BORTON LAWSON

Making Our Client's Vision a Reality

July 31, 2020

PENN LAKE DAM ASSESSMENT

Evaluation of Existing Deficiencies and Rehabilitation/Replacement Alternatives

Prepared for:
Penn Lake Park Borough
Luzerne County, Pennsylvania

In Association With:

Gannett Fleming

Excellence Delivered As Promised

Project Number: 2020-4778-002

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I. PROJECT BACKGROUND

Penn Lake Dam (PADEP Identifier #: D40-028) is a 300-foot long, approximately 30-foot tall earthen embankment dam located in Penn Lake Park Borough, Luzerne County, Pennsylvania. The dam was built on the original alignment of Wright's Creek and resulted in formation of Penn Lake which currently has a storage capacity of 246 acre-feet at a normal pool elevation of 1331.2 feet and a storage capacity of approximately 500 acre-feet at the crest of the Dam. The principal spillway for the Dam is situated east of the main embankment and is comprised of four corrugated metal arches that maintain the lake's normal pool elevation.

The Dam is classified as a Class C-1 "high hazard" dam by the Pennsylvania Department of Environmental Protection (PADEP) with the letter grade denoting the size category and the numerical rating representing the hazard potential downstream of the dam. The DEP dam classification criteria from PA Code Chapter 105 is provided for reference in Appendix A.

Constructed circa 1905 by the Bear Creek Ice Company, the dam was intended to obstruct Wright's Creek and form a lake for the purpose of ice harvesting. At that time, ice from the lake was loaded onto rail cars at the crest of the dam and transported for sale. The eventual emergence of refrigeration rendered the ice production industry irrelevant and the Bear Creek Ice Company would eventually sell Penn Lake, the Dam, and surrounding property to Mr. and Mrs. Harry Goeringer for real estate development in 1938.

Penn Lake Dam has a long history of deficiencies having been constructed before many advances in dam design and engineering were made. Early records indicate that excessive seepage was a concern at the dam based on correspondence reviewed from 1911.

Repairs and modifications were made to the main embankment of the dam and spillway between 1984 and 1985 following a geotechnical investigation performed by F.T. Kitlinski and Associates in 1982. This report included rehabilitation plans for a filter blanket, toe drain, construction of a downstream stability berm, modifications to the outlet control conduit, and extension of the existing 36-inch outlet pipe to the toe of the proposed stability berm. In addition to these modifications to the embankment, the capacity of the spillway was increased by replacing twelve 42-inch diameter steel pipes with four (4) 4'-7" x 17'-3" corrugated metal arches. The current hydraulic capacity as a result of these improvements is approximately 4,000 cubic feet per second (cfs).

In August 2000, during an inspection of the dam, PADEP observed seepage to be three to four times greater than that estimated the year prior. As a result of this observation, two reports were produced: A January 2001 report prepared by Gannett Fleming identifying several deficiencies at the Dam and a December 2003 Report prepared by Borton-Lawson on the results of a hydrologic analysis and an incremental breach analysis.

The most recent repair of the dam occurred in 2006 when the outlet control valves were repaired and a new upstream control valve was installed to meet regulatory requirements mandating a control valve at the upstream side of the outlet works. Penn Lake was drained to facilitate this work.

In March 2020, Penn Lake Park Borough (PLPB) received a letter from PADEP Division of Dam Safety. In this letter, which is referenced in Appendix B, PADEP noted two primary deficiencies at the Dam which are cause for concern:

1. *The existing spillway is capable of passing just 30% of the required Probable Maximum Flood (PMF) as affirmed through a new hydraulic analysis utilizing the recently released "Probable Maximum Precipitation Study for Pennsylvania" Prepared by Applied Weather Associates, LLC, March 2019.*

2. *Changing conditions in uncontrolled seepage flow is observed at the dam. A site visit by PADEP on February 25, 2020 found "changing conditions in the location of documented flow and varying estimates of the volume, especially for the seepage presenting at the vicinity of the outlet conduit."*

The letter proceeds to inform PLPB that PADEP is designating Penn Lake Dam as "Unsafe". The Pennsylvania Code Chapter 105 Section 105.136 defines an unsafe dam as "*a dam with deficiencies of such a nature that if not corrected could result in the failure of the dam with subsequent loss of lives or substantial property damage.*" An unsafe designation is not to imply that failure of the dam is imminent. However, PADEP may require Penn Lake to be drained, in part or completely, until deficiencies have been addressed.

PLPB's response to the PADEP March letter was issued on May 29, 2020 acknowledging the deficiencies identified by PADEP and outlining the Borough's approach to addressing these. The letter discusses the scope of work of this dam assessment and also presents a preliminary schedule for implementation.

II. Existing Deficiencies and Associated Risks

In addition to the deficiencies noted in the March 2020 letter from PADEP, other deficiencies were identified through this assessment. The following deficiencies are discussed in order of most severe to least concerning along with the potential risks presented by each.

A. Inadequate Spillway Capacity

As previously discussed, the existing spillway is seriously undersized and has capacity to pass only 30% of the Probable Maximum Flood (PMF). The PMF is generally defined as the theoretically largest flood resulting from a combination of

the most severe meteorological and hydrologic conditions that could conceivably occur in a given area. The PMF is roughly equivalent to the 10,000 year flood in most cases. This design requirement to pass the PMF is imposed on all dams classified as "high hazard" for which a failure could result in loss of life or significant property damage.

A failure of the Dam stemming from inadequate spillway capacity would likely occur in the form of overtopping. In this case, the flow exiting through the spillway would not keep pace with flow entering Penn Lake via Wright's Creek. The pool level of the Lake would increase until flow overtopped the dam embankment. Hydrodynamic forces on the crest and downstream slope of the embankment would likely result in erosion and failure of the earthen embankment.

B. Uncontrolled Seepage

Seepage is produced by unbalanced hydraulic head (water levels) between the upstream and downstream sides of the Dam. In modern earthen embankment dams, seepage is normally limited by an impervious zone at the core of the dam. Seepage that passes through the impervious core and dam foundation is intercepted by an internal filtered seepage collection system often consisting of a chimney and blanket drain. Seepage intercepted by the filtered drainage system is collected and discharged through a perforated drain pipe at the toe of the dam and discharged to the stream or channel. Some very old dams, such as Penn Lake Dam, were not engineered in accordance with modern standards and do not have this defensive measure. Prior subsurface exploration consisting of four borings performed at Penn Lake Dam in 1982 found the embankment to be comprised of mostly homogeneous fill materials and lacking any impervious layer or filter zone. High rates of uncontrolled and unfiltered seepage have been observed at the dam throughout its 115 years of service.

The primary risk of uncontrolled seepage is a failure due to internal erosion. This mode of failure can occur slowly over time and increase during periods of increased hydraulic pressure. If unfiltered, seepage may be transporting fine soil particles from inside the dam embankment. Over time, this internal erosion can form internal voids or create a larger "pipe" thus increasing seepage flows and erosion and hastening failure of the embankment. Internal erosion failures often occur along outlet conduits that penetrate the dam. The highest concentration of seepage at Penn Lake Dam is occurring in the vicinity of the outlet conduit.

C. Deteriorated Conduit and Control Valves

The primary means of controlling the pool level within Penn Lake is the existing spillway. However, an outlet conduit at the dam is required as a means to lower Penn Lake for maintenance activities and during emergencies. Currently, the upstream outlet control valve is stuck in the closed position and when efforts to open the valve were met with resistance, it was abandoned for fear it would not close once opened and the lake would drain. Resistance of the control valve may be due to debris within the chamber or deferred maintenance by not exercising the gate on a regular basis. An inoperable control valve can leave a dam owner helpless in an emergency situation by not having a means to lower the lake.

In addition to the inoperable control valve, the ductile iron conduit through the embankment is 115 years old with the exception of the extension installed in 1985 at the time the existing rock stability berm was constructed. The conduit was last video inspected in 2003 and found to be 95% covered in rust blisters; no joints could be identified through the rust.

D. Sloping Embankment Crest

Dams are typically constructed with a level crest unless specifically designed to overtop. In the event overtopping occurs, a level crest causes the reservoir to spill evenly over the embankment rather than concentrating flow at a low point. The crest of Penn Lake Dam varies in elevation from 1340.5 feet at the east end to 1336.5 feet at the west end. Overtopping of the dam embankment will therefore concentrate at the west abutment and erode the embankment more quickly than if the overtopping were to occur evenly across the dam crest. The risks associated with this deficiency magnify the risk presented by the inadequate spillway capacity discussed previously.

E. Public Utilities Located within or in Close Proximity to the Dam

It is noted that various public utilities have installed infrastructure within the dam embankment, or in close proximity to the dam. The practice of installing utilities through a dam is discouraged by PADEP for a number of reasons.

If a water or sanitary sewer pipeline is pressurized, failure of the pipeline within the embankment could cause internal erosion of the embankment. Maintenance on utilities within the dam also often require excavation of the embankment. Excavation of the embankment, even for purposes of maintenance is discouraged due to the temporary compromise to structural integrity of the dam, especially when the lake is

at or above normal pool elevation. Furthermore, having pipelines within the dam can create seepage paths, thus increasing the risk of internal erosion failures or deformation of the embankment.

F. Potential Blocking of Spillway Inlet

With the existing spillway comprised of multiple corrugated pipe arches, the opportunity exists for blockages to occur at one or more of these arch openings during high flows. Large woody debris or drifting watercraft could obstruct the spillway openings and reduce the spillway capacity.

G. Erosion Protection on Upstream Embankment Slope

While wave action on Penn Lake is minimal, it is common practice to maintain riprap on the upstream embankment face to prevent wave action erosion. Original hand-placed riprap appears in fair condition. Future modifications to the dam should consider evaluation of the upstream riprap protection and repair or replacement of the riprap, if needed.

Consequences of a Dam Failure

A previous analysis of the inundation area between Penn Lake and the Lehigh River completed in 2003 found that 25 structures and approximately 90 people would be impacted in a PMF dam breach scenario. Hollenback Road and Middleburg Road are also impacted in the PMF breach scenario.

Failure of a dam can occur for numerous reasons and at any time. Therefore, dam breach analyses generally model at least three different scenarios: a full PMF breach, a half PMF breach, and a sunny day breach. The inundation area map provided in Appendix E shows the inundation limits for a worst-case PMF breach.

It is the intent of this report to not only identify the existing deficiencies and risks surrounding the Penn Lake Dam, but also to provide solutions to address the deficiencies and maintain the lake for generations to come.

III. Conceptual Alternatives

The following alternatives are presented in order of ascending cost as anticipated by the engineer. Only alternatives which address the deficiencies stated in this report are considered viable. These alternatives generally fall into one of two approaches: (1) address all deficiencies through modifications to or replacement of the existing dam embankment or (2) address only embankment related deficiencies at the dam and resolve spillway deficiencies at the spillway. While all of the following alternatives technically address the stated deficiencies, each comes with unique advantages, disadvantages, risks, and uncertainties, and each will require at least a partial drawdown of Penn Lake to implement.

A. Widen Spillway – Modify Dam Embankment – Slip-line Conduit

ESTIMATED COST - $1.9 MILLION (Details in Appendix C)

Generally regarded as the least expensive approach to satisfying PADEP requirements, this alternative provides the required spillway capacity by entirely removing the existing corrugated metal arch culverts and roadway and widening the spillway.

An initial concern was that increasing flow through the existing spillway would only result in moving the control point downstream where a restriction in the channel or floodplain would choke the flow and prevent the PMF from passing despite widening of the spillway. By utilizing a two-dimensional hydraulic computer model (HEC-RAS), it was determined that a widened spillway is capable of passing the PMF discharge of 10,600 cfs as preliminarily calculated by PADEP using the recently released *"Probable Maximum Precipitation Study for Pennsylvania"*. The model was also used to simulate a flow rate of 15,000 cfs as a conservative approach in the event a higher PMF is calculated either in design or in the future. Both models demonstrate that the point at which flow is regulated remains at the widened spillway crest or control section and is not transferred further downstream. These findings, supported by the referenced hydraulic modeling, suggest that widening the spillway is a feasible solution to achieving the required spillway capacity. Graphics demonstrating downstream flow depths for both flow rates analyzed are presented in Appendix C.

Deficiencies at the dam embankment can be addressed by removing the existing rock stability berm, constructing a chimney drain and blanket drain, and buttressing the embankment with a flatter (3H:1V) downstream slope. The existing outlet conduit can be slip-lined and extended to the new toe of embankment. By constructing a modern filtered seepage collection system

within the embankment, seepage currently uncontrolled would be filtered, collected, and discharged to the stream in a controlled fashion.

Temporary draining of Penn Lake is necessary to perform these modifications including repairs to the outlet control valve. Although the valve is currently malfunctioning, the Borough believes it can be opened for the purpose of draining the lake and allowing repairs. In the event the valve cannot be opened, it is possible for the lake to be drained using siphons.

