DELAWARE RIVERKEEPER NETWORK

July 17, 2020

VIA ELECTRONIC MAIL
Southeast Region: Waterways & Wetlands Program Manager
Pennsylvania Department of Environmental Protection
2 East Main Street
Norristown, PA 19401
ra-epww-sero@pa.gov

Re: Headquarters Road over Tinicum Creek Replacement Project
Permit No. E0901120-026, Pennsylvania Department of Transportation

Dear Recipient,

The Delaware Riverkeeper Network and Maya van Rossum, the Delaware Riverkeeper, submit the following comment in opposition to the Joint Permit Application ("Application") submitted by Pennsylvania Department of Transportation ("PennDOT") Engineering District 06. PennDOT proposes to demolish the historically invaluable Headquarters Road Bridge (also known as Sheephole Bridge or Burnt Mill Bridge) along Tinicum Creek located in the Ridge Valley Rural Historic District in Tinicum Township, Bucks County, and construct a modern two-lane bridge in its place (hereinafter, the "Project").

The Headquarters Road Bridge was built in 1812 as a pier-to-pier bridge, as a part of a historic horse-powered agricultural community in a uniquely hilly valley setting. Tinicum Creek serves as the defining feature of this area. Tinicum Creek is listed in Pennsylvania as an Exceptional Value ("EV") stream, *see* 25 Pa. Code. § 93.9e, and federally as a Scenic River, 16 U.S.C. § 1274(a)(165)(A)(vi). The community was registered in 1992 as the Ridge Valley Rural Historic District in the National Register of Historic Places.[1]

The historic district was first established as an agricultural community in the late eighteenth century, and the Headquarters Road Bridge provided a vital commercial link for its residents, possibly initially constructed as a wooden covered bridge. In 1919, as the automobile became a more common means of conveyance, the superstructure of Headquarters Road Bridge was replaced with a concrete deck, while the original abutments and piers remained. Around this time, as modern farming techniques rendered the steep-sloped district less suitable for farming, notable members of the New York art community began purchasing

[1] Nat'l Park Serv., U.S. Dept. of the Interior, National Register of Historic Places Registration Form for Ridge Valley Rural Historic District, 1992 (hereinafter "National Register Ridge Valley Registration Form").

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property in the area due to its scenic beauty. Since that time, Headquarters Road Bridge has continued to serve the district not only as a relic of history, but as a vital element of the aesthetic experience of living in and traveling through Ridge Valley. In its registration, the Ridge Valley Rural Historic District was specifically noted for the "fine collection of six bridges" as an "important element" of the district.[2] In 2011, Headquarters Road Bridge was closed to traffic due to the deterioration of the concrete deck.

In 2002, the Delaware Valley Regional Planning Commission's Transportation Improvement Program ("TIP") identified funding for the Project, and PennDOT began evaluating options for completing the Project. PennDOT and the Federal Highway Administration ("FHWA") began the scoping process for the Project pursuant to Section 4(f) of the Department of Transportation Act of 1966.[3] In 2006, the Keeper of the National Register of Historic Places determined that Headquarters Road Bridge was eligible for inclusion in the National Register as a contributing element to the Ridge Valley Rural Historic District, and that destruction and replacement of the bridge would result in an "adverse effect" upon the district.[4] FHWA then initiated the National Historic Preservation Act[5] Section 106 consultation process, which included consulting parties made op of federal and state agencies and officials, as well as local officials, residents, and DRN. During this process, the Pennsylvania State Historic Preservation Office found that the physical destruction of Headquarters Road Bridge would result in an adverse effect.[6] The Section 106 consultation resulted in a memorandum of agreement in 2017. In August 2018, FHWA and PennDOT concluded the Section 4(f) process and determined that the Project qualified for a categorical exclusion from the National Environmental Policy Act.[7] That decision was challenged by DRN, and the resolution of that challenge is currently pending.[8]

PennDOT's Application seeks an individual permit pursuant to the Dam Safety and Encroachments Act, 32 Pa. Cons. Stat. §§ 693.1-693.27, and its implementing regulations, 25 Pa. Code Chapter 105, a water quality certification pursuant to the federal Clean Water Act Section 401, 33 U.S.C. § 1341, and coverage under the state-administered general dredge and fill permit, PASPGP-5, pursuant to the Clean Water Act Section 404, 33 U.S.C. § 1344. The Pennsylvania Department of Environmental Protection ("PADEP") must deny this application because the Project will have an adverse impact on the public natural resources,[9] it will infringe upon the rights of the People enumerated in the Pennsylvania Constitution,[10] it will cause substantial erosion to the bed and banks and thus the water quality of Tinicum Creek,[11] and the Project is based on an unreasonable rejection of a less historically and environmentally destructive option.[12] In addition, PADEP cannot grant PennDOT coverage for the Project under Pennsylvania State General Permit-5 until both the United States Army Corps of Engineers and the National Park Service complete their substantive review and approvals of the Project.[13]

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[2] *Id*
[3] 49 U.S.C. § 303.
[4] Nat'l Park Serv., Dep't of the Interior, Determination of Eligibility Notification for Headquarters Road Bridge (AKA Burnt Mill Bridge) (Apr. 28, 2006) (hereinafter "Headquarters Road Bridge Determination of Eligibility").
[5] 154 U.S.C. §§ 300101, *et seq.*
[6] Letter from Douglas C. McLearen, Chief, Div. of Archaeology and Prot., Pa. State Historic Preservation Office, to Brian Thompson, Director, Bureau of Project Delivery, Pa. Dep't of Transp. (July 22, 2016).
[7] 42 U.S.C. §§ 4321–4370h.
[8] *See Delaware Riverkeeper Network v. Pa. Dep't of Transp.* (E.D. Pa. No. 2:18-cv-04508).
[9] *See* 25 Pa. Code. § 105.16(c)(1),(4), and Section III, *infra*.
[10] *See* Pa. Const., art. I, § 27, and Section III, *infra.*
[11] *See* 25 Pa. Code. § 105.161(a)(4), and Section IV, *infra*.
[12] *See* Section VII, *infra*.
[13] *See* Sections V & VI, *infra*.

