake Dam should remain as a "high hazard" classification, or be re-classified back to "significant hazard" as it had been prior to the October 2010 letter.

The results of the modeling performed for both the Sunny Day event and 100-year storm event (as a worse case scenario) are attached. Inundation of several structures and Class I and II roadways are expected based on this modeling work, with the higher flood levels being experienced during the 100-year storm event due to the already high water levels from the storm. These modeling results also demonstrated that flood waters from the failure of the Pleasant Lake Dam during the 100-year storm event would be within inches of the crest of the Chase Pond Dam. However, assuming that this dam has

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been properly designed and maintained, we do not believe that these modeled flood elevations, would result in automatic failure of this dam. This is in contrast to the assumptions we made for two other dams, the Mill Pond Dam and Hayes Pond Dam, located between Pleasant Lake Dam and Chase Pond Dam, which our modeling assumed would fail. Thus, we believe it is appropriate that the downstream extent of the dam breach modeling of the Pleasant Lake Dam, is at the Chase Pond Dam. The potential affects of downstream flood waters being discharged from the designed failure of the flashboards at the spillway at Chase Pond Dam in terms of public safety are discussed below.

The modeled results, especially the failure of the Pleasant Lake dam during the 100-year storm event, indicated flooding of several Class I and II roadways that would make these roads impassible. This same modeled worse-case event resulted in over one-foot of inundation of the first floor elevation of one residence (468 Elkins Rd). Such impact to an inhabited structure appears to meet the definition of an Class C structure, or high hazard dam, under Env-Wr-101.09 (b). However, we believe if this building is no longer used as an inhabited structure, than the dam may no longer meet the definition of a "high hazard" dam due to impacts at this structure. The other questionable issue is whether the flow velocity and water elevation that may be experienced at another residence located at 9 Hillcrest Drive, would result in structural failure of this residence. Modeled water elevations are less than one foot above the first floor, but the foundation of this residence could sustain major impact due to its close proximity to the stream channel. Structural analysis of this building has not been performed to determine if this foundation could withstand these flows.

Emergency Action Plan

The second purpose served by the dam breach modeling and inundation mapping is the development of the Emergency Action Plan (EAP) for the Pleasant Lake Dam. The inundation mapping, based on the results of our studies, indicate that public safety is at risk from the dam's failure during both the Sunny Day and 100-year storm event. The area most at risk is in Elkins Village, located immediately downstream of the Pleasant Lake Dam. As noted in the report, the timeframes to peak flood arrival at the modeled cross-sections from the Sunny Day and 100-year storm events are very short, and almost equivalent. Also, with limited exception, the spatial extent of inundation from both failure scenarios in this area is also very similar. As a result, based on the modeling performed, we believe:

- these two scenarios best illustrate the impacts to public safety, and that no other "in-between storm events" or sensitivity modeling runs are warranted to plan for public safety;
- that for EAP use, the inundation map need only illustrate the inundation boundary of the 100-year storm event, which is the worse-case scenario. Showing both boundary lines could compromise the usability of the map for evacuation purposes. Although the inundation area is smaller in a few places during the Sunny Day event, we recommend that a conservative approach to evacuation and road closures be employed. Use of this single inundation boundary would also address the extent of inundation from storms less than the 100-year storm event; and
- that inundation of inhabited structures or roadways from failure of the dam are limited to those in the Town of New London.

As noted above, the dam breach modeling conducted provided results which suggest that the flood water height and duration at Chase Pond Dam does not support the automatic assumption that Chase Pond Dam would fail as a result of the failure of Pleasant Lake Dam. The Chase Pond Dam has flashboards designed to fail at the water elevations expected at this dam, which should have been designed to allow the spillway to then convey the flood waters at a designed rate. High water levels will occur

downstream from Chase Pond Dam, as the flood water from Pleasant Lake moves downstream. However, we believe that public safety actions resulting from the "designed failure" of the flashboards would be part of the emergency action planning incorporated into the EAP that should exist for the Chase Pond Dam, which we understand is a Class B or "significant hazard" dam. This dam's EAP would also address emergency needs should this dam fail due to unexpected circumstances.