Multiple permutations of this alternative exist from a dead-end road at the spillway to an emergency fjord crossing, to a narrower opening featuring a labyrinth spillway and bridge. Each variation is accompanied by its own benefits and disadvantages including increased costs in addition to the estimated amount provided for this Alternative. An illustration of Alternative A is provided in Appendix C.

A disadvantage of this alternative is that it does not reduce or eliminate the seepage through the embankment. This alternative could be modified to improve the imperviousness of the embankment by lining the upstream embankment slope. This approach assumes the source of the seepage is primarily through the embankment. It is possible that the source of the seepage is through the foundation.

B. Modify and Armor Embankment with Roller-Compacted Concrete

ESTIMATED COST - $7 MILLION

In the event the existing spillway site is not able to be widened due to difficulties with property ownership or general desire to maintain continuity of the roadway, additional spillway capacity may be achieved at the dam. By designing the crest of the dam to an elevation at which it is intended to be overtopped, the dam cam be modified to be overtopped and perform as an auxiliary spillway.

Some dams have been designed for this capacity by armoring the downstream embankment with roller-compacted concrete (RCC) to prevent erosion during overtopping. Since simply armoring the embankment does not solve the uncontrolled seepage, the same embankment measures described for Alternative A are necessary to manage seepage prior to armoring of the Dam. One risk imposed by this method of armoring is the potential that a pre-existing defect exists in the dam embankment that goes undetected and eventually results in erosion or a void within the embankment and remains masked by the

rigid armoring such that the dam owner or inspector could remain unaware of the deficiency.

C. Modify and Armor Embankment with Articulated Concrete Blocks

ESTIMATED COST - $7 MILLION

Similar to Alternative B, the dam embankment can be armored using articulating concrete block mats (ACBs). ACBs are a relatively new technology for armoring dam embankments. An advantage over RCC is that ACBs are less rigid and tend to conform to depressions in the embankment, providing advance warning of an embankment problem or failure. Several dams fitted with this technology have been overtopped and performed well.

In the case of Alternatives B and C, the steps taken in Alternative A to filter uncontrolled seepage and buttress the existing embankment are still required prior to armoring of the embankment. While PADEP has permitted use of armoring methods in the past, it is typically considered an option of last resort when other options are not economical or practicable.

D. New Roller Compacted Concrete Dam/Spillway Downstream

ESTIMATED COST - $8-$10 MILLION

Previous alternatives discussed to this point have focused on modifying the existing civil works to address deficiencies; however, the primary drawback with all previous options is that the original, non-engineered embankment still comprises the overwhelming majority of the dam. Residual risks associated with the existing embankment still exist. A way to completely eliminate the residual risks is to replace the existing dam with a new dam.

Construction of a new RCC dam just downstream of the existing embankment offers several benefits. The existing dam can function as a cofferdam during construction allowing Penn Lake to maintain a permanent pool as opposed to being completely drained. Continuity of the roadway can be maintained as there is no requirement to remove the existing embankment once the RCC dam is constructed downstream. The new RCC dam would function as an emergency spillway to supplement the primary spillway and provide the discharge capacity needed to safely convey the PMF. No modifications are required to the existing spillway as part of this alternative. An illustration of Alternative D is provided in Appendix D.

Potential drawbacks to this alternative are the higher cost to design and construct, and the uncertainty in the cost which is highly dependent on the depth to the foundation bedrock downstream of the existing dam. A depth to bedrock of 20 feet would result in far higher costs than a bedrock foundation at 10 feet. A subsurface investigation program would be necessary to investigate geotechnical conditions at the anticipated site of an RCC dam and develop an opinion of probable cost with accuracy.

E. Replace Dam with Roller Compacted Concrete Dam/Spillway

ESTIMATED COST - $10 MILLION

The primary benefit of constructing a new RCC dam in the present location of the existing dam is the simpler and shorter dam alignment and the fact that the top of bedrock is higher. However, new borings would still be required into the bedrock to determine that the strength and uniformity of the foundation is suitable to withstand the hydraulic forces acting upon an RCC dam and control seepage.

Despite the potential for cost savings presented by the higher bedrock foundation at the existing dam site, this alternative necessitates draining of Penn Lake and complete removal of the existing earthen embankment. With these considerations in mind, it is possible that any cost savings realized by encountering shallower bedrock is quickly negated by the costs of removing the existing dam.

F. Replace Dam with Modern Embankment Dam and Enlarge Spillway

ESTIMATED COST - $10 MILLION

Replacing the existing earthen embankment dam in with a modern embankment dam can also serve the needs of the Borough and satisfy the concerns of PADEP. An instance in which a new modern embankment dam might be a more attractive alternative than a new RCC dam is when the foundation bedrock is found unsuitable to support the hydraulic forces acting upon an RCC dam. Embankment dams are less reliant upon a bedrock foundation for their stability.

IV. Next Steps & Recommended Schedule

Upon meeting with Penn Lake Park Borough officials and the Borough's Dam Committee and presenting the aforementioned alternatives discussed in this report, it has been determined that Alternative A best addresses the deficiencies observed by

PADEP and is most within the Borough's funding capacity. The modifications proposed in Alternative A may require a Dam Permit if the top of dam elevation is increased in accordance with Chapter 105 Section 105.89(a) and Section 105.81. Alternatively, the modifications may be performed under a Letter of Authorization if the top of dam can be leveled without raising the dam.

This report which presents the findings and determinations of the dam assessment will be sent to PADEP to precede a future Consent Order and Agreement between PADEP and PLPB. A meeting will be scheduled with PADEP to discuss the proposed action plan and schedule for implementation and to receive comments from PADEP on the desired alternative and regulatory requirements.

If PADEP is receptive of the Borough's proposed approach and schedule for addressing the noted dam deficiencies, Borton-Lawson will coordinate with the Borough on developing and executing the scope for the next phase of the project.

An anticipated timeframe to complete design, permitting, bidding, and construction of Alternative A is provided below:

- **Engineering Design & Permitting:** September 2020 – August 2021
- **Advertisement, Bidding, and Award:** September 2021 – October 2021
- **Construction:** October 2021 – June 2022

APPENDIX A

Dam Classification Criteria

DAM AND RESERVOIR CLASSIFICATION CRITERIA FROM PA CODE CHAPTER 105

SIZE CATEGORY

Category	*Impoundment Storage (Acre Feet)*	*Dam Height (Feet)*
A	Equal to or greater than 50,000	Equal to or greater than 100
B	Less than 50,000 but greater than 1000	Less than 100 but greater than 40
C	Equal to or less than 1000	Equal to or less than 40

HAZARD POTENTIAL CATEGORY

Category	*Population at Risk*	*Economic Loss*
1	Substantial (Numerous homes or small businesses or a large business or school).	Excessive such as extensive residential, commercial, or agricultural damage, or substantial public inconvenience.
2	Few (A small number of homes or small businesses.)	Appreciable such as limited residential, commercial, or agricultural damage, or moderate public inconvenience.
3	None expected (no permanent structures for human habitation or employment.)	Significant damage to private or public property and short duration public inconvenience such as damage to storage facilities or loss of critical stream crossings.

APPENDIX B

PADEP Correspondence

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

March 30, 2020

Mr. Paul Rogan
Penn Lake Park Borough
P.O. Box 14
White Haven, PA 18661

Re: Annual Inspection Reports
Unsafe Dam Declaration
Penn Lake Dam
DEP File No. D40-028

Dear Mr. Rogan:

The Department of Environmental Protection, Division of Dam Safety (Department) has reviewed the 2019 and past Annual Inspection Reports for Penn Lake Dam. We thank the Penn Lake Park Borough (Borough) for its cooperation with the Department and for conducting the annual inspections.

The Borough should review the recommendations in the reports with its engineer and implement any necessary maintenance and repairs. Please be advised that repairs, other than minor maintenance, will likely require written approval from the Department prior to performing any work. Minor maintenance includes activities such as vegetation and debris removal, filling of animal burrows, and patching or sealing of small areas.

In addition to reviewing the inspection reports and as previously documented in our past letters to the Borough, the spillway at Penn Lake Dam is undersized and does not meet the requirements of Section 105.98 of the Department's Chapter 105 Regulations. This was reaffirmed by performing an updated hydraulic analysis of the dam using the recently released results of the "Probable Maximum Precipitation Study for Pennsylvania". This study replaces the extreme rainfall data in Hydrometeorological Reports (HMRs) 33, 40, 51, and 52 for use in calculating the PMP for sites within the Commonwealth of Pennsylvania. The study evaluated close to one hundred past recorded extreme rainfall events in and around Pennsylvania to develop an improved and updated approach to determining the PMP. In addition to the study, a user tool has been developed to determine the PMP rainfall amounts for local, regional, and tropical storms. This study and user tool can be found at https://www.dep.pa.gov/Business/Water/Waterways/DamSafety/Pages/Probable-Maximum-Precipitation-Study-.aspx

In using the results of the study, the Department has determined that the spillway is capable of passing only 30% of the required Probable Maximum Flood (PMF) design storm. The spillway is therefore considered to be seriously inadequate.

In addition, the Department is concerned with the amount of uncontrolled seepage flow at the dam. Previous Department inspections and findings during a site visit on February 25, 2020 note changing

conditions in the location of documented flow and varying estimates of the volume, especially for the seepage presenting at the vicinity of the outlet conduit.

Given the concerns discussed above, and since failure of the dam has the potential for loss of life to occur in the downstream inundation area, the Department is compelled to consider the Penn Lake Dam to be "Unsafe."

The "Unsafe" designation is not to suggest that this dam is at risk for imminent failure, but that it is severely deficient in meeting the requirements of the Dam Safety and Encroachments Act and the Department's Chapter 105 regulations. Section 105.136 of the Department's regulations define an unsafe dam as, "A dam with deficiencies of such a nature that if not corrected could result in the failure of the dam with subsequent loss of lives or substantial property damage." The Borough's dam is at risk of failure if subject to a storm event much less than the design flood that the dam is required to withstand, plus uncontrolled/unfiltered seepage can lead to the loss of soil material internal to the dam and may result in a "piping" type failure of the embankment.

The Department requests the Borough provide an updated schedule for addressing deficiencies at this dam by June 1, 2020. We expect to use this schedule to develop a Consent Order and Agreement to ensure the timely completion of tasks to rectify concerns with the safety of this dam. Also, the Department may require the reservoir created by the dam to be partially or completely drained to reduce the potential risk to downstream areas until deficiencies at the dam are corrected.

The Borough should ensure that monitoring and documentation of the seepage conditions at the dam, especially at the location of the drawdown conduit, are occurring more frequently than the quarterly inspections as required under Section 105.53.

We look forward to the Borough's continued cooperation in addressing the deficiencies at the Penn Lake Dam in a timely manner. If the Borough or its engineer has any questions regarding this letter, please contact me by e-mail at ricreising@pa.gov or by telephone at 717.772.5989.

Sincerely,

Richard A. Reisinger, P.E.
Chief
Division of Dam Safety

cc: Nicholas Argot, P.E., Borton Lawson Engineering, Inc.

PENN LAKE PARK BOROUGH

P. O. Box 14

White Haven, PA 18661

570-443-8017

plpborosecretary@yahoo.com

May 29, 2020

Richard A. Reisinger, PE
Chief, Division of Dam Safety
Pennsylvania Department of Environmental Protection
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17101

RE: Unsafe Dam Declaration
Penn Lake Dam
DEP File No. D40-028

Dear Mr. Reisinger:

Please allow this letter to serve as Penn Lake Park Borough's (Borough) response to the letter received from the Pennsylvania Department of Environmental Protection (PADEP), Division of Dam Safety, dated March 30, 2020, in which PADEP determined Penn Lake Dam to be in an "Unsafe" condition.

On behalf of the Borough, I want to express that we take our responsibility as a dam owner seriously and have reviewed your recommendations thoroughly. As evidence of our dedication to the safety of inhabitants and property downstream of the dam, as well as to the residents of the Borough who benefit from the dam's existence, we have recently contracted Borton-Lawson Engineering to perform a comprehensive assessment of the dam that will yield concept level recommendations for addressing noted deficiencies. Additionally, as part of this assessment, Borton-Lawson has engaged Paul Schweiger of Gannett Fleming to provide additional expertise in the areas of seepage analysis, geotechnical, and overall dam infrastructure evaluation.