I. PADEP Must Hold a Hearing on PennDOT's Application Because the Project Involves an Increased Discharge to the Exceptional Value Tinicum Creek.

Pennsylvania's antidegradation regulations require that when a new discharge to exceptional value waters is proposed, an interested person may request a public hearing.[14] Upon such request, PADEP is required to hold the hearing.[15] On June 15, 2020, DRN requested a public hearing on the Application.[16] DRN's request for a hearing was denied by Southeast Regional Director Patrick Patterson on the basis that the regulations did not require a hearing.[17] DRN hereby requests reconsideration of its original request.

The Project, if carried out, would result in "new, additional or increased discharge to Exceptional Value Waters."[18] Tinicum Creek is an Exceptional Value water under Pennsylvania's water quality regulations.[19] PennDOT's Application makes clear that the Project will involve new, additional, and increased discharges. First, the Project is required to obtain a Clean Water Act Section 404 permit, which is a permit that allows discharge of dredge or fill material. In addition, according to the Environmental Assessment submitted by PennDOT, the Project involves the replacement of two existing drainage pipe outlets and "will result in a 249 cu-ft runoff increase during the 2-Year/24-hr storm event."[20] In addition, three new stormwater inlets are proposed, which will collect runoff that previously traveled overland into the stream, and discharge stormwater into Tinicum Creek via a drainage pipe.[21] Furthermore, the displacement of the bridge to a new location, along with increased stormwater runoff from the expanded bridge footprint, will result in high levels of stream erosion and associated turbidity and sedimentation, increasing the nonpoint source pollution discharges.

Thus, the project clearly involves new, additional, or increased discharge to the Exceptional Value Tinicum Creek, and PADEP's regulations require a public hearing based upon DRN's multiple requests during the public comment period.

II. PennDOT's Application for a Chapter 105 Individual Permit and Section 401 Water Quality Certification Should Not Be Granted Because it is Administratively Deficient.

PADEP cannot approve PennDOT's Application for a Chapter 105 permit or a Clean Water Act Section 401 Certificate because the Application is incomplete and inaccurate.[22] "An application for a permit is complete when the necessary information is provided and requirements under the act and this chapter have been satisfied by the applicant."[23] PennDOT's Application is missing vital information necessary for PADEP to evaluate the Project, including an accurate and updated Hydrologic & Hydraulic Study based on the current proposed plans, complete signed and dated engineering and site plans, a stormwater management analysis, and a post-construction stormwater management plan. In addition, the Application is inaccurate in several important respects, including: the alleged 0.44-acre area of disturbance is a significant underestimate; PennDOT discounted their stormwater contribution and erroneously answered "no" to question 6.0 on page

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[14] 25 Pa. Code § 93.4c(b)(1)(ii).
[15] *Id.*
[16] E-mail with attached letter from Maya van Rossum, the Delaware Riverkeeper, to Patrick Patterson, Regional Director, PADEP (June 15, 2020).
[17] E-mail from Patrick Patterson, Regional Director, PADEP, to Maya van Rossum, the Delaware Riverkeeper (June 17, 2020).
[18] 25 Pa. Code § 93.4c(b)(1)(ii).
[19] 25 Pa. Code. § 93.9e.
[20] Joint Permit Application, Environmental Assessment at 17.
[21] Joint Permit Application, Environmental Assessment at 16-17.
[22] *See* 25 Pa. Code § 105.21(a)(1).
[23] 25 Pa. Code § 105.13a(a).

four of the Application when asked whether the project will involve discharge of stormwater to a surface water; the Environmental Assessment inaccurately states no risks of impacts to the downstream stream bed and stream banks; and application materials claim to "increase" the free-flowing nature of Tinicum Creek when the stream currently exists in a free-flowing condition with no impediments to biological movement through the bridge section. Finally, the applicant failed to complete the application as instructed. For instance, required items in checklists and forms were left blank instead of including either relevant information or "NA" as required.

A. Site Plans

Applications "must be accompanied by information, maps, plans, specifications, design analyses, test reports and other data specifically required under [Chapter 105] and additional information as required under the Department to determine compliance with this chapter."[24] Required information includes a site plan, which must contain, among other things: a "complete demarcation of the floodplains and regulated waters . . . on the site"; "existing roads, utility lines, lots, other manmade structures and natural features such as contour lines and drainage patterns"; "proposed structures or activities included in the project, which shall be identified by labeling"; and "a cross sectional view of the regulated waters to be impacted before and after the structure or activity is constructed."[25] Certification of the final site plans is required: "Plans, specifications and reports accompanying applications for any category of dams, or for bridges and other water obstructions or encroachments which would pose a threat to human life or substantial potential risk to property shall be affixed with the seal of a registered professional engineer and a certification, signed by the registered professional engineer . . . ."[26]

In PennDOT's application, the site plans fail to show existing conditions of the bridge in plan view with the necessary and routine information such as positions and distances, instead obscuring those existing conditions with the proposed replacement bridge such that little or no information on the existing bridge can be identified from the submitted plans. Similarly, the critical information for both the existing bridge and the proposed bridge are not provided such as station positions for the bridge openings that are needed for modeling of the hydrology and hydraulics under both scenarios. Likewise, the incomplete plan set fails to document and characterize all of the sensitive environmental resources and the activities which threaten those resources. In addition, the Site-Specific Drawings uploaded by the applicant on May 20, 2020, (as documented in the permit file) fail to include the certification, signature, or seal by the qualified engineer responsible for preparing the plans.