At this time, we are seeking your review of only the dam breach modeling aspect of the EAP. We have provided this overall emergency planning background as an introduction to our proposed approach to the EAP. Please note that we are in consultation with the local emergency response agencies in New London regarding the draft inundation map and EAP. Once we have obtained their comments and suggestions, along with your approval of the dam breach modeling, we will be submitting a draft EAP (including the EAP inundation map) for your separate review.

Thank you for your time and assistance on this request. Please do not hesitate to call me or Mr. Joseph McLean at 207-725-8721, ext. 3785 and 3762, respectively, to discuss this report.

Sincerely,

WRIGHT-PIERCE

Patricia McIlvaine
Project Manager

Joseph M. McLean, P.E.
Project engineer

cc: Mr. Richard Lee, Town of New London (w/ attachments)
File

PLEASANT LAKE DAM
BREACH ANALYSIS REPORT

prepared for the

TOWN of NEW LONDON, NEW HAMPSHIRE

DECEMBER 2011

WRIGHT-PIERCE
Engineering a Better Environment

TOWN OF NEW LONDON, NEW HAMPSHIRE

PLEASANT LAKE DAM
BREACH ANALYSIS REPORT

DECEMBER 2011

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PLEASANT LAKE DAM

BREACH ANALYSIS REPORT

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SECTION 1
INTRODUCTION

1.1 BACKGROUND

In a letter dated October 28, 2009, the Town of New London (the Town) was informed by the New Hampshire Department of Environmental Services, Dam Bureau, (NHDES) that the Pleasant Lake Dam (NHDES #176.02) had been reclassified to "high hazard" from "significant hazard". This reclassification was due to the expected overtopping and probable failure of the Mill Pond Dam (NHDES #176.03), located about 450 feet downstream, by failure of the Pleasant Lake Dam. The Mill Pond Dam at that time was classified as "high hazard", and as a result, under NHDES regulations, the Pleasant Lake Dam was required to carry this same classification. Subsequently in a letter dated March 24, 2011, the owner of the Mill Pond Dam was notified that this dam had been re-classified to "low hazard" as the structure that would have been impacted by failure of the Mill Pond Dam had been removed. Consultation on July 29, 2011 with Mr. Jeff Blaney, P.E. of NHDES, indicated that despite the original rationale for the classification change to the Pleasant Lake Dam, that dam breach modeling would be necessary to confirm the appropriate hazard classification of this dam. The Town secured the services for Wright-Pierce to perform the required dam breach analysis for the Pleasant Lake Dam. Wright-Pierce has completed the dam breach analysis, with this report being issued to both the Town and NHDES.

1.2 PURPOSE OF REPORT

The purpose of this report is to summarize the results of the breach modeling conducted on the Pleasant Lake Dam (NHDES #176.02) to determine the potential impact of failure of this dam. The breach analysis was conducted in accordance with applicable sections of CHAPTER Env-Wr 100 through 500. The dam breach analysis will assist in determining the appropriate hazard classification of the dam, and for use in development of the Emergency Action Plan for the dam, specifically the inundation Map.

1.3 DAM BREACH ANALYSIS REQUIREMENTS AND PARAMETERS

The location of the dam is shown on Figures 1 & 2. The following sections of this Report present the results of the required dam breach analysis, including routing of the flow downstream of the dam, completed in accordance with Env-Wr 502. The results also include an assessment of all structures potentially impacted by a dam failure, including the depth of flooding at critical structures or groups of structures. As discussed later in this Report, a "worst case" analysis was used in the dam breach modeling.

SECTION 2
DAM BREACH ANALYSIS

2.1 SITE DESCRIPTION

The Pleasant Lake Dam is located in the Town of New London, Merrimack County, New Hampshire, immediately upstream of Elkins Village. Figure 1 illustrates the location of the dam and lake on a USGS topographic map. The Pleasant Lake Dam is at the eastern end of Pleasant Lake and discharges to a tributary to the Blackwater River.