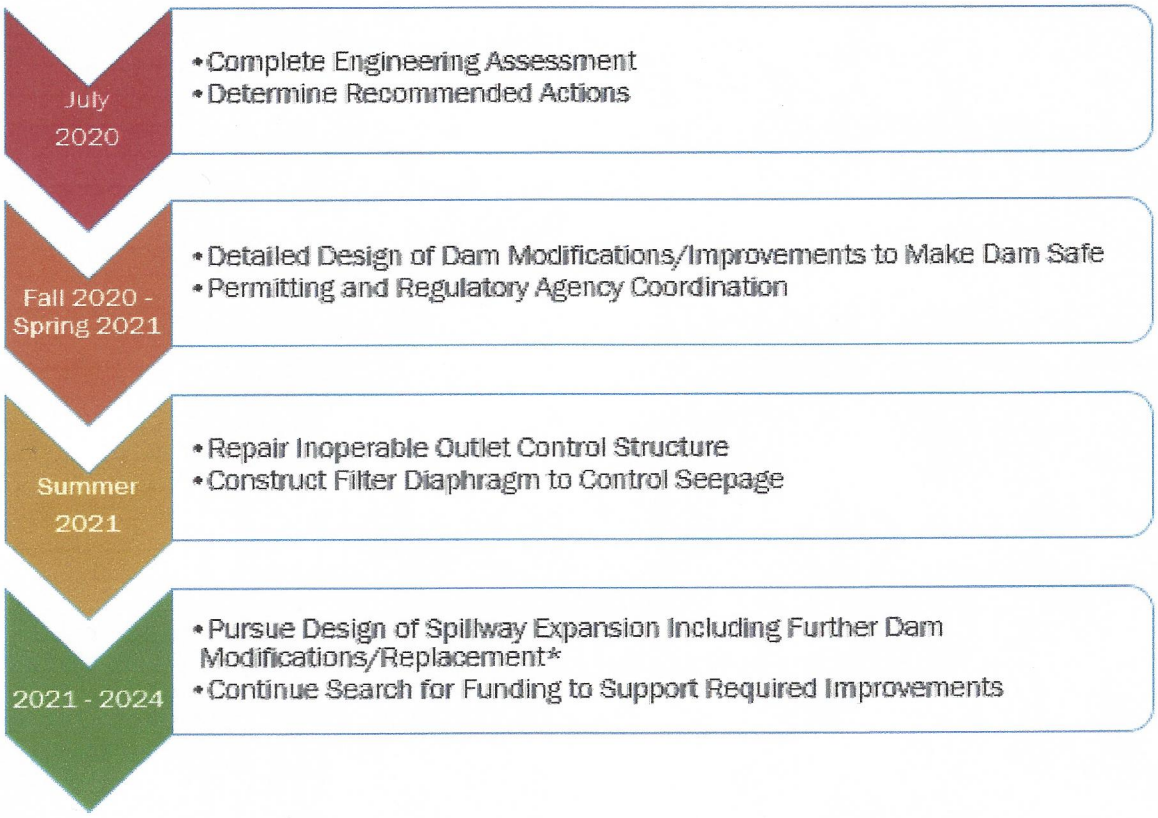
The scope of services to be provided by the engineering team in this phase includes:

- Detailed topographic survey of the dam and spillway;
- Site inspection and evaluation of existing available information including historical inspection reports, meeting minutes, past agency correspondence, and engineering technical reports;
- Development of concept level alternatives to adequately address deficiencies and associated opinions of probable cost for each viable alternative explored;
- Preparation of a summary letter report including final recommendations for dam infrastructure rehabilitation and/or replacement and a schedule for implementation;
- Coordination with PADEP, Division of Dam Safety.

The engineering assessment of Penn Lake Dam will be completed and submitted to PADEP no later than July 31, 2020. Please be advised that the Borough is also actively working to identify various sources of funding to cover the expected high costs of dam rehabilitation (whether temporary or permanent) and/or dam replacement, as well as the associated engineering fees for design and permitting. Excluding the award of a significant grant, the Borough will most realistically need to complete the required dam infrastructure improvements in a phased approach.

A schedule outlining this phased approach is provided below. Our proposed schedule is preliminary at this time and will be further refined upon completion of the dam assessment.

We hope you will find our proposed approach acceptable and, in return, the Borough is willing to enter into a Consent Order and Agreement with PADEP based upon a final schedule to be developed from our engineer's assessment of the dam and final recommendations. The Borough shall continue to monitor and document seepage conditions at the dam on a more frequent basis, and complete formal inspections on a bi-annual basis.



**Proposed actions and timeline for completion is subject to change upon conclusion of the engineer's assessment of Penn Lake Dam.*

If you would like to discuss our proposed approach and preliminary schedule for addressing noted deficiencies of Penn Lake Dam, please contact me at 570.956.9784 or email rogan@pobox.com. If needed, we can schedule a teleconference meeting with the Borough, our engineering team, and PADEP to establish a comprehensive and agreed upon approach.

Sincerely,

Paul Rogan
Council President
Penn Lake Park Borough

PR/cs

c: Samantha Albert, PE, PMP (Borton-Lawson)

Nicholas Argot, PE (Borton-Lawson)

Thomas Lawson, PE, PLS (Borton-Lawson)

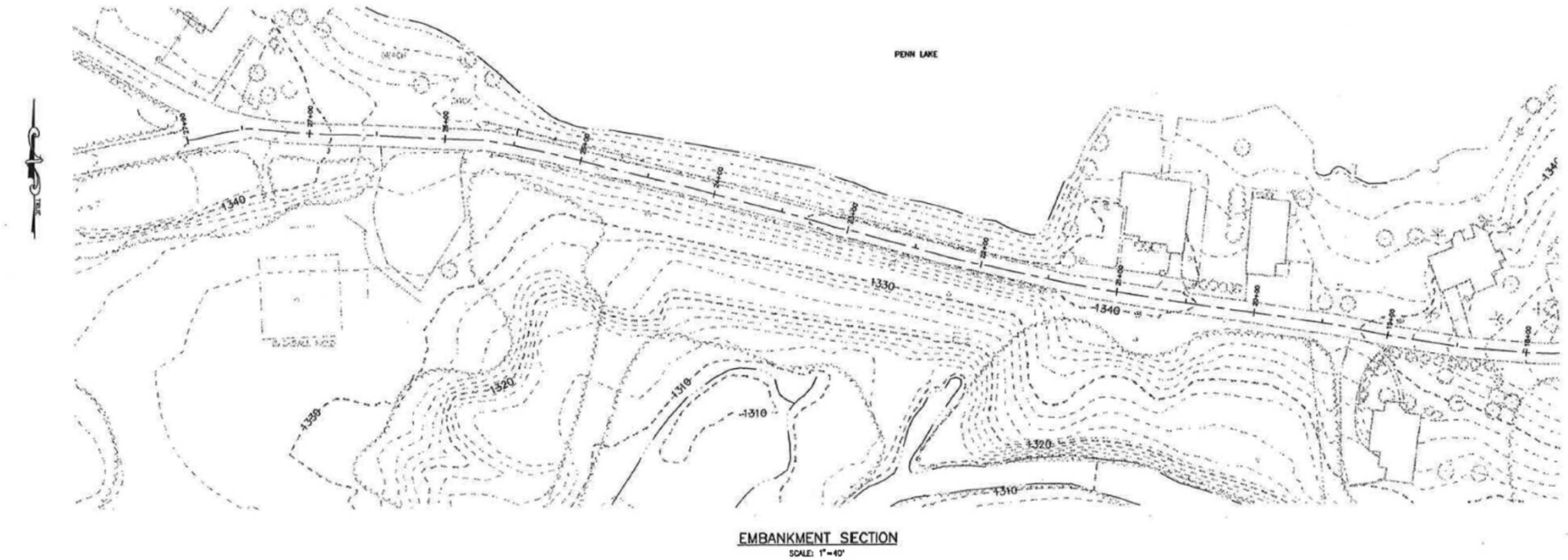
Paul Schweiger, PE, CFM (Gannett Fleming)

APPENDIX C

Alternative A Illustrations

Engineer's Opinion of Probable Cost

Plan of Main Embankment



EMBANKMENT SECTION
SCALE: 1"=40'

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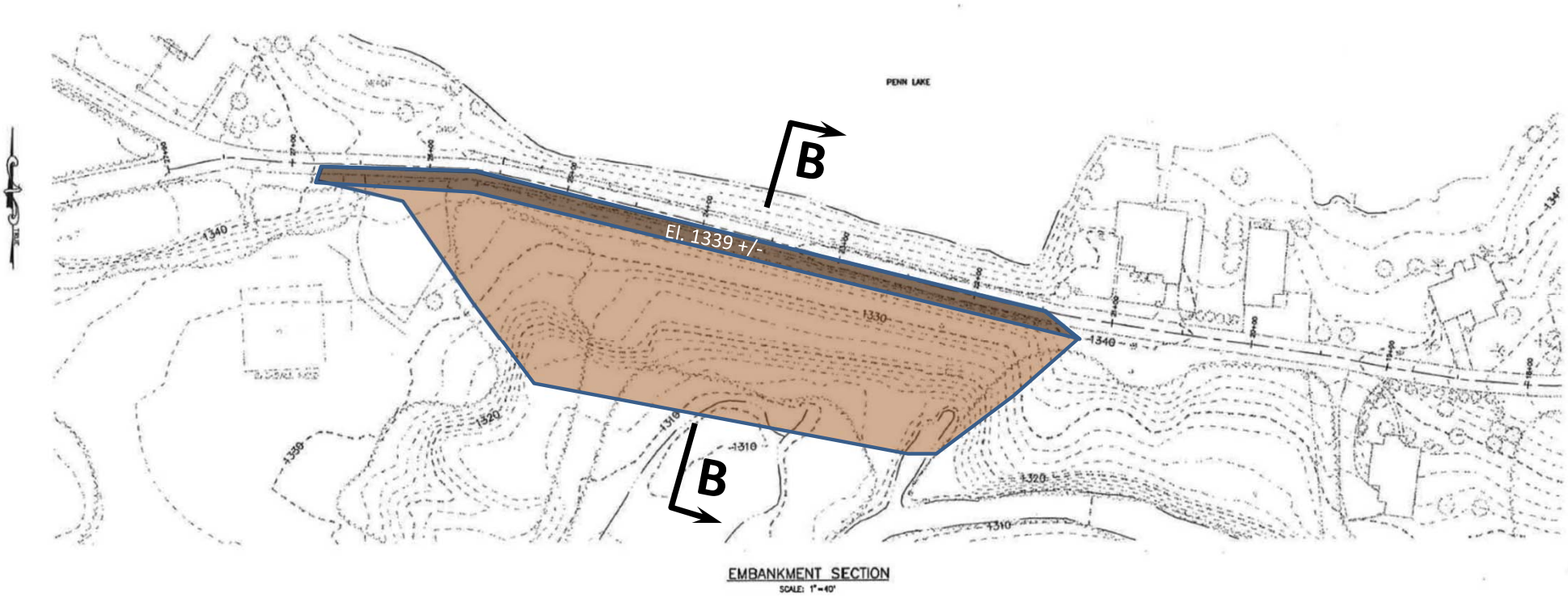
New Filtered Embankment Section Downstream



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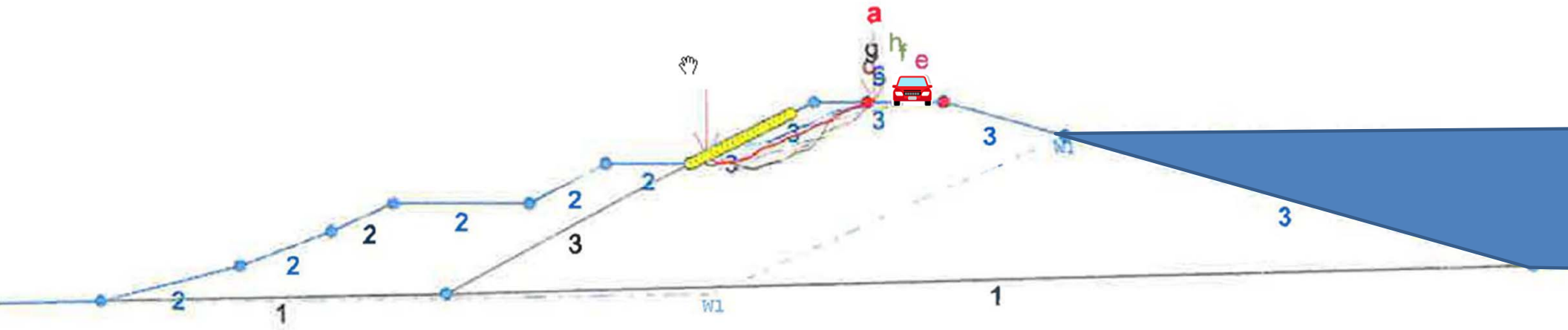
Existing Embankment Section