B. Engineering Plans

When submitting an application for the construction of a bridge, an applicant must include "[p]lans showing the location, type, size and height of the proposed bridge . . . and detailing the topographic features, elevations and structures so as to enable an appraisal of the hazard potential of the structure."[27] This information is customarily found in engineering plans, which PennDOT failed to provide in its application. The application must also provide a "hydrologic and hydraulic analysis which shall include: data on size, shape and characteristics of the watershed; the amount and frequency of the design flood; the hydraulic capacity of the structure; the hydraulic capacity of the channel upstream and downstream; and, where flooding is a problem, flood damage and backwater analysis."[28] As explained in Section II.F of this comment, *supra*,

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[24] 25 Pa. Code § 105.13(e).
[25] 25 Pa. Code § 105.13(e)(1)(i).
[26] 25 Pa. Code § 105.13(j).

PennDOT's Hydrologic & Hydraulic Analysis is deficient. Indeed, multiple substantive omissions were documented by an independent engineering firm.[29]

C. Stormwater Management Analysis

A stormwater management analysis is required for this project, and the analysis must be included in the permit application materials: "an analysis of the project's impact on the Stormwater Management Plan and a letter from the county or municipality commenting on the analysis shall be included."[30] Instead of providing the analysis for both PADEP review and for possible review by the public, the applicant instead included only a simple two-sentence statement that the analysis was prepared and shared with the local municipality: "A stormwater management analysis was performed and a consistency request letter was sent to the Tinicum Township Zoning Officer for review and approval on January 14, 2020. Tinicum Township provided approval on May 1, 2020. The Consistency Letter and approval are attached." For any stream in the Commonwealth, such disregard for public disclosure of a major environmental threat is unacceptable. For the highest levels of anti-degradation streams, such as the EV Tinicum Creek here for this project, this is a blatant disregard for the protections to water quality and the full Clean Streams Laws and Clean Water Act protections afforded by the anti-degradation designation.

D. Post-Construction Stormwater Plans

PADEP's Chapter 105 regulations require an applicant to comply with Chapter 102 by preparing an erosion and sediment ("E&S") control plan.[31] Chapter 102 provides, in turn, that "a person proposing a new earth disturbance activity that requires permit coverage under this chapter *or other new Department permit that requires compliance with this chapter* shall be responsible to ensure that a written [post-construction stormwater management ("PCSM")] Plan is developed, implemented, operated and maintained in accordance with this section."[32] This plan must be separate from the E&S plan.[33] The goals of a PCSM plan are to "preserve the integrity of stream channels and maintain and protect the physical, biological, and chemical qualities of the receiving stream," "prevent an increase in the rate of stormwater runoff," "minimize any increase in stormwater runoff volume," "minimize impervious areas," "maximize the protection of existing drainage features and existing vegetation," "minimize land clearing and grading," "minimize soil compaction," and "utilize other structural or nonstructural [best management practices ("BMPs")] that prevent or minimize changes in stormwater runoff."[34]

PennDOT's application fails to include a separate PSCM Plan along with its E&S Plan, contrary to the explicit requirements of Chapter 102. This omission is not merely a harmless oversight—the Project involves a notable increase in impervious surfaces, which will cause an increase in both the rate and volume of stormwater runoff for decades after construction is complete. In addition, one of the greatest environmental risks associated with the current project relates to the downstream riparian corridor. Chapter 102 requires the PSCM Plan to address riparian buffer impacts and to manage risks to the riparian buffers.[35]

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[29] Rippled Waters Engineering "Technical Expert Report regarding Environmental Impacts related to the Headquarters Road Bridge Replacement Tinicum Township, Bucks County, Pennsylvania;" report issued July 16, 2020 (hereinafter "Rippled Waters Engineering 2020")
[30] 25 Pa. Code. § 105.13(1)(v).
[31] *See* 25 Pa. Code § 105.46(a).
[32] 25 Pa. Code § 102.8(a) (emphasis added).
[33] 25 Pa. Code § 102.8(d).
[34] 25 Pa. Code § 102.8(b).
[35] 25 Pa. Code § 102.8(f)(14).