The 360 foot long dam consists of a mortared stone face which blends into the surrounding grades. The majority of the dam has been reinforced with a concrete facing, in front of the mortared stone, to an elevation approximately 2 feet below the crest of the dam. The crest of the majority of the dam has been constructed to an elevation of 807. The existing ground elevation on either side of the dam appears to be lower than this crest. A boat ramp adjoining the right side of the dam has an elevation of 806 which is below the adjoining dam embankment. On the left side of the dam there is an area where the mortared stone face terminates and a loose placed stone wall continues with the crest elevation dropping to an elevation below that of the rest of the dam crest.

The emergency spillway located on the right side of the dam adjacent to the boat launch, is a sloped concrete shelf that has a crest elevation of 804.8, with a step crest 1 foot below the spillway crest elevation. The spillway is located between two concrete walls and is a total of 57 feet wide including the 19.5 foot wide step crest. Below the spillway is a channel with large concrete blocks forming the walls and large stone rip rap lining the bottom of the channel. This spillway channel joins the lake outfall channel just above the Elkins Road box culvert.

Lake water elevation is controlled through a recently upgraded electrically controlled sluice gate at the gate house. The sluice gate discharges to a 42 inch diameter pipe in the outlet structure. According to operation plans on file with NHDES, the lake surface is maintained at different two

elevations depending on the time of year. Beginning in mid-October the lake surface is lowered to an elevation of 802.2, and maintained at that level until the spring. At the end of May the lake is allowed to rise to an elevation of 803 for the summer months. Pleasant Lake is approximately 603 acres in size and is a recreational resource for the area. The Pleasant Lake Watershed, which is predominantly undeveloped, is approximately 11.2 square miles, all within the Town of New London. As shown on Figure 2, the area immediately downstream of the dam is a rural residential area known as Elkins Village.

2.2 MODEL INPUT DATA COLLECTION

Data for the hydrologic and hydraulic models for this breach analysis was collected from the following sources:

Site Visit

Wright-Pierce staff visited the Pleasant Lake Dam site and surrounding area on October 21, 2011. Field notes recorded pertinent information relative to the subject dam including dimensions, material of construction, and current condition. In addition, topography and vegetative cover downstream of the dam was observed and photographed. Specific observations were made of critical areas and structures potentially impacted by the failure of the Pleasant Lake Dam.

Newly Acquired Survey Data

Survey data was collected by Wright-Pierce, on August 12, 2011, at various points downstream of the Pleasant Lake Dam. This survey effort included detailed cross sections at critical points along the tributary to the Blackwater River extending from the area adjacent to the dam downstream to the wetland area surrounding the confluence with Whitney Book. This survey work was tied into two benchmark points located on the concrete dam structure. These benchmark points were taken from a plan prepared by Jesseman Associates, PC, entitled "Pleasant Lake Dam (Elkins Dam) Existing Conditions Site Plan" dated August 6, 1998. The benchmarks shown on that plan, BM#1 and BM#2 have elevations of 806.78 and 805.06 respectively, which closely relate to NGVD '29 vertical datum. Survey data was obtained to

determine the sill elevation for various residential structures located along the river, as well as pertinent grade breaks and existing obstructions at critical cross sections downstream of the dam. This survey data was utilized as the primary source of geometric information incorporated in the HEC-RAS model. Graphical representations of this data, combined with survey data from a previous study, are shown on Figures 7 through 21.

Site Photographs

Photographs were taken of the site and surrounding area during the August and October site visits. Photographs collected during the site visits were referenced during the development of the model and included factors such as down gradient geometry and vegetative cover. Select photographs are contained in Appendix A.

Geographical Information System (GIS) and Aerial Photographs

GIS information and Aerial Photographs were obtained from NH GRANIT and have been used as preliminary planning tools for the study development and in support of the study graphics.