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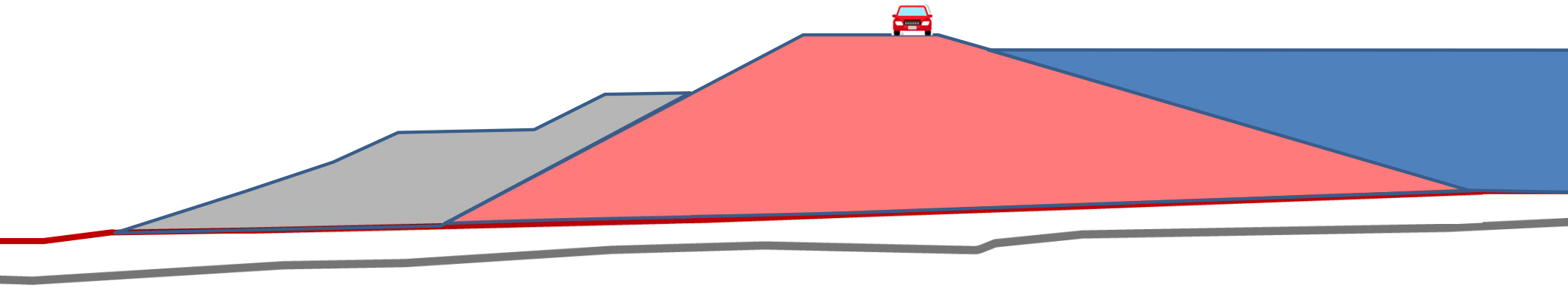
Existing Embankment Section



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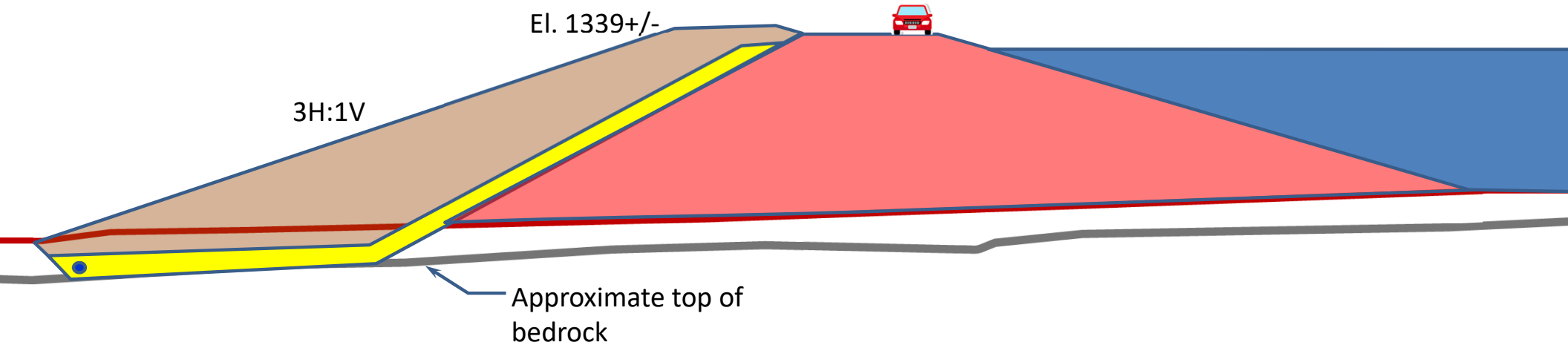
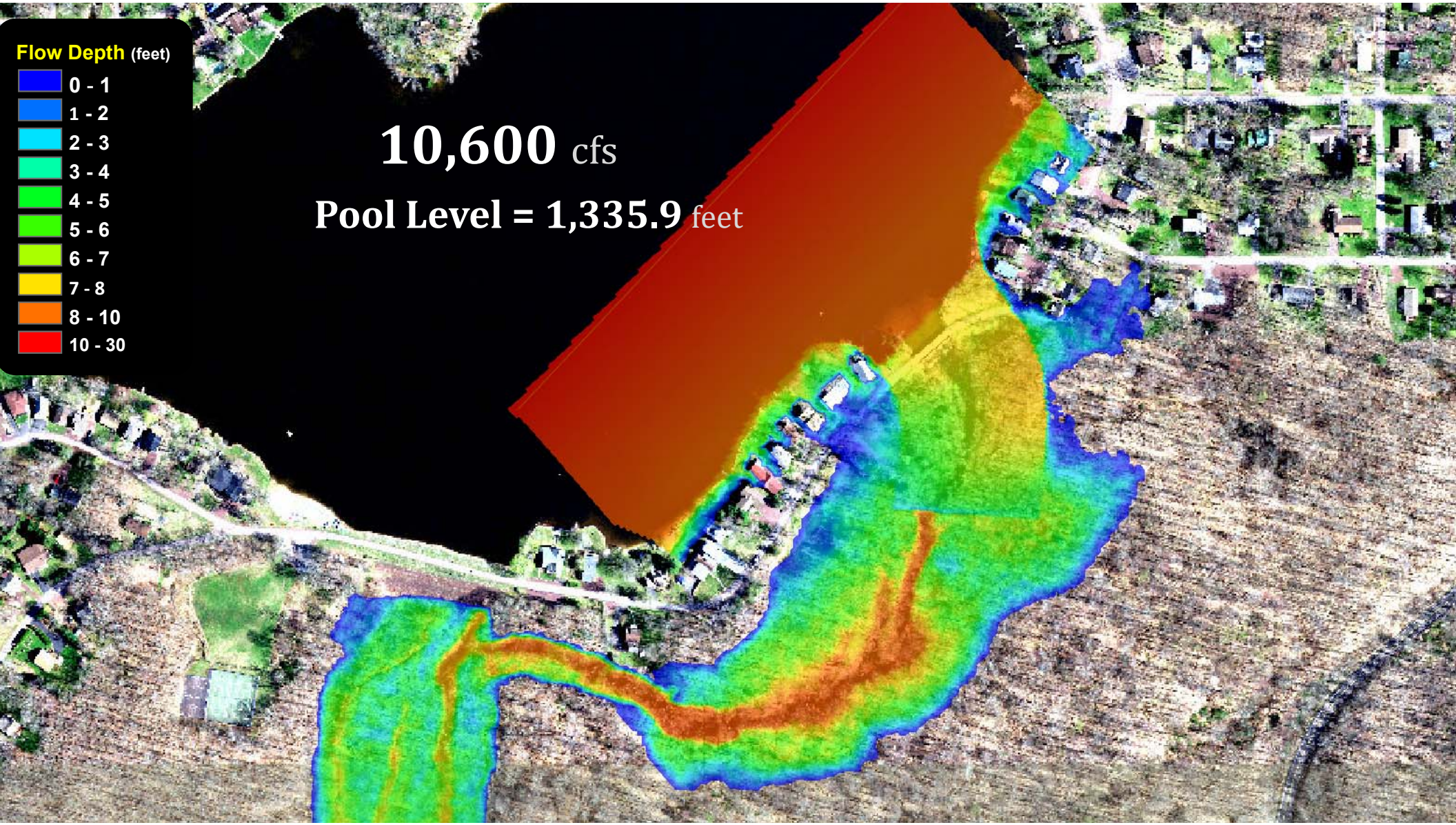
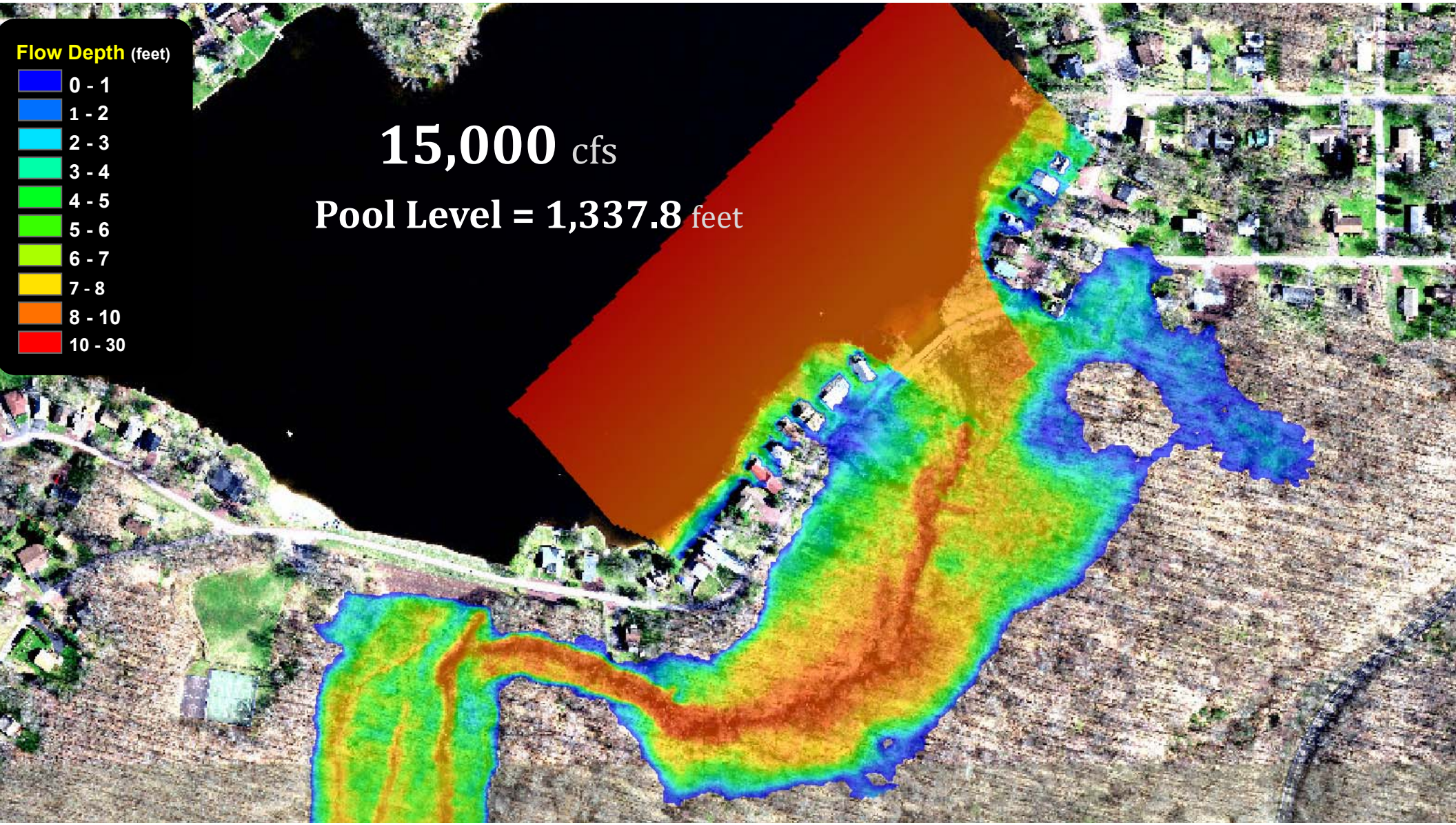
Embankment Section with Filtered Seepage Collection System and Flattened Downstream Slope



BORTON LAWSON

Gannett Fleming


Flow Depth (feet)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 10
10 - 30
10,600 cfs
Pool Level = 1,335.9 feet


Flow Depth (feet)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 10
10 - 30
15,000 cfs
Pool Level = 1,337.8 feet

JOB NO.:	2020-4778-002		
JOB NAME:	Penn Lake Dam Assessment		
CALCULATED BY:	CPS/BL	DATE	7/31/2020
CHECKED BY:	PGS/GF, SGA/BL	DATE	7/31/2020
SCALE:	None	DESIGN PHASE : Conceptual Level	

OPINION OF PROBABLE COST - ALTERNATIVE A

Widen Spillway, Modify Dam Embankment, Slip Line Conduit, Repair Control Valve

This alternative results in eleimination of the road at the spillway and does not consider alternatives to maintain continuity of the raodway.