E. Outdated Analyses

It is critical to highlight that the current Hydrologic & Hydraulic Study is both outdated and lacks sufficient and consistent technical details to assess the erosion impacts of the PennDOT proposal. An independent engineering review concluded that the problems with the Hydrologic & Hydraulic Study were so significant that "Urban Engineers should review all of their data for consistency and accuracy and revise the modeling and design as necessary to ensure the project does not result in degradation of the creek and resubmit the applications for technical review."[36]

The Hydrologic & Hydraulic Study by Urban Engineers was finalized in July 2019. Since that time, there have been multiple significant changes to the proposed project that will affect the flow of water and the velocities and scour of that water at and around the Headquarters Road Bridge. These include the addition of a retaining wall in the floodplain along the western approach road as well as multiple revisions to the grading, scour protection, and demolition of existing structures of the bridge, particularly at and around the western bridge abutment. These changes can be seen in a comparison between the plans included in the July-2019 Hydrologic & Hydraulic Study[37] and the updated May-2020 plans submitted with the permit application.[38] Particularly because of the significant controversy about erosion of the stream bed and stream banks along this western bank, these design modifications may have large impacts on the velocities, scour, and erosion of the bed and banks of Tinicum Creek. Combined with inconsistencies and other problems in the Hydrologic & Hydraulic Study[39], the environmental impacts from the Project as currently designed cannot be evaluated and assessed.

The Erosion & Sediment Control Plan also was significantly updated based on changes to the bridge approach and the bridge structure, with the current revision dates to the Erosion & Sediment Control Plan as May 4, 2020. These revisions are relevant to the structures, the erosion of soils and sediment, and the environmental impact from these activities. However, the Bucks County Conservation District has not seen or approved these revisions. The BCCD approval occurred 3 months prior to these revisions with plans dated January 3, 2020. Given the important changes to the project plan, and the requirement for the county conservation district to review any updated plans, the current approval of the Erosion & Sediment Control Plan is out of date and invalid for the current project proposal. The independent engineering review of these plans likewise concludes that the outdated and missing information requires resubmission: "the full plans and calculations should be resubmitted to the Bucks County Conservation District for a new review to ensure that the design is in compliance with the Chapter 102 standards. The plans approved by the Conservation District were inconsistent with the latest plans provided to RWE for review and all information and documentation should be re-reviewed."[40] PADEP has an independent duty to evaluate the Erosion and Sedimentation Control plan for compliance with Chapter 102, as Chapter 105 mandates compliance with Chapter 102, and PennDOT's request for coverage under PASPGP-5 requires PADEP to evaluate these plans as well. Again, the permit application cannot be evaluated in its current form to accurately assess environmental impacts and compliance.

Finally, the assessment of threatened and endangered species is on the verge of expiration. With continuing surveys and data submissions on the distribution of important at-risk species in the Commonwealth, old assessment can be particularly problematic. The submitted PNDI Date of Review is

[36] Rippled Waters Engineering 2020 at 8
[37] Urban Engineers, "Type, Size, and Location; sheet 1 of 2" at 3450
[38] Site-Specific Drawings or Standard Drawings in permit application, "General Plan and Elevation, sheet 1 of 48" at 9
[39] Rippled Waters Engineering 2020

[40] Rippled Waters Engineering 2020 at 18

8/8/2018, with a qualification that determinations and responses are valid for only two years. Thus, within weeks of the comment deadline, and during the period in which PADEP and other agencies will be reviewing the environmental impacts from this project, the current PNDI search will expire.

F. Insufficient Detail in Hydrologic & Hydraulic Study

The current Hydrologic & Hydraulic Study is both outdated and lacks sufficient and consistent technical details to assess the erosion impacts of the PennDOT proposal. Most relevant to the erosion impacts on the downstream riparian corridor is the failure to model the flow velocities at the level of detail that is needed to assess the impacts from the Project.

The current Hydrologic & Hydraulic Study is a simple one-dimensional HEC-RAS study that provides coarse measurements of flow, such as average flow velocity, and fails to provide location-specific velocities that would be relevant to answer questions on the specific increase in velocity at each position along the downstream western stream bank of Tinicum Creek. Clearly, PADEP has the authority to require such location-specific detail be included in the Hydrologic & Hydraulic Study.[41] In this instance, it is impossible to accurately assess the full extent of the erosion of the bed and bank downstream of the bridge without this two-dimensional model and the location-specific estimates of flow under existing conditions vs proposed conditions.[42] Thus, while the Hydrologic & Hydraulic Study from PennDOT confirms the downstream risks to the stream bed and banks, it fails to properly document existing and future conditions in a manner that allows PADEP and the public to fully assess these impacts.

G. Inaccuracies

PennDOT's Application contains numerous inaccuracies, inconsistencies, exaggerations, and fallacious statements that render the application materials illegitimate for considering the environmental impacts accurately and completely. Here, we detail some of the most important and most egregious.

The Environmental Assessment is among the documents that most severely misrepresents the environmental impacts, and is replete with inaccuracies and exaggerations. As documented earlier in our comments, the largest and most severe of these misrepresentations is a complete failure to acknowledge the impacts from moving the bridge abutments 15 feet westward and the indirect impacts this will cause for erosion of stream banks and the riparian corridor. As the Environmental Assessment correctly points out, "Indirect impacts consist of altering the chemical, physical or biological components of an aquatic resource to the extent that changes to the functions of the resource results; indirect impacts do not result in a loss of resource acreage."[43]

Yet DRN clearly demonstrates (see detailed discussion below) that moving the bridge abutments 15 feet (nearly equal to the width of the downstream riparian corridor) will increase the velocities near-bank and direct the water flow at the stream bank. This will erode the stream bank and riparian corridor, affecting both the physical as well as the biological components of the Tinicum Creek ecosystem. Instead of documenting these indirect impacts, every entry in the Environmental Assessment for indirect impacts is stated to be Zero. Not a single square foot or linear meter of stream bank or riparian corridor is acknowledged as being at risk for impacts from the movement of the bridge abutments that then directly aligns the flow for erosion of the downstream bed, bank, and forested corridor. PennDOT and its consultants go even further and completely and categorically deny the possibility of impacts to the riparian corridor:

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41 25 Pa. Code § 105.151(4).
42 Rippled Waters Engineering 2020 at 18
43 Joint Permit Application, Environmental Assessment at 10.