Previous Survey Data

The Town of New London had previously contracted with Stevens Engineering to conduct a Dam Break Analysis for the Pleasant Lake Dam in September 1993. For that report, cross sections of the brook channel, bridges, and dams in the Elkins Village area were surveyed by Stevens Engineering in May 1993. Graphical representations of those detailed cross sections along the river were included in Appendix 3 of that report. Copies of that report and survey data were acquired from NHDES and utilized, in conjunction with newly acquired survey data, as a source of geometric information incorporated in the HEC-RAS model.

Previous Studies

Pertinent data was obtained form the following past studies to support the modeling work:

1. Pleasant Lake Dam Break - New London, New Hampshire, Stevens Engineering, September 1993.
2. Pleasant Lake Dam Stability Report, Environmental Strategies, February 1987.

3. Chase Pond Dam Hydrologic Analysis, Gomez and Sullivan Engineers, P.C., January 2011.

2.3 HYDROLOGIC MODEL DEVELOPMENT

Env.-Wr 502.06(d) identifies that the dam breach flow should be routed together with the base flows for the sunny day and 100-year storm event. The flow rates for this analysis were determined from various sources. The drainage areas upstream of the Pleasant Lake dam were analyzed utilizing the SCS TR-20 methodology. The drainage areas downstream of the Pleasant Lake dam were estimated based upon the USGS Regression Technique and previous studies on file with the NHDES.

SCS TR-20 Modeling Upstream of Pleasant Lake Dam

The Pleasant Lake Watershed was analyzed and modeled utilizing the SCS TR-20 methodology. HydroCAD (release 9.00) computer modeling software was utilized to perform the computations. This method relies heavily upon detailed watershed characteristics and historical rainfall data to model estimated peak discharges at selected recurrence intervals.

Five sub-watersheds were delineated and determined to collectively form the Pleasant Lake Watershed. These sub-watersheds (labeled as 1-5) have been shown on Figure 3 - Watershed Map included herein. The total Pleasant Lake Watershed, comprised of the five aforementioned sub-watersheds, is approximately 11.2 square miles.

The hydrologic soil classifications, for the five Pleasant Lake sub-watersheds, were obtained from the Natural Resources Conservation Service (NRCS). The soil distribution, throughout these five sub-watersheds, is shown on the attached Figure 4.

The time of concentration (Tc) for each of the five sub-watersheds has been calculated utilizing the SCS Lag equation. Primary variables for the Lag equation are the hydraulic length of flow for the longest path in the sub-watershed (L), the SCS runoff curve number (CN), and the average sub-watershed slope (S). The flow path (L) was determined by several manual

delineations and iterations. The longest L value was selected. The runoff curve number (CN) utilized for sub-watersheds 1 through 5 was determined by calculating a weighted average based on land cover and the hydrologic soil classifications as outlined above. The sub-watersheds are predominantly undeveloped, classified as good woods, with some large field areas and a small percentage of impervious cover. Average sub-watershed slope (S) was calculated, utilizing ArcGIS computer software, by constructing a terrain model (TIN) from the best available topographic information. The average slope of the terrain model, calculated by ArcGIS for each of the five Pleasant Lake sub-watersheds, was determined to be 13.72%, 8.64%, 13.01%, 5.12% and 0.00% respectively.

Rainfall data for New London, NH, utilized in the SCS TR-20 methodology, was obtained from the NRCC Research Publication RR 93-5, Atlas of Precipitation Extremes for Northeastern United States and Southeastern Canada, 1995. Rainfall for the 100-year Type III, 24-hour storm event was determined to be 6.6 inches.

<u>USGS Regression Analysis for the Whitney Brook Watershed</u>

The USGS Regression Technique was selected to determine the flow rate for the 100-year storm event for the Whitney Brook Watershed (Sub-watershed 6). The equation utilized to calculate these flow rates was published in the Nationwide Summary of USGS Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, USGS Water-Resources Investigations Report 94-4002. $Q100 = 0.55A^{1.05} S^{0.56} (I2, 24)^{2.72}$.