Item No.	Item	Unit of Measure	Quantity	Unit Cost	Total
1	Mobilization/Demobilization	LS	1	$50,000	$50,000
2	Clearing and Grubing	LS	1	$10,000	$10,000
3	Erosion and Sediment Control	LS	1	$15,000	$15,000
4	Outlet Control Valve Replacement	LS	1	$100,000	$100,000
5	Utility Relocation	LS	1	$100,000	$100,000
6	Site Restoration	LS	1	$55,000	$55,000
7	Demolition of Existing Spillway	LS	1	$50,000	$50,000
8	Class A Concrete (Reconstruct Sill)*	CY	200	$800	$160,000
9	Unclassified Borrow Excavation	CY	16,600	$20	$332,000
10	Drain Fill	CY	2,100	$80	$168,000
11	Perforated Drain Pipe, 12"	LF	250	$30	$7,500
12	Embankment Fill (Compacted)	CY	13,100	$8	$104,800
13	Topsoil/Seed/Mulch Embankment	CY	650	$60	$39,000
14	Conduit Extension & Slip Lining**	LF	175	$300	$52,500
				SUBTOTAL- CONSTRUCTION	**$1,243,800**
				25% ENGINEERING* **	**$310,950**
				25% CONTINGENCY	**$388,688**
				TOTAL	**$1,943,438**

**Assume sill 300' Length, 3' wide, and 6' to bedrock.*

***Assuming unit price of $50/LF for 30" HPE Pipe and sliplining cost equal to 6x material cost. (Source: Contech)*

****Fee estimate for design, permitting, bidding and construction administration services. Does not include full time Resident Construction Inspection.*

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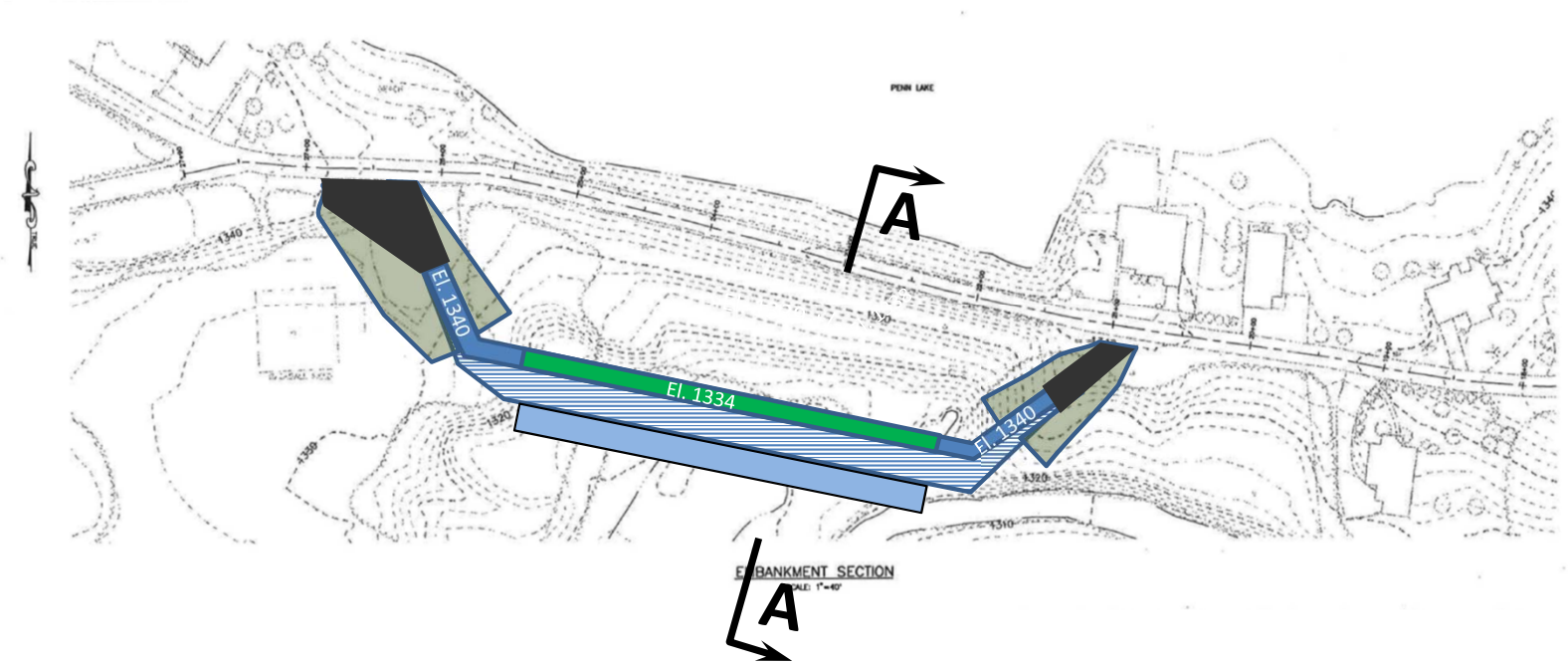
APPENDIX D

Alternative D Illustrations

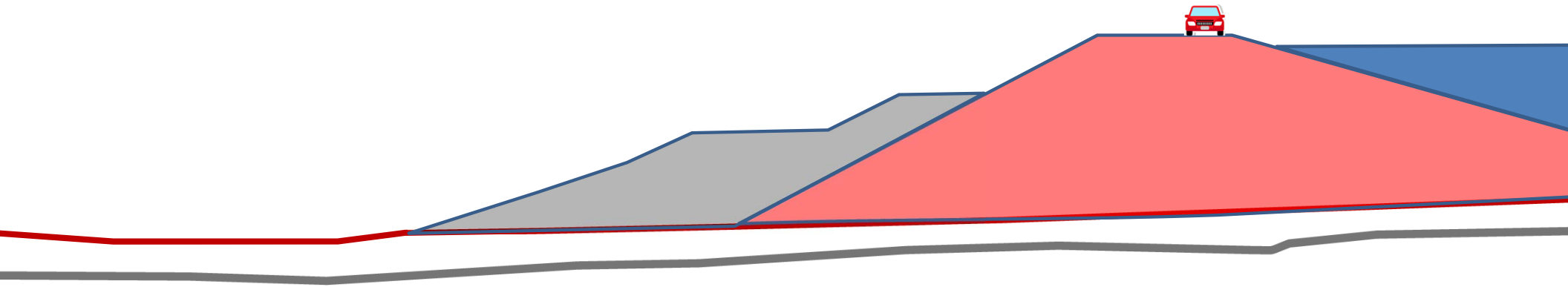
New RCC Dam/Spillway Downstream



BORTON LAWSON

Gannett Fleming

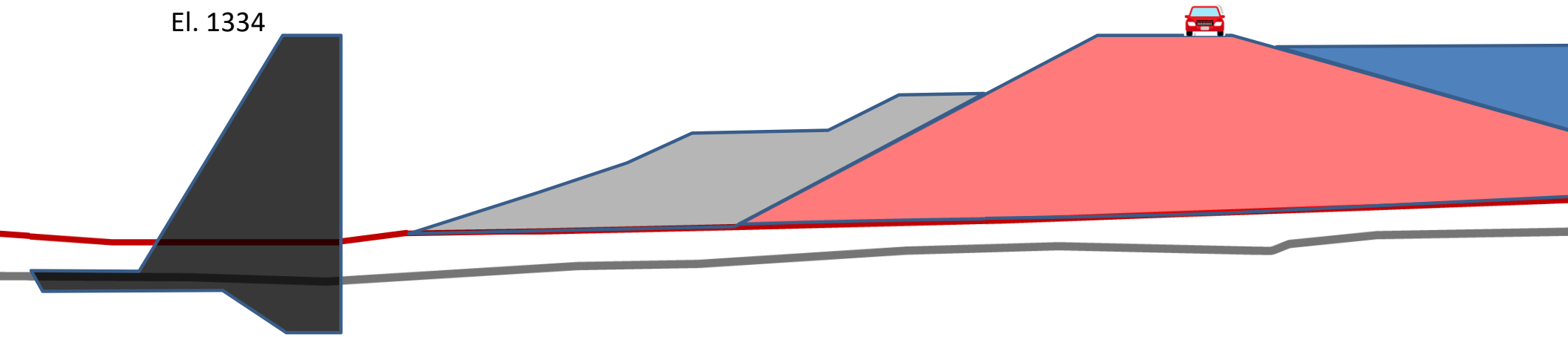
Existing Embankment Section



BORTON LAWSON

Gannett Fleming

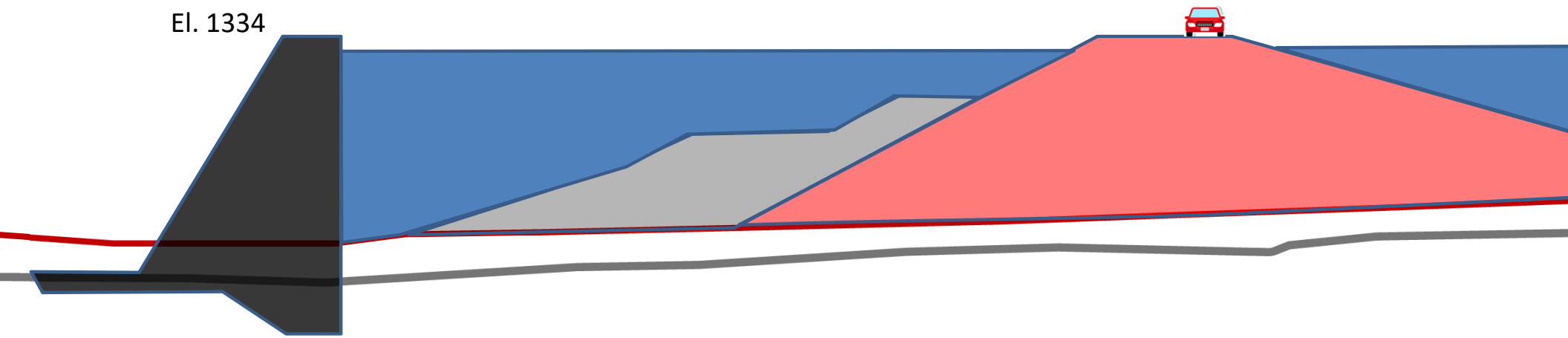
Existing Embankment Section with New RCC Dam/Spillway Downstream



BORTON LAWSON

Gannett Fleming

Existing Embankment Section with New RCC Dam/Spillway Downstream

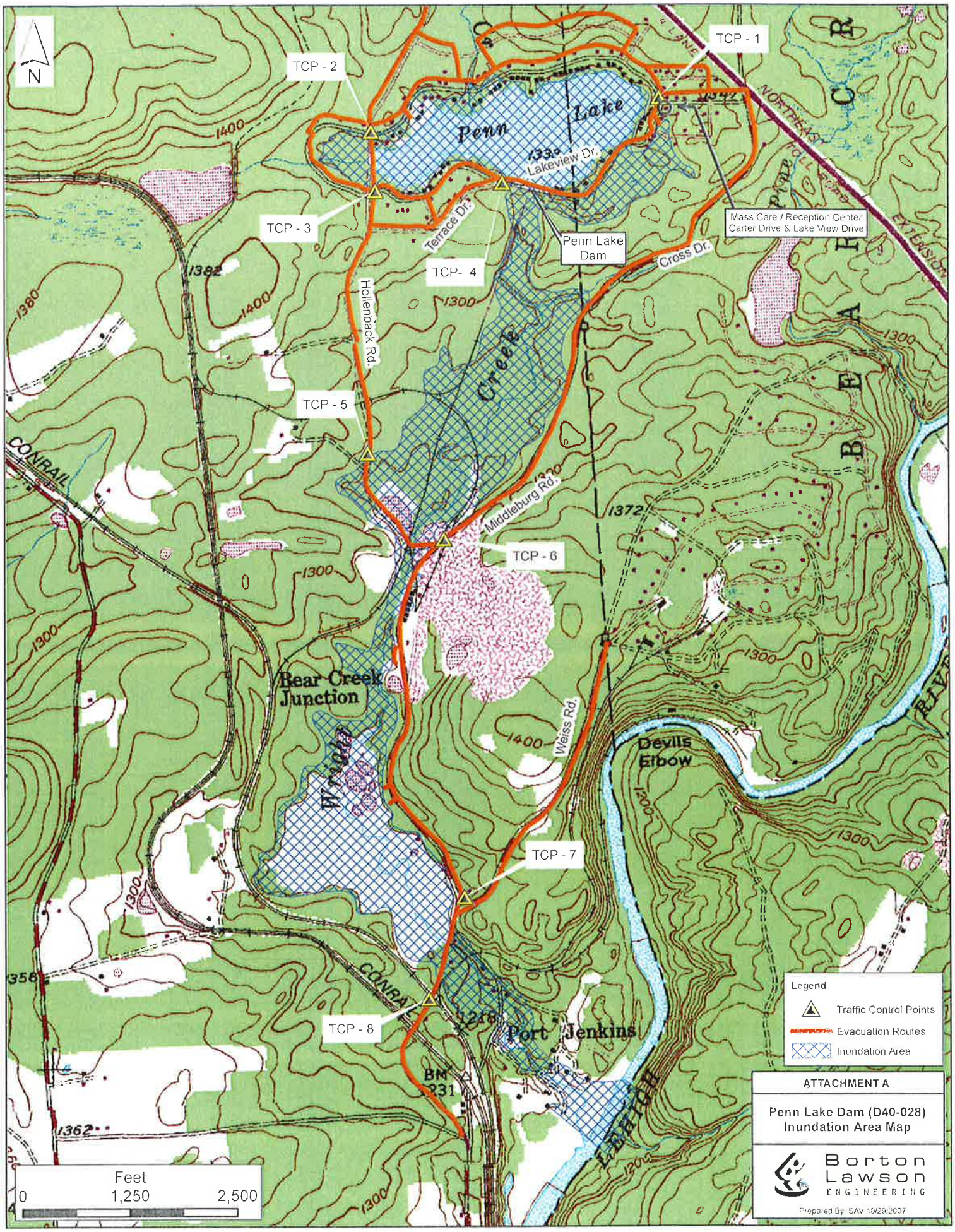


BORTON LAWSON

Gannett Fleming

APPENDIX E

Inundation Map


N
TCP - 1
TCP - 2
TCP - 3
TCP- 4
TCP - 5
TCP - 6
TCP - 7
TCP - 8
Penn Lake
Lakeview Dr.
Terrace Dr.
Penn Lake Dam
Mass Care / Reception Center
Carter Drive & Lake View Drive
Cross Dr.
Hollenback Rd.
Middleburg Rd.
Weiss Rd.
Bear Creek Junction
Devils Elbow
Port Jenkins
CONRAIL
BM 231
1400
1382
1380
1300
1372
1362
1356
1200
Feet
0
1,250
2,500
Legend
Traffic Control Points
Evacuation Routes
Inundation Area
ATTACHMENT A
Penn Lake Dam (D40-028)
Inundation Area Map
Borton Lawson ENGINEERING
Prepared By: SAV 10/29/2007