> *The upstream and downstream riparian properties consist of forested areas, dense herbaceous vegetation, pasture, and residential lawn. As discussed below, the impacts from the subfacilites are not anticipated to affect or change the use, aesthetics, hydrologic, biogeochemical, or ecology of the upstream or downstream riparian properties.*[44]

PennDOT grossly misrepresents the environmental impacts in a document that is required to fully and candidly acknowledge the environmental risks, impacts, and remediation measures.

Another repeated exaggeration on the part of PennDOT and its consultants in the Environmental Assessment (and elsewhere in the application package) is the claim for positive effects on free-flowing nature of Tinicum Creek. Here is an environmental benefit being claimed by PennDOT through the reduction from two piers to one pier for the bridge. Yet there exists no biological impediments to the free-flowing nature of Tinicum Creek at the Headquarters Road Bridge. Neither migratory fish, nor resident fish, nor invertebrates or any other group of biological organisms encounter a migration issue at the Headquarters Road Bridge in its current configuration. In fact, observations by DRN staff over two decades at the bridge have consistently shown a lack of any impediments to the free-flowing condition of Tinicum Creek, including snorkel surveys where resident fish were observed to move unimpeded from below the bridge to above the bridge. At times, even PennDOT's submissions acknowledge that Tinicum Creek currently exists in a free-flowing state.[45] It appears that PennDOT seeks to claim environmental benefits when, in fact and as demonstrated herein, the PennDOT proposal will lead to significant environmental impacts to Tincum Creek both near-term and far into the future.

Central to the assessment of environmental impacts from this project is the changes to the flow in Tinicum Creek brought about by shifting the bridge abutments westward (see detailed discussion below). It is particularly striking and problematic, therefore, that the proposed extent of this movement is impossible to ascertain from the permit application submissions. This is related, in part, to the failure of the applicant to submit complete and updated site and engineering plans for the proposed project. Yet the drawings that have been submitted also fail to provide the details that would allow an assessment of environmental impacts. The Existing Conditions provide the surveyed station positions of each of the current features (piers, abutments). However, the Proposed Conditions fail to provide the corresponding proposed station positions of each of the proposed features. As a result, the distance that the bridge abutments are proposed to be moved cannot be determined accurately or precisely.

From our calculations using partial data provided on these plans and estimation using the scales of the drawings, it appears that the bridge abutments are moved between 15.5 and 17.5 feet for the western bridge abutment, and between 10.0 and 12.0 feet for the eastern bridge abutment.[46,47,48] Similarly, the application materials quantify the existing bridge opening with different numbers and dimensions for different submissions. These inconsistencies and incomplete submissions call into question the validity of all analyses that are based on the proposed bridge conditions, including the Scour Calculations, the Hydrologic &

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44 Joint Permit Application, Environmental Assessment at 14.

45 Joint Permit Application, Environmental Assessment at 101 & 117

46 Rippled Waters Engineering 2020 at 9

47 note: although the exact distance the bridge abutments are proposed to be shifted westward cannot be determined based on the applicant's current submission, DRN will use the stated movement of 15 ft for the western bridge abutment while acknowledging that this shift may be substantially greater

48 note: the eastern bridge abutment moving out into the floodway and stream channel itself is a violation of Chapter 105 regulations; see 25 Pa Code § 105.164

Hydraulic Study, the Anti-Degradation Analysis, and the Environmental Assessment itself. Again, the magnitude of these problems is such that an independent engineering firm concluded that the consultant for the Hydrologic & Hydraulic Study "resubmit the applications for technical review."[49]

The Anti-Degradation Analysis likewise contains multiple inaccurate statement or misrepresentations of facts. Central among them is an underestimate for the Limit of Disturbance for construction activities. As detailed in the attached independent engineering report, the Limit of Disturbance has been significantly underestimated for this project, with many key features omitted from the analysis.[50] The underestimation is so significant that the true extent of the Limit of Disturbance could even exceed 1 acre, triggering additional environmental reviews and requirements.[51] The Limit of Disturbance is likewise mis-represented in other parts of the submission, including the Erosion & Sediment Control Plan.

The Anti-Degradation Analysis likewise misrepresents the extent and efficacy of the efforts to protect water quality through erosion and scour protection measures. The report states "The existing stream bank on the southwest quadrant will be stabilized as a part of this project by installing rock protect choked [sic] with streambed materials. This will reduce the chance of future streambank erosion."[52] Yet a review of all plans, including those provided in the Anti-Degradation Analysis itself, show that the use of conventional engineering protections (e.g., rip-rap, grout) extend only around the bridge features themselves, including 25 feet downstream from the proposed bridge. Instead of protecting the stream bank from erosion, as stated, these efforts simply are designed to protect the bridge infrastructure. The stream bed, stream banks, and the riparian corridor for 200 feet and more downstream in the direct and immediate path of high flows remain unprotected by any proposed stabilization or mitigation measures. Instead of protecting these resources in an anti-degradation EV stream, the proposed project threatens these very resources by putting them directly in harm's way and failing to take appropriate measures after introducing a new threat to their integrity.

Finally, the applicant appears to misrepresent the National Historic Preservation Act Section 106 consultation process and dates. The date of October 20, 2002, does not appear to be correct, and this date does not match records from outside agencies (e.g., Delaware Valley Regional Planning Commission).