Sub-watershed 6, as shown on Figure 3 - Watershed Map, delineates the area contributing runoff to Whitney Brook. The area (A) of the Whitney Brook Watershed is approximately 1.21 square miles. The channel slope (S) for the Whitney Brook was determined to be 145.53 ft/mile. The channel slope, measured from USGS topographic maps, denotes the length between 10% and 85% upstream of the Whitney Brook outlet.

Rainfall data for New London, NH, utilized in the USGS Regression equation, was obtained from Figure 1 - The 2-year 24-hour precipitation in New Hampshire of the Nationwide Summary of USGS Regional Regression Equations for Estimating Magnitude and Frequency of Floods for

Ungaged Sites. The rainfall (I2,24) for the 2-year 24-hour storm event was determined to be 2.9 inches.

Flow Rate Summary

The sunny day flow was estimated to be approximately 50 cubic feet per second (cfs) from the Pleasant Lake dam.

Flow rates for the 100-year storm event, derived from the aforementioned sources, are summarized below in Table 2-1:

Table 2-1: Flow Rate Summary

Watershed	100-year Storm Event Flow (cfs)
Pleasant Lake (outflow at dam)[A]	370
Whitney Brook[B]	200
Chase Pond (outflow at dam)[C]	1300

A. Flow rate calculated utilizing SCS TR-20 as described above. Printed results of the HydroCAD modeling and hydrologic computations are contained in Appendix B of this report.

B. Flow rate estimated utilizing USGS Regression equation as described above.

C. Flow rate taken from Chase Pond Dam Hydrologic Analysis, prepared by Gomez and Sullivan Engineers, P.C., January 26, 2011.

2.4 HYDRAULIC MODEL DEVELOPMENT

The hydraulic modeling for the breach analysis was completed using the U.S. Army Corps of Engineers Hydraulic Engineering Center's River Analysis System (HEC-RAS) computer program (Version 4.1.0). HEC-RAS is computer software designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels. The system is capable of performing steady and unsteady flow water surface profile calculations in addition to dam breach scenarios. HEC-RAS is a widely used and available modeling software program for breach analyses and is an accepted model by NHDES.

The HEC-RAS model for the dam breach analysis was developed using a combination of the aforementioned data. Model input parameters and geometry of specific physical features,

including downstream cross sections, for the breach analysis were primarily obtained from GIS, newly acquired survey data and information on file with NHDES.

Model Limits and Cross Sections

The upstream limit of the model is located just upstream from the Pleasant Lake Dam (NHDES #176.02). The downstream limit is at the Chase Pond Dam (NHDES #253.02), located in the town of Wilmot, New Hampshire. The model limits and cross section locations are shown on Figures 5 and 6.

Boundary Conditions

Upstream and downstream boundary conditions were provided for the model. The upstream boundary condition was set as the base flow rate and the downstream boundary condition was set as normal depth.

Breach Parameters

In order to determine the "worst case" extent of flooding due to failure of the Pleasant Lake dam, this breach analysis includes not only a breach at the Pleasant Lake Dam, but also the subsequent failures at two dams downstream (Mill Pond Dam and the Hayes Pond Dam). This series of dam breaches and the parameters of each breach are further described below.

Due to the construction style of the Pleasant Lake Dam (NHDES #176.02), a fairly conservative approach was taken to model the mode of dam failure and breach. As modeled, the dam failure would begin by a piping failure (via cracking of the concrete) located near the location of the sluice gate outlet. This piping would initiate a complete failure of all of the concrete surrounding the sluice gate and 42" outlet pipe to the full 11 foot height of the dam. The Pleasant Lake dam breach, modeled in accordance with Env-Wr 502.06, Table 5.1, was assumed to have an average breach width (BR) 35.5 feet, left and right side slopes (Z) of 0.5, and a total time to failure (TFH) of 0.5 hours (approximately 30 minutes).