APPENDIX F

Survey Base Plan

PENN LAKE

12" DOUBLE
15" DOUBLE
8"
1335
HYDRANDT
"PEDESTRIAN CROSSING"
LAKEVIEW DRIVE
PIEZOMETER
GUIDE RAIL
BL BENCHMARK
CHISEL SQUARE
ON WALL
ELEV: 1338.00'
WALL
15"
24"
15"
24"
18"
WALL
N/F
DAVID J. KEBLISH, GARY S. KEBLISH, PAUL K. KEBLISH,
PETER A. KEBLISH III, JOSEPH VAN NAME
N12S2-4-10
DBK 3011 PG 202488
LAKEVIEW DRIVE
1340
PPL ATTCH
54542N35034
PIEZOMETER
GUIDE RAIL
1335
OE
PPL ATTCH
54570N3502
GUY WIRE
1330
PPL ATTCH
54556N3503
PIEZOMETER
1325
ROCK STABILITY BERM
WALL
VAULT
PAVED DRIVE
1330
1320
1315
1325
1320
1315
1310
36" CAST
IRON PIPE
CHANNEL TO WRIGHT'S CREEK
TREE LINE
N/F
DAVID J. KEBLISH, GARY S. KEBLISH, PAUL K. KEBLISH,
PETER A. KEBLISH III, JOSEPH VAN NAME
N12S2-4-6
DBK 3011 PG 202488
N/F
BOROUGH OF PENN LAKE
N12S1-A-3A
APPROX. LOCATION
OF WATER LINE
TREE LINE
1310
1310

GRAPHIC SCALE (IN FEET)
0' 20' 40' 60'

P:\PENNLAKEBORO\2020\4778\002\02-CADD\BASE\CX-BASE_2020-4778-002 PENNLAKE.dwg - 7/30/2020 2:58 PM

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811
OR
1-800-242-1776

REVISIONS		
NO.	DATE	DESCRIPTION

SEALS

DRAWING TITLE & PROJECT NAME

DAM EMBANKMENT BASE PLAN

PENN LAKE DAM
PENN LAKE PARK BOROUGH
LUZERNE COUNTY, PA

DRAWN BY	BXP
CHECKED BY	CPS
DATE	JULY 31, 2020
PROJECT NUMBER	2020-4778-002
DRAWING NUMBER	EX-1

PENN LAKE

N/F
JAMES P. FLANAGAN, WILLIAM J. FLANAGAN, KATHLEEN J. ESTRELLA, PATRICK J. FLANAGAN
N12S1-4-3
DBK 2718 PG 732

N/F
WILLIAM & KAREN A. GREEN
N12S1-4-1

(4) 4'-7" X 17'-3"
CORRUGATED METAL ARCHES

TREE LINE

6" QUAD

"CAUTION" GUIDE RAIL GUIDE RAIL "CAUTION"

LAKEVIEW DRIVE

1335

"CAUTION" GUIDE RAIL BRIDGE GUIDE RAIL "CAUTION"

1335

PPL ATTCH
5463BN35061

OE

UPOLE NO ID

PPL 54651N35069

1330

TREE LINE

WRIGHT'S CREEK

1330

TREE LINE

N/F
CHRISTOPHER W. & COLLEEN E. LAWSON
N12S1-6-5
DBK 3009 PG 1891

N/F
DANIEL R. & MICHELLE A. CRONAUER
N12S1-6-7
DBK 3016 PG 26063

N/F
BARRIE J. MARINO
N12S1-6-6
DBK 3010 PG 182421

N/F
UNKNOWN
N12S1-4-24

N/F
JAMES P. FLANAGAN, WILLIAM J. FLANAGAN, KATHLEEN J. ESTRELLA, PATRICK J. FLANAGAN
N12S1-4-22
DBK 2718 PG 732

N/F
BOROUGH OF PENN LAKE
N12S1-A-3A

GRAPHIC SCALE (IN FEET)
0' 20' 40' 60'

P:\PENNLAKEBORO\2020\4778002\02-CADD\BASECX-BASE_2020-4778-002 PENNLAKE.dwg - 7/30/2020 2:59 PM

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REVISIONS

NO.	DATE	DESCRIPTION

SEALS

DRAWING TITLE & PROJECT NAME

PRIMARY SPILLWAY BASE PLAN

PENN LAKE DAM
PENN LAKE PARK BOROUGH
LUZERNE COUNTY, PA

DRAWN BY	BXP
CHECKED BY	CPS
DATE	JULY 31, 2020
PROJECT NUMBER	2020-4778-002
DRAWING NUMBER	EX-2

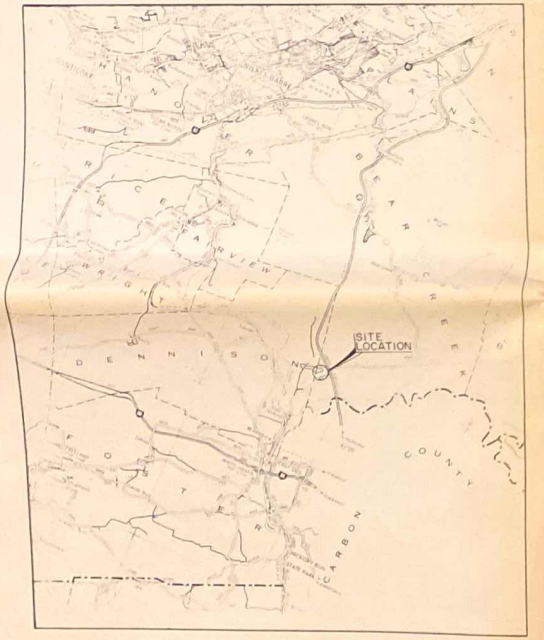
APPENDIX G

1984 As-Built Drawings & Construction Photos

REPAIR OF PENN LAKE DAM

BOROUGH OF PENN LAKE PARK
DENNISON AND BEAR CREEK TOWNSHIPS
LUZERNE COUNTY, PENNSYLVANIA

AS-BUILT



SCALE IN MILES

LOCATION MAP

MARCH 30, 1984

F. T. KITLINSKI & ASSOCIATES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
HARRISBURG, PENNSYLVANIA

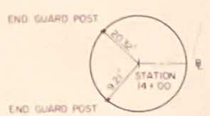
FTK PROJECT NO. 3241

APPROVED: BOROUGH OF
PENN LAKE DAM

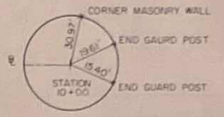
PRESIDENT OF COUNCIL

D40-28B

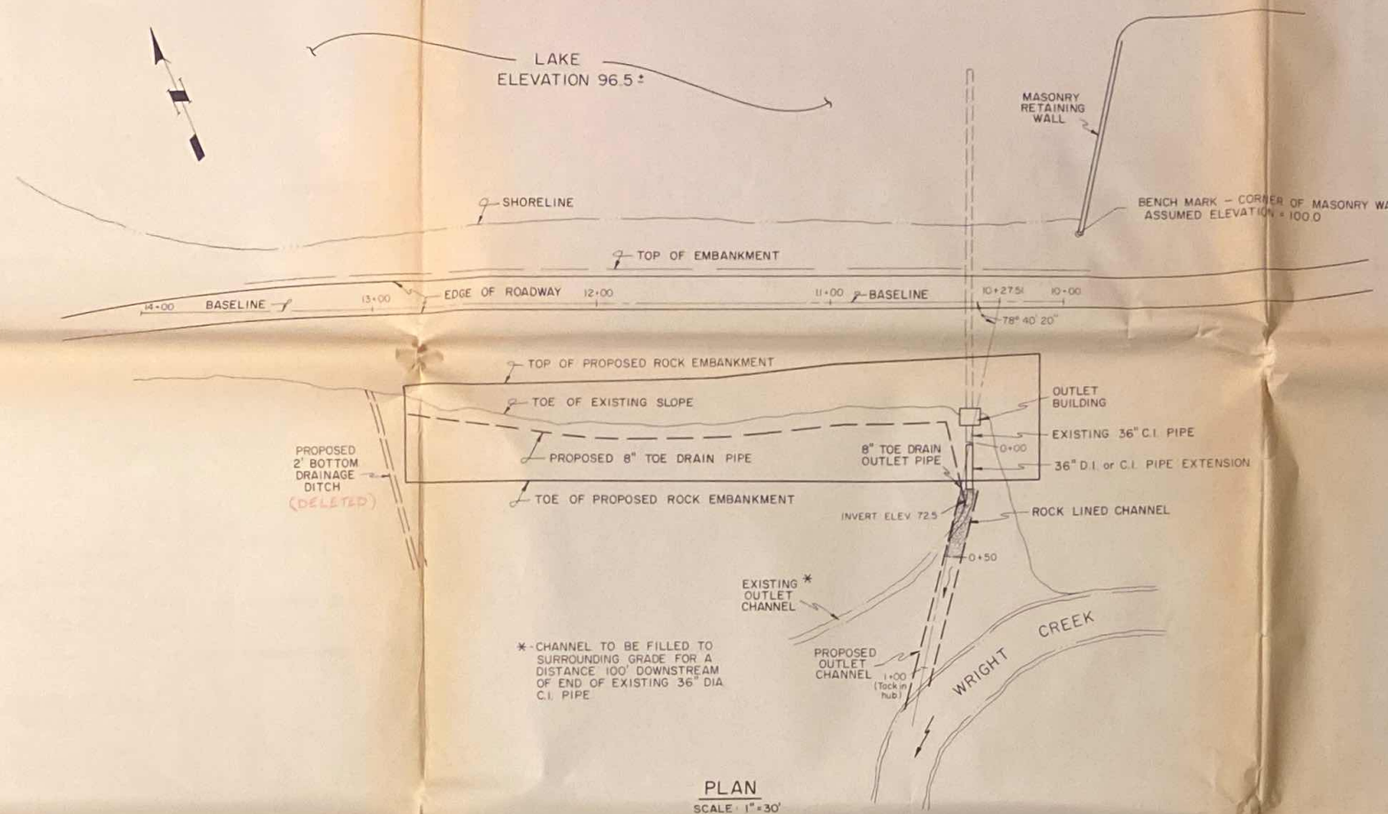
~~D28~~



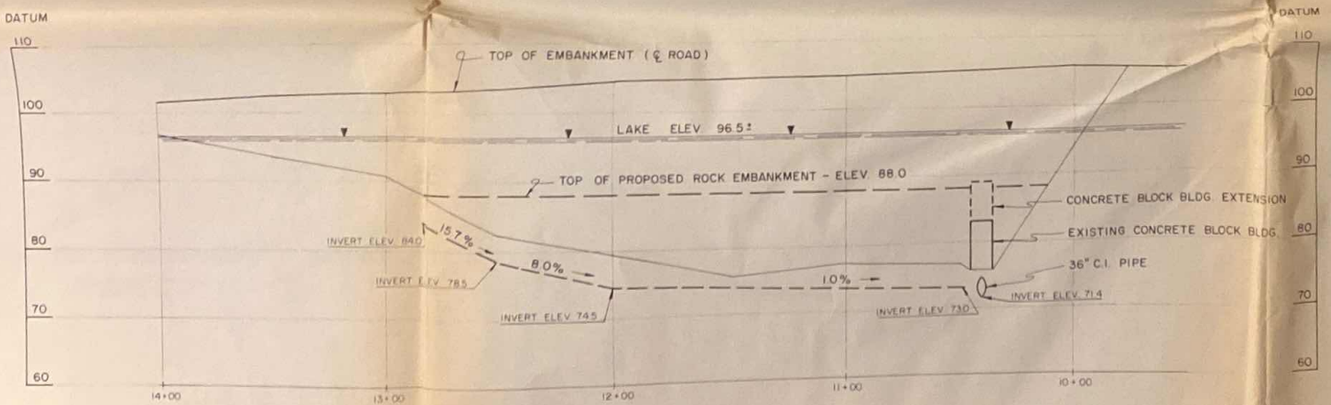
REFERENCE STATION 14+00



REFERENCE STATION 10+00



PLAN
SCALE: 1" = 30'