III. PADEP Cannot Issue a Chapter 105 Permit for the Project Because it Will Have an Adverse Impact on Public Natural Resources and Will Infringe on the People's Right to the Preservation of the Natural, Scenic, Historic and Esthetic Values of the Environment Contrary to Article I, Section 27 of the Pennsylvania Constitution.

In clear and unequivocal language, PADEP's Chapter 105 regulations prohibit the issuance of a permit within a National scenic river or an exceptional value water "unless the applicant demonstrates and the Department finds that the project will not have an adverse impact upon the public natural resources."[53] "Public natural resources" is not defined in Chapter 105, but is used in Pennsylvania's Green Amendment, Article I, section 27 of the Pennsylvania Constitution, which is expressly incorporated in PADEP's Chapter 105 regulations.[54] That amendment provides:

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[49] Rippled Waters Engineering 2020 at 8
[50] Rippled Waters Engineering 2020 at 15
[51] *Id.*
[52] Joint Permit Application, Antidegradation Analysis at 8
[53] 25 Pa. Code § 105.16(c)(1), (4).
[54] *See* 25 Pa. Code § 105.2(4).

> *The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.*[55]

As explained throughout this comment, the Project will have an adverse impact upon Tinicum Creek due to the erosion that will occur once the historic Headquarters Road Bridge is destroyed and the modern two-lane bridge is constructed. This adverse impact means that PADEP cannot approve the Project as it currently stands, as it is strictly prohibited from doing so by Section 105.16(c).[56]

PADEP also has a constitutional duty to conserve and maintain the public natural resources, explicitly recognized as an integral part of its implementation of Chapter 105.[57]In his groundbreaking plurality opinion in *Robinson Township, Delaware Riverkeeper Network v. Commonwealth of Pennsylvania,*[58] Chief Justice Castille explained that the drafters of Article I, Section 27 "left unqualified the phrase public natural resources, suggesting that the term fairly implicates relatively broad aspects of the environment, and is amenable to change over time to conform, for example, with the development of related legal and societal concerns. The concept of public natural resources includes not only state-owned lands, waterways, and mineral reserves, but also resources that implicate the public interest, such as ambient air, surface and ground water, wild flora, and fauna (including fish) that are outside the scope of purely private property."[59] Tinicum Creek, as well as its bed, banks, and riparian areas, are included in the public natural resources.

PADEP has a constitutional "duty to refrain from permitting . . . the degradation, diminution, or depletion of public natural resources, whether such degradation, diminution, or depletion would occur through direct state action or indirectly, *e.g.* because of the state's failure to restrain the actions of private parties."[60] Here, the relevant third party is another agency of the Commonwealth—PennDOT. Therefore, both PADEP and PennDOT must fulfill the constitutional duty to comply with Article 1, Section 27. In the context of this Application, PADEP must be vigilant in preventing not only "actions with immediate severe impact on public natural resources," but also "actions with minimal or insignificant present consequences that are actually or likely to have significant or irreversible effects in the short or long term."[61] As documented in this comment, there will be degrading consequences of the proposed project, including that over time the increased velocity will destroy the river-right riparian area and potentially destroy the historic pasture beyond the current riparian buffer. This erosion will also harm water quality by increasing the sediment load in Tinicum Creek and potentially damaging the special hard-bottom habitat that is suited for warm water aquaculture.

Pennsylvania's Green Amendment also protects the right of the People to the "preservation of natural, scenic, historic and esthetic values of the environment."[62] The right to preservation "implicates a holistic analytical approach to ensure both the protection from harm or damage and to ensure the maintenance and perpetuation of an environment of quality for the benefit of future generations."[63] As determined by the Keeper of the National Register, Headquarters Road Bridge is a contributing property to the National Register-listed Ridge Valley Rural Historic District.

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[55] Pa. Const. Art. I, § 27.
[56] 25 Pa. Code § 105.16(c).
[57] *See* 25 Pa. Code § 105.2(4).
[58] 83 A.3d 901 (Pa. 2013).
[59] *Id.* at 955 (plurality opinion) (citation omitted).
[60] *Id.* at 957.
[61] *Id.* at 959.
[62] Pa. Const., art. I, § 27.
[63] *Robinson Twp.*, 83 A.3d at 951.

As explained by Kutztown University Professor Rob Reynolds – an expert in historic preservation –in our attached materials:

> *The current alignment of the Headquarters Road Bridge anchors the southern end of the Ridge Valley Rural Historic District. Removal of the bridge, installing a new bridge of modern design, altering the alignment, and changing the way the current bridge connects Headquarters Road, Sheep Hole Road, or Red Hill Road would be an adverse effect that could lead to delisting the district or reconfiguring the boundary for this area.*
>
> *The Headquarters Road Bridge remains an integral contributing resource of the Ridge Valley Rural Historic District. It is the oldest bridge of its type left in Pennsylvania and is one of only a few spans in America over 200 years old. The 1919 rebuilding of this bridge actually adds to, rather than detracts from, the integrity of the structure. Those renovations tie this span to a larger transformation of creek crossings in the Ridge Valley Historic District, which mostly date to the early auto era. The demolition of this span and the installation of a modern bridge will cause an irreparable adverse impact to the stellar collection of creek crossings, which form the central axis of the Ridge Valley Rural Historic District.*

In addition, the Ridge Valley Rural Historic District features "winding dirt roads, stone farmsteads and outbuildings, fields and meadows" which are "found in visual harmony with the intact and undisturbed wetlands and woodlands," features that "provide an outstanding context for the district's architecture."[64] As noted in our comments and expert reports, demolition and of the Headquarters Road bridge will have cascading effects on many of the Historic District's key landscape, ecological and historic elements.