The first downstream dam is the Mill Pond Dam (Dam #2 Elkins Road, NHDES #176.03). As modeled, the dam failure at the Mill Pond Dam would begin by a piping failure (via cracking of

the concrete structure) located in the dam embankment. This piping would initiate a complete failure of the 15 foot high embankment. The Mill Pond dam breach, modeled in accordance with Env-Wr 502.06, Table 5.1, was assumed to have an average breach width (BR) of 43.8 feet, left and right side slopes (Z) of 0.5 and 0 respectively, and a total time to failure (TFH) of 0.2 hours (approximately 12 minutes).

The second downstream dam is the Hayes Pond Dam (Dam #3 Elkins Road, NHDES #176.04). As modeled, the dam failure at the Hayes Pond Dam would begin by a piping failure located in the dam embankment. This piping would initiate a complete failure of the 6.2 foot high embankment. The Hayes Pond dam breach, modeled in accordance with Env-Wr 502.06, Table 5.1, was assumed to have an average breach width (BR) of 29.7 feet, left and right side slopes (Z) of 1 and 0.5 respectively, and a total time to failure (TFH) of 0.1 hours (approximately 6 minutes).

2.5 DAM BREACH ANALYSIS AND RESULTS

The flows for the sunny day and 100-year storm event were modeled without breaching the dams in a steady state in order to provide a baseline to compare the additional impacts caused by a breach of the three aforementioned dams. The breaches were then modeled in addition to those steady flow rates for the sunny day and 100-year event to determine the maximum extent of damage caused by the dam failures.

Inundation mapping was developed for the breach analysis model run under the flow condition for the sunny day and 100-year event. This map depicts the predicted downstream flood water boundaries and the following:

1) The location of prominent structures and features adjacent to the "river".
2) The mean channel velocity during the peak flow condition.
3) The peak water surface elevation.
4) The time from the start of dam breach to the arrival of the flood wave.
5) The time from the start of dam breach to the peak water surface elevation.

The inundation map was created by projecting the HEC-RAS model data into GIS and is shown on Figures 5 and 6. Select tabular output data from the HEC-RAS model is included in Appendix C.

As mentioned previously, the study area immediately downstream of the Pleasant Lake Dam is the residential area of Elkins Village. There are several bridges and dams, as well as various properties located in the Elkins Village area that are at risk of flooding from the subject dam breach. Graphical depictions of these critical cross sections and the modeling results for those areas are included on Figures 7 through 21. The following tables 2-2 and 2-3 provide detailed results of the hydraulic modeling of the breach wave during the sunny day and 100-year event at critical cross sections.

Table 2-2: Breach Wave Summary for the Sunny Day Event

River Section	Description	Structure Elev. (ft)	Sunny Day Water Surface Elevation		Flood Depth Due to Breach (in)	Time to Flood Wave Arrival (min.)	Time to Peak W.S. Elev. (min.)	Peak Channel Vel. (ft/s)
			Baseline Elev. (ft)	Breach Elev. (ft)				
9900	Bridge #1	804.6	797.6	802.7	0	5	30	10.6
9600	Dam #2	802.0	797.6	802.3	3	5	30	2.4
9418/9745	468 Elkins Rd	790.5	787.8	793.2	33	6	38	3.3
9243/9673	Bridge #2	794.6	787.8	794.8	3	7	38	7.7
9243/9673	490 Elkins Rd	794.1	787.3	793.2	0	7	38	8.3
9243/9673	490 Elkins Rd	792.3	787.3	793.2	11	7	38	8.3
9150/9278	Bridge #3	791.1	787.2	793.2	25	8	38	5.4
9150/9278	495 Elkins Rd	795.6	786.0	788.8	0	10	38	3.5
9150/9278	32 Sherman St	796.6	786.0	788.8	0	10	38	3.5
9079	9 Hillcrest Dr	792.4	786.6	792.5	1	8	38	6.9
9046	Bridge #4	788.8	786.3	792.5	44	8	38	8.0
9046	Garage	791.0	786.3	792.5	18	8	38	8.0
9046	508 Elkins Rd	795.8	786.3	792.5	0	8	38	8.0
8915/9068	527 Elkins Rd	793.4	785.2	788.3	0	10	38	3.0
8860	Bridge #5	789.7	785.2	787.8	0	10	37	6.4
8568	Dam #3	785.5	785.2	788.0	30	11	38	3.0
8280	Bridge #6	773.6	767.1	776.2	31	12	41	4.8
8280	559 Elkins Rd	793.8	767.1	776.2	0	12	41	4.8
7990	45 Scythe Shop Rd	783.6	766.6	770.9	0	17	43	1.3
7990	1 Elkins Rd	773.2	766.6	770.9	0	17	43	1.3
7720	Dam #4	767.2	766.5	770.6	41	17	43	3.6
7000	Confluence w/Whitney		751.9	754.9		30	53	4.6
3050	Bridge #7	711.7	702.9	708.9	0	55	89	6.2
530	Chase Dam	702.6	702.8	704.2	19	60	108	1.4