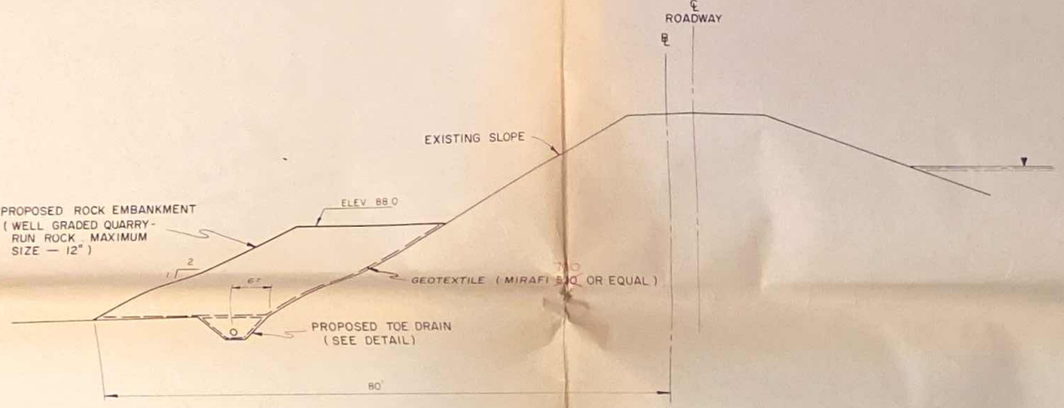
PROFILE
HOR. SCALE: 1" = 30'
VERT. SCALE: 1" = 10'

REPAIR OF PENN LAKE DAM

BOROUGH OF PENN LAKE PARK
DENNISON AND BEAR CREEK TOWNSHIPS
LUZERNE COUNTY, PENNSYLVANIA

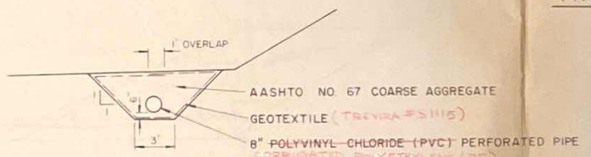
PLAN and PROFILE

SCALE		DATE
AS SHOWN	F.T. KITLINSKI & ASSOCIATES, INC.	MAR 30,1984
DRAWN BY	Consulting Geotechnical Engineers	DWG. NO.
G.A.A.	Harrisburg, Pennsylvania	2



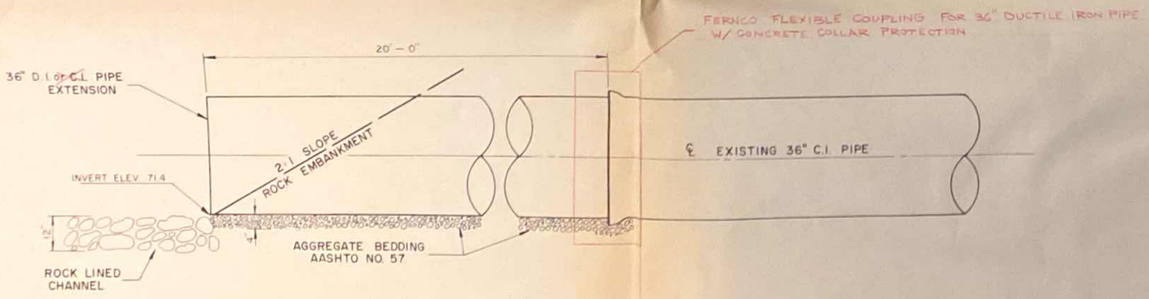
TYPICAL SECTION

NO SCALE



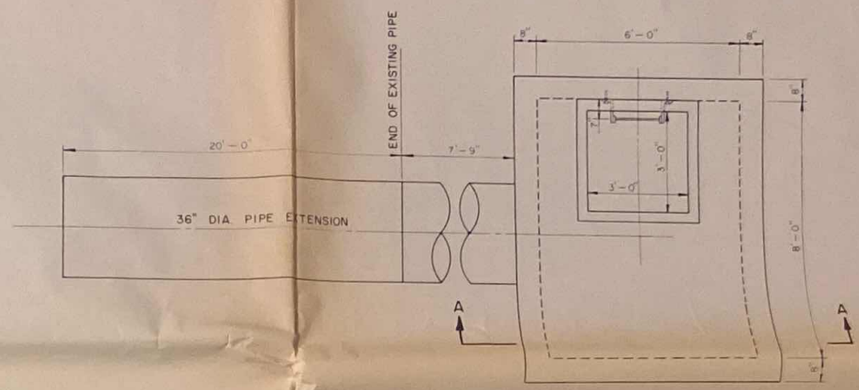
TOE DRAIN DETAIL

NO SCALE



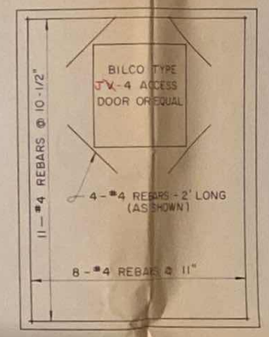
PIPE EXTENSION DETAIL

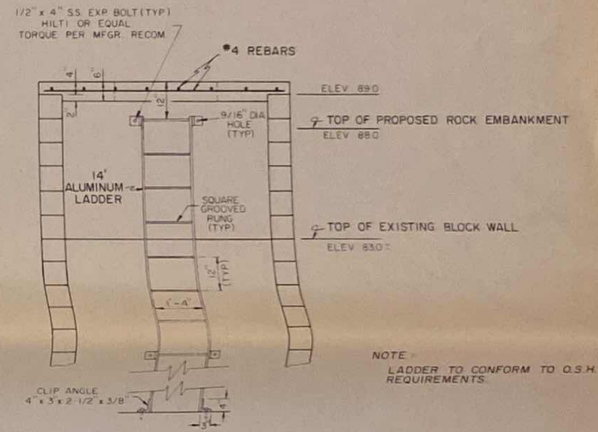
SCALE : 1/2" = 1'



PLAN

SCALE : 1/2" = 1'





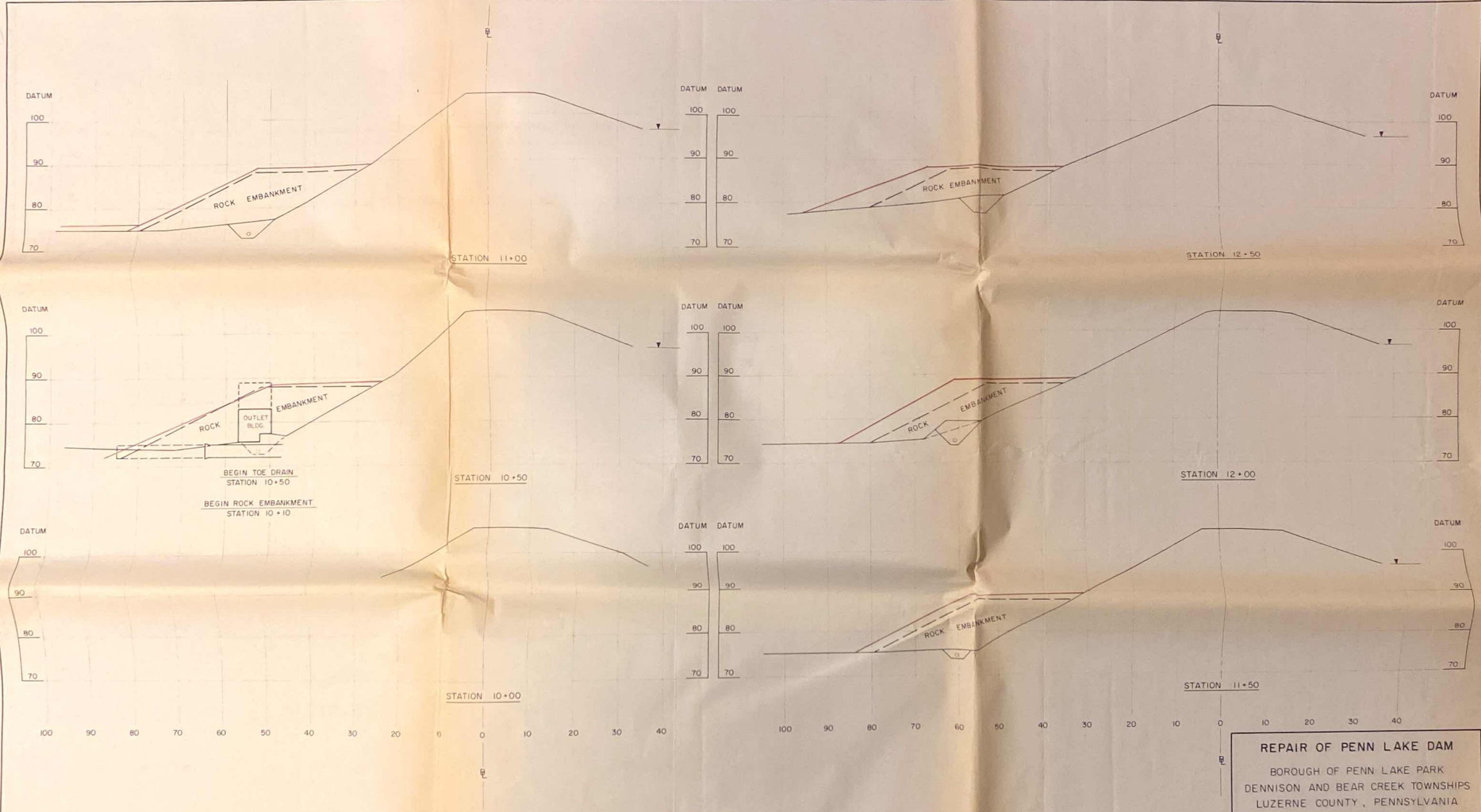
NOTE:
LADDER TO CONFORM TO O.S.H.A. REQUIREMENTS.

REPAIR OF PENN LAKE DAM

BOROUGH OF PENN LAKE PARK
DENNISON AND BEAR CREEK TOWNSHIPS
LUZERNE COUNTY, PENNSYLVANIA

CONSTRUCTION DETAILS

SCALE: AS SHOWN DRAWN BY: G.A.A.	F.T. KITLINSKI & ASSOCIATES, INC. Consulting Geotechnical Engineers Harrisburg, Pennsylvania	DATE: MAR. 30, 1982 DWG. NO. 3

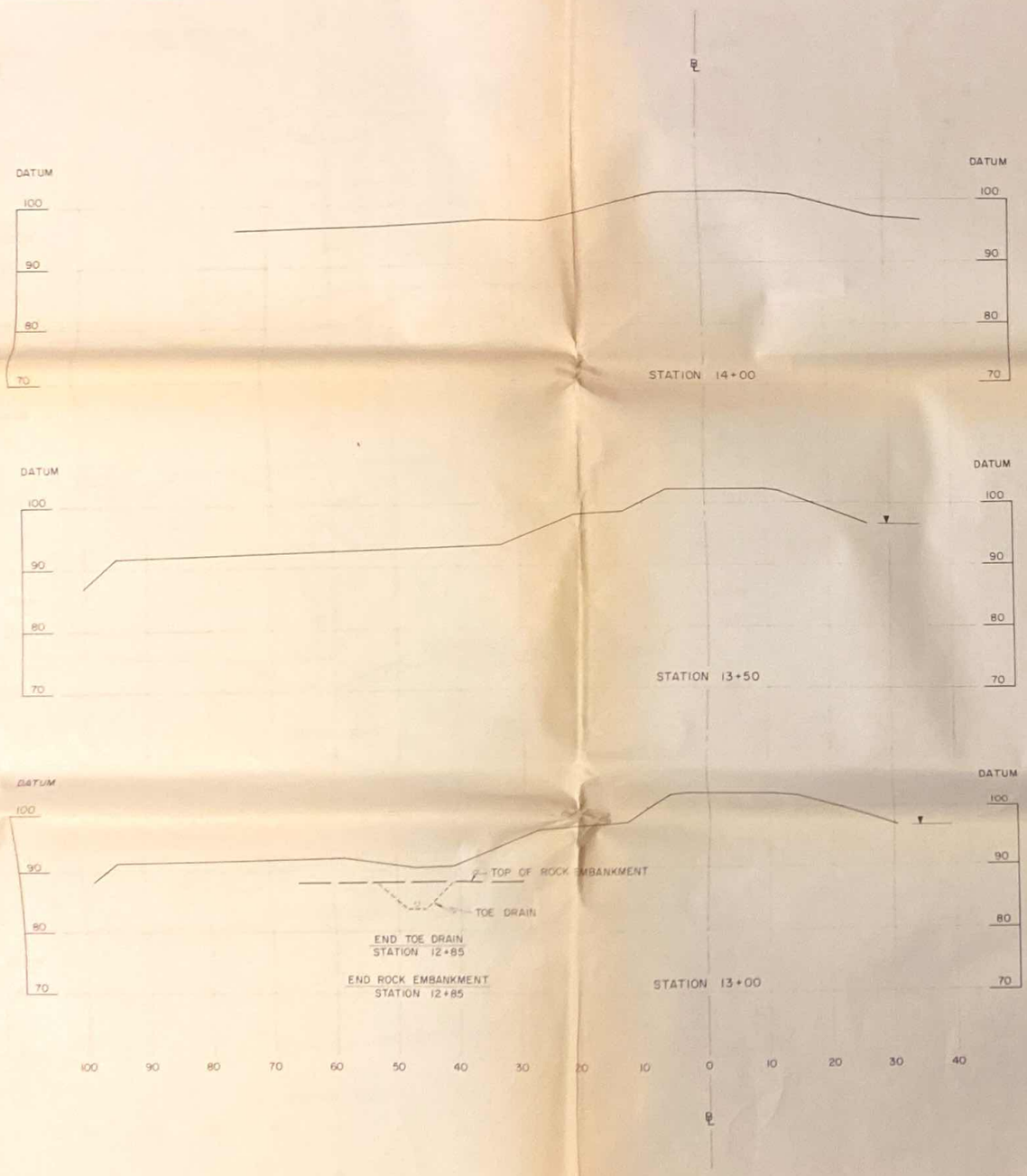


REPAIR OF PENN LAKE DAM

BOROUGH OF PENN LAKE PARK
DENNISON AND BEAR CREEK TOWNSHIPS
LUZERNE COUNTY, PENNSYLVANIA

EMBANKMENT CROSS-SECTIONS

SCALE		DATE
AS SHOWN DRAWN BY G.A.A.	F.T. KITLINSKI & ASSOCIATES, INC. Consulting Geotechnical Engineers Harrisburg, Pennsylvania	MAR. 30, 1984 DWG. NO. 4