The Headquarters Road Bridge is a part of a Township wide collection of bridge types unequalled anywhere else in the Commonwealth, or potentially the nation. This collection documents and demonstrates the evolution of waterway crossings from the ford through a variety of distinguished examples of early bridge types, pillar, wooden and metal trusses of many types from all eras, arched and early concrete deck structures. As such, demolition of this bridge does not just destroy the structure itself, but it removes a key part of an existing, live demonstration of history and the evolution of bridges that are a part of the founding of this nation.

Destroying this historic collection of crossings, critical landscape elements of the Ridge Valley Rural Historic District (e.g. the historic pasture), and potentially the district designation itself, by allowing the demolition of Headquarters Road bridge and the cascading stream and landscape affects, rises to the level of a constitutional violation, particularly given that there is an alternative that can fulfill the project need and avoid these significant harms.

"The corollary of the people's Section 27 reservation of right to an environment of quality is an obligation on the government's behalf to refrain from unduly infringing upon or violating the right . . . ."[65] Given that there is another option that preserves the bridge, preserves the states' natural resources, including the scenic, historic and esthetic values of the environment, and fulfills the transportation and safety needs of the community, there is clearly an alternative path demonstrating that the proposed demolition and construction proposal is a clear case of the state (PennDOT and PADEP) unduly infringing on the constitutional rights of the people of Pennsylvania.

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[65] *Id.* at 952.

Pennsylvania's Green Amendment does not require that every old structure remain untouched or that Pennsylvanians remain trapped in a time capsule and never update buildings or infrastructure. At the very minimum, however, where a structure has been nationally recognized as contributing to a unique and valuable historic district, where the structure's removal would adversely impact the district and historic values of the surrounding environment, where the structure's demolition would forever destroy an otherwise intact unique collection of historic structures, and where it has been established that that structure can be rehabilitated in a historically and ecologically sensitive manner to serve its functional purpose, the destruction of that resource would be a violation of rights and duties recognized in the Pennsylvania state constitution.[66]

IV. PADEP Cannot Issue a Chapter 105 Permit for the Project Because it Will Cause Extensive Erosion to the Stream Bed and Banks of Tinicum Creek.

Inherent in any bridge repair or reconstruction work is the imperative to "do no harm." Indeed, Pennsylvania has codified such a requirement in Chapter 105:

> *The structure may not so increase velocity or direct flow in a manner which results in erosion of stream beds and banks.*[67]

Nowhere in the Commonwealth is such an imperative more critical than in our most protected anti-degradation waters, our Exceptional Value streams. In addition to the many requirements under Chapter 105 to protect streams, floodplains, and the entire riparian corridor, Chapter 93 requirements under the anti-degradation provisions require "The water quality of Exceptional Value Waters shall be maintained and protected."[68]

The Headquarters Road Bridge across Tinicum Creek has stood in its current location since 1812, a year when many of this nation's founding fathers still walked the earth (e.g., Thomas Jefferson, James Madison, John Adams). Even in the operative timeframes of fluvial geomorphology, 200 years represents a significant period of time for a controlling structure in a stream's channel form to be in place and around which the channel bed, the stream banks, the riparian corridor, and the floodplain have evolved and stabilized. Indeed, the Headquarters Road Bridge is celebrated as a contributing element to the Ridge Valley Rural Historic District precisely because the bridge and the rural landscape have remained relatively intact for over 200 years and provide a window into our nation's history.[69]

In this stable historic setting, nothing could maintain that stability and continue to protect the stream's bed and banks more than to retain this historic bridge structure in its existing position. In particular, the mature forested riparian zones downstream of the bridge exist in their current configuration because of 200 years of stream bank establishment, plant succession, and local land use that supported and maintained mature hardwood trees as the dominant component of this riparian zone. Yet while the riparian zone is composed of mature hardwood trees, the southwestern (RiverRight) riparian corridor is narrow along this historic pasture, with vegetated widths ranging from 12 feet up to only 20 feet for the first 200 feet downstream of the bridge. These specific widths are essential when considering environmental impacts of the Project. The riparian zone immediately below the bridge typically is less than 20 feet wide, and is often less than 15 feet wide. Despite a currently stable configuration among the bridge abutments, the stream banks, and the riparian

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[66] *Robinson Twp.*, 83 A.3d at 954.
[67] 25 Pa. Code § 105.161(a)(4).
[68] 25 Pa. Code § 93.4a(d).
[69] see color map attachment "Ridge Valley Rural Historic District, Contributing Parcels, Bridges, and Fords (Tinicum Township, Bucks County, Pennsylvania)"

zone, there is a narrow zone of tolerance and a precariously small riparian zone that must be protected and maintained in order to protect the health of Tinicum Creek and to fully maintain and protect the water quality of this EV stream.