Table 2-3: Breach Wave Summary for the 100-year Event

River Section	Description	Structure Elev. (ft)	100-year Water Surface Elevation		Flood Depth Due to Breach (in)	Time to Flood Wave Arrival (min.)	Time to Peak W.S. Elev. (min.)	Peak Channel Vel. (ft/s)
			Baseline Elev. (ft)	Breach Elev. (ft)				
9900	Bridge #1	804.6	801.3	805.8	14	5	30	4.9
9600	Dam #2	797.0	801.0	803.6	32	5	31	2.5
9418/9745	468 Elkins Rd	790.5	790.8	795.7	59	5	39	5.7
9243/9673	Bridge #2	794.6	790.1	796.5	24	5	39	6.7
9243/9673	490 Elkins Rd	794.1	790.2	793.7	0	5	39	9.5
9243/9673	490 Elkins Rd	792.3	790.2	793.7	17	5	39	9.5
9150/9278	Bridge #3	791.1	789.5	793.7	31	6	40	3.9
9150/9278	495 Elkins Rd	795.6	787.2	791.3	0	6	40	5.7
9150/9278	32 Sherman St	796.6	787.2	791.3	0	6	40	5.7
9079	9 Hillcrest Dr	792.4	788.3	793.3	11	6	40	6.3
9046	Bridge #4	788.8	787.8	793.3	54	6	40	8.0
9046	Garage	791.0	787.8	793.3	28	6	40	8.0
9046	508 Elkins Rd	795.8	787.8	793.3	0	6	40	8.0
8915/9068	527 Elkins Rd	793.4	786.5	790.8	0	7	37	4.7
8860	Bridge #5	789.6	786.5	790.7	14	7	40	4.9
8568	Dam #3	784.7	786.5	789.0	30	7	36	3.6
8280	Bridge #6	773.6	769.9	776.9	39	8	42	5.3
8280	559 Elkins Rd	793.8	769.9	776.9	0	8	42	5.3
7990	45 Scythe Shop Rd	783.6	768.3	772.3	0	10	43	1.5
7990	1 Elkins Rd	773.2	768.3	772.3	0	10	43	1.5
7720	Dam #4	767.2	768.2	771.8	44	10	43	4.5
7000	Confluence w/Whitney		753.8	756.4		10	48	5.4
3050	Bridge #7	711.7	710.0	713.7	25	10	65	5.1
530	Chase Dam	702.6	703.8	706.2	30	15	169	2.0

SECTION 3
CONCLUSIONS

In general, our analysis has a similar conclusion as the previous "Dam Break" report prepared by Stevens Engineering, dated September 1993. As stated in that report, "…many areas in Elkins would be unsafe if the Pleasant Lake Dam were to fail. Not only are there structures near the brook which could be damaged, but also travel through the village would be severely limited. Even though the dam might fail quite quickly as assumed in [the Stevens Engineering] analysis, the large size of Pleasant Lake and the relatively small breach [will] lead to the potential of flooding in Elkins extending for more than a day."