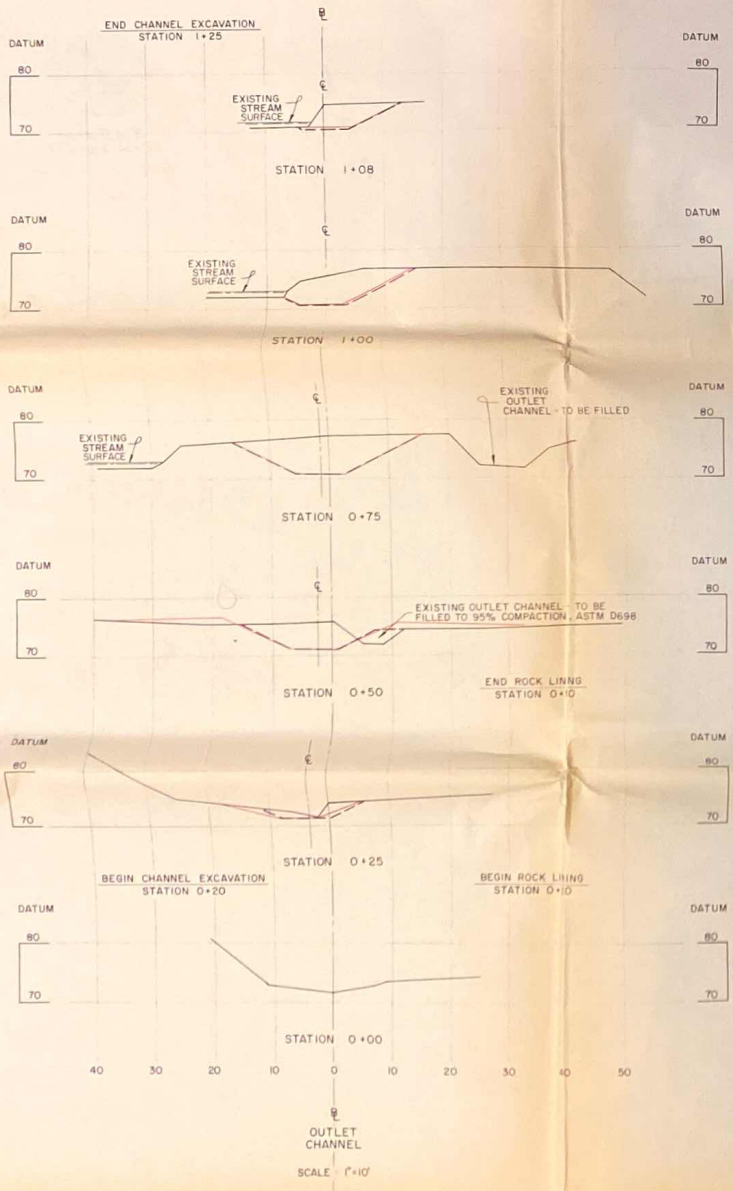
SCALE : 1" = 10'

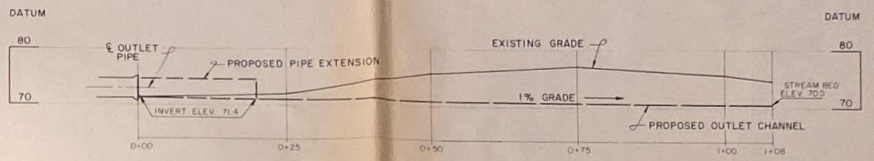
REPAIR OF PENN LAKE DAM

BOROUGH OF PENN LAKE PARK
DENNISON AND BEAR CREEK TOWNSHIPS
LUZERNE COUNTY, PENNSYLVANIA

EMBANKMENT CROSS-SECTIONS

SCALE AS SHOWN DRAWN BY G.A.A	F.T. KITLINSKY & ASSOCIATES, INC Consulting Geotechnical Engineers Harrisburg, Pennsylvania	DATE MAR 30, 1984 DWG. NO. 5





PROFILE ALONG CHANNEL CENTERLINE

SCALE: 1" = 10'

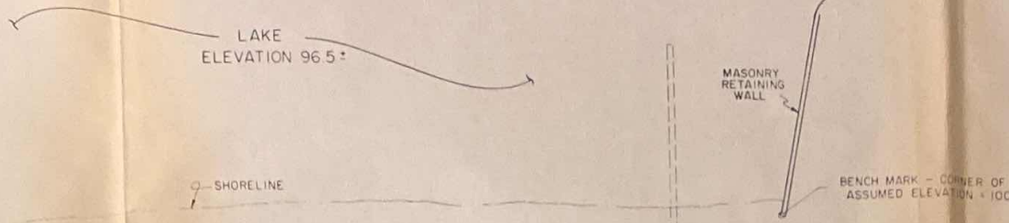
REPAIR OF PENN LAKE DAM

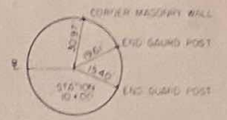
BOROUGH OF PENN LAKE PARK
DENNISON AND BEAR CREEK TOWNSHIPS
LUZERNE COUNTY, PENNSYLVANIA

OUTLET CHANNEL
CROSS-SECTIONS and PROFILE

SCALE: AS SHOWN DRAWN BY: G.A.A.	F.T. KITLINSKI & ASSOCIATES, INC. Consulting Geotechnical Engineers Harrisburg, Pennsylvania	DATE: MAR. 30, 1984 DWG. NO. 6

REFERENCE
STATION 14+00





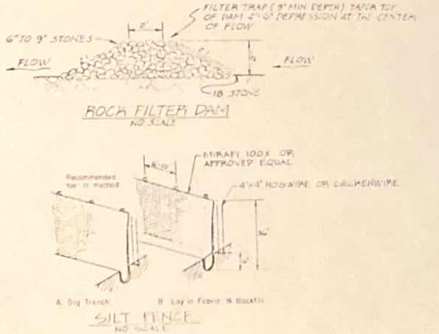
REFERENCE
STATION 10+00

ChC - Chenango gravelly loam
(8 to 15 percent slope)

OpD - Oquaga and Lordstown
extremely stony silt loam
(8 to 25 percent slope)

WmB - Wellsboro very stony silt loam
(3 to 8 percent slope)

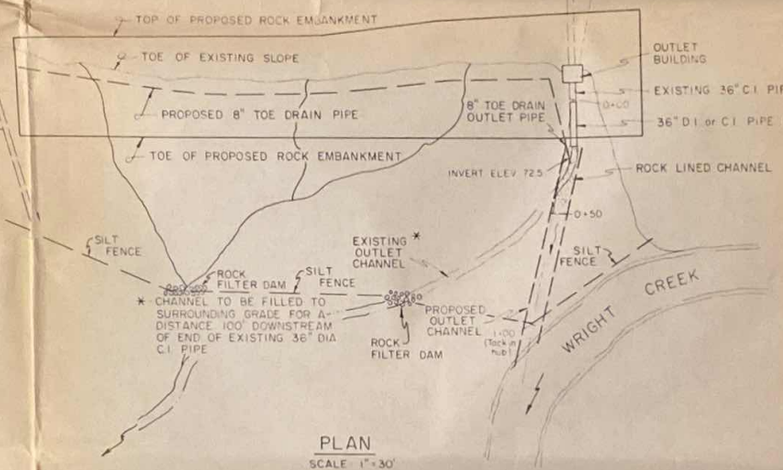
SOIL TYPES
SCALE 1" = 1667'



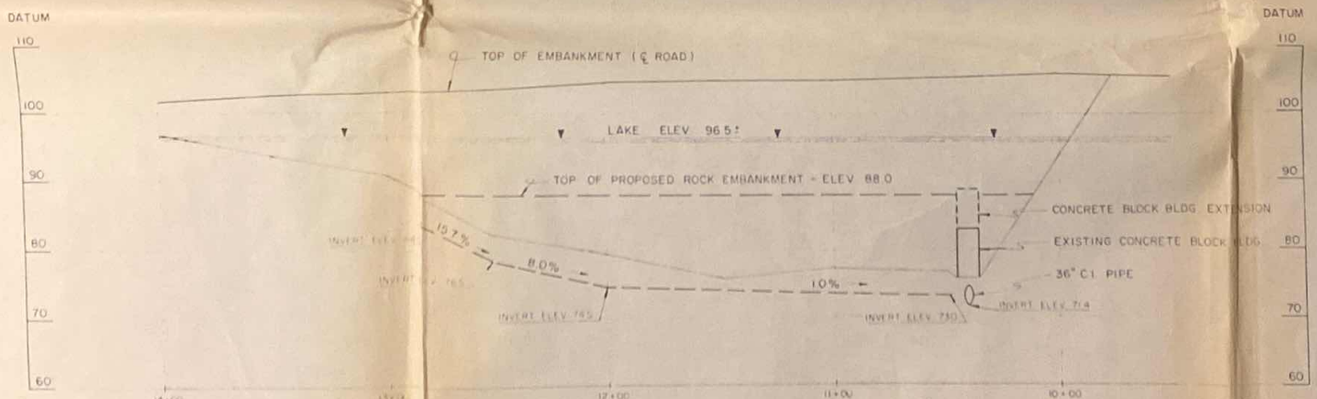
ROCK FILTER DAM
NO SCALE

SILT FENCE
NO SCALE

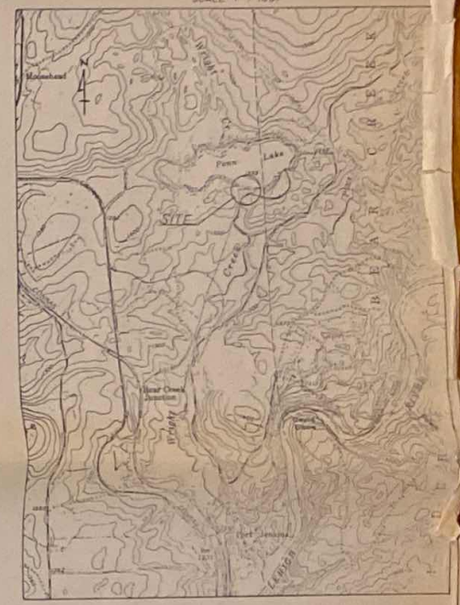
PROPOSED
2' BOTTOM
DRAINAGE
DITCH
(DELETED)



PLAN
SCALE 1"=30'



PROFILE
HOR SCALE 1"=30'
VERT SCALE 1"=10'



LOCATION MAP
SCALE 1" = 2000'

REPAIR OF PENN LAKE DAM

BOROUGH OF PENN LAKE PARK
DENNISON AND BEAR CREEK TOWNSHIPS
LUZERNE COUNTY, PENNSYLVANIA

EROSION & SEDIMENTATION CONTROL PLAN

SCALE		DATE
AS SHOWN	F.T. KITLINSKI & ASSOCIATES, INC.	MAY 30, 1980
DRAWN BY	Consulting Geotechnical Engineers	DWG. NO.
G.A.A.	Harrisburg, Pennsylvania	7