The area most severely affected by a breach of the Pleasant Lake Dam is the area located downstream of the Dam to a point where the receiving channel converges with Whitney Brook in a relatively large wetland area. This area of flooding is detailed on the Elkins Village Inundation Area Map (Figure 6) and the associated cross sections (Figures 7 through 19). Flooding in this area will occur rapidly and has the potential to affect several structures. The extent of flooding is illustrated on the referenced Figures. These structures include the garage/storage buildings located at 490 and 495 Elkins Road (see Figures 10 and 11, Photos 8 and 12) and the garage at 508 Elkins Road (see Figure 13 and Photo 11). The basement/foundation of two inhabited residential structures also appear to be affected, which are identified as 468 Elkins Road (see Figure 9 and Photo 7) and 9 Hillcrest Drive (see Figure 12 and Photo 10).

Several of the roadways through Elkins Village will also be flooded. During a sunny day breach event scenario, Elkins Road will be inundated in the Village area, however it appears that the bridge just downstream of the Pleasant Lake Dam at Wilmot Center Road and the three bridge Crossings associated with Elkins Road will not be overtopped. However, the supporting infrastructure of the Wilmot Center Road Bridge (Section 9900) will be impacted by floodwaters with velocities greater than 10 feet per second, which is extremely erosive and may result in undermining and structural failure of the bridge. In the event of a breach during the 100-year flood event, all of the associated bridges at Elkins Road and Wilmot Center Road will be

overtopped and damage to each should be anticipated. In all breach scenarios, access/egress to the residences along Elkins Road in Elkins Village will be jeopardized.

The severity of the conditions in Elkins Village (in all breach scenarios) is anticipated to peak between 30 and 45 minutes of the initial breach of the Pleasant Lake Dam. Due to the ample volume of water contained in Pleasant Lake, severe conditions are anticipated to be sustained for an extended period, which should continue for over a day and only gradually improve as the water level of Pleasant Lake is slowly drawn down.

The highest peak flows and impacts associated with the dam breach of the Pleasant Lake Dam will be significantly dissipated as the associated flood wave converges with Whitney Brook and flows through the undeveloped wooded areas downstream of Elkins Village. As shown on the overall Inundation Map (Figure 5), the flood wave will travel approximately a mile through undeveloped woodland and wetlands downstream of Elkins Village prior to reaching the next downstream structure, which is the bridge at Woodland Lane, just upstream of Chase Pond (Section 3050 and Figure 20). At this location, it is unlikely that any significant damage will occur to the crossing during a breach of the dam on a sunny day. However, a breach of the dam during the 100-year event will likely cause flooding to overtop the road.

The Chase Pond Dam will also be affected by both breach scenarios (Section 530 and Figure 21). The spillway of the Chase Pond Dam has been constructed with a set of flashboards designed to "break away" during large flooding events. As such, these flashboards and their functionality have a significant affect on the flood elevation in Chase Pond and peak flow downstream of the Chase Pond Dam. Our analysis has assumed that these flashboards will function as designed and indicated in the Chase Pond Dam Hydrologic Analysis prepared by Gomez and Sullivan Engineers, P.C., and will break away completely once water surface elevations in Chase Pond reach 704.2 feet. Under this assumption, the spillway of Chase Pond Dam should have capacity to convey the flood flows from the modeled breach events associated with failure of the Pleasant Lake Dam.

During a sunny day breach of the Pleasant Lake Dam, the water surface of Chase Pond should elevate to a point where the flashboards in Chase Pond break away. This breaking of the flashboards is anticipated to occur approximately 1.8 hours (108 minutes) after a breach of the Pleasant Lake Dam. It is also anticipated that during a 100-year event, the flashboards will have broken away by the storm flood, prior to the breach wave arrival. During this 100-year flood, a breach of the Pleasant Lake Dam will cause a peak water surface elevation within inches of the crest of the Chase Pond Dam. Thus, failure of Chase Pond Dam due to overtopping is not likely to occur, and therefore, further analysis downstream of the Chase Pond Dam was not incorporated into this Dam Breach analysis. This peak condition at Chase Pond Dam during a 100-year event is anticipated to be reached approximately 2.8 hours (169 minutes) after a breach of the Pleasant Lake Dam.