Instead of recognizing and protecting the current stream bed, stream banks, and the riparian zone, the current proposal from PennDOT instead intends to shift the bridge abutments 15 feet further to the southwest (RiverRight) and directs both higher velocities and greater volumes of water directly at the narrow riparian corridor downstream of the bridge. With the downstream western riparian corridor often only 15 feet wide, it is clear that the shift of the bridge abutments 15 feet to the southwest (RiverRight) presents an existential threat to this riparian corridor. As we document below, PennDOT fails on two fronts to address this significant environmental threat. **First, the PennDOT proposal creates a clear and significant environmental risk for Tinicum Creek, its bed, and its banks.** PennDOT, however, systematically fails to acknowledge this risk, and in so doing precludes PADEP's accurate and full evaluation of the risks from the PennDOT proposal. **Second, in failing to acknowledge the risks, PennDOT further fails to plan for the impacts to the downstream riparian zone**, instead using conventional and narrowly-focused scour measures only in the immediate vicinity of the proposed replacement bridge.

Yet before we document the many failures and inadequacies of the Project, it is vital to emphasize that corrective measures to control erosion are far inferior to preventative measures that forestall the risks of erosion in the first place. As attributed to another founding father nearly 300 years ago, Benjamin Franklin once advised Philadelphia that "an ounce of prevention is worth a pound of cure." For Tinicum Creek, preventing impacts to the stream bed and banks is as simple as repairing the Headquarters Road Bridge in its current location and configuration (a task entirely feasible, as documented by both PennDOT and outside engineers; see later discussion). Through repair of the bridge in its current configuration, including the bridge abutments, there is no violation of Chapter 105 by increasing velocities and directing flows in a manner which results in erosion of stream bed and banks. This viable alternative is inappropriately dismissed in PennDOTs submissions (we also address this inappropriate dismissal below) and in so doing, PennDOT creates problems of instability and erosion which it then fails to solve. It is important to keep in mind the "prevention" approach to the environmental problems PennDOT is creating in this EV stream, where adverse impacts on the public natural resources are prohibited.[70]

The environmental risks from the Project, particularly the shift in bridge abutments 15 feet to the southwest, are clear to see and easy to document. This shift in the bridge location and the stream channel places the downstream riparian corridor (typically 15 feet wide in the downstream reach, as noted above) directly in the path of high flow velocities and the full force and volume of flood waters, conditions which do not exist with the existing conditions and the historic abutments and piers in their current configuration. This shift in the location of the abutments and the flow of Tinicum Creek will cause erosion of stream bed and stream banks in clear violation of Chapter 105 regulations.[71] The proposed project cannot be given the relevant permits and remain compliant with the Chapter 105 regulations.

While PennDOT fails to directly comprehensively address this inevitable erosion of the stream bed and banks in their permit submission materials (see below), the documents submitted by PennDOT (as well as other materials created by PennDOT and others) nevertheless clearly show these erosional risks and impacts. First, in all of the PennDOT plans showing both the proposed western bridge abutment and the downstream riparian corridor, the continuation of the flow path along the western bridge abutment in a straight line downstream shows the stream flow directed at or even behind (i.e., further westward) of the existing

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[70] *See* 25 Pa. Code § 105.16(c)(4).

[71] *See* 25 Pa. Code §§ 105.14(b)(3), 105.16(c), 105.161(a)(4), 105.242(b).

downstream riparian corridor.[72] This is not a subtle or difficult to envision risk. By moving both bridge abutments westward, and in particular by moving the western bridge abutment 15 feet further to the west with a 15-foot wide downstream riparian corridor, the riparian corridor is now opened up to the direct path of moderate and high flows in Tinicum Creek. As noted below, PennDOT does not mitigate this risk, either, so nothing stands in the way of high velocities and flood flows from eroding the downstream stream banks and severely impacting the riparian corridor and the water quality of this EV stream.

The second source we use to clearly illustrate this stream bed and stream bank erosion is a set of visualizations both from PennDOT plans, PennDOT photos, and our own illustrated photos.[73] The first set of three images are based of the PennDOT Erosion & Sediment Control Plans, sheet 11 of 11 entitled "Stabilization Plan." In this sequence, we highlight the location of the bridge abutment, the location of the riparian corridor immediately downstream and now exposed with the shifted abutment, and then the unimpeded flow vector directed directly at the riparian corridor and stream bank because of the shift in the abutment location. The second set of two images uses an aerial drone photograph and a visualization of the 15 ft movement of the abutments to document the exposed and eroded riparian corridor downstream of the bridge. The third set of two images uses PennDOTs online visualization of the current vs proposed bridge looking downstream through the bridge opening.[74] Like in the previous aerial photos, the movement of the western bridge abutment clearly exposes and puts the downstream riparian corridor on the RiverRight in the path of the stream's new path, particularly under the higher erosive flow events such as bankfull floods. In addition, by moving both the western and the eastern bridge abutments, not just is the RiverRight exposed to higher flows, but the entire cross section is redirected further west and the force of high flow events entirely shifts westward and (like a fire hose) concentrates the force toward the western stream bank. Finally, the last four images in this attachment use GoogleEarth aerial photographs, again looking downstream, to illustrate the impacts of the bridge abutment shifts to the west. In these images, the new positions of the bridge abutments are indicated, the direction of the flow along the westward riparian corridor is shown, and then the immediate and likely long-term impacts to the riparian corridor and the adjacent pasture are visualized. These last two slides help to document the magnitude of the stream bank erosion, the extent of impacts, and the threats to the EV water quality of Tinicum Creek.

The PennDOT Hydrologic and Hydraulic Study further illustrates how the proposal increases water velocity and shifts the direction of flow to create erosion of the stream bed and stream bank.[75] This report repeatedly highlights how the bridge abutments and channel are shifted 15 feet to the west. The report also documents significant increases in flow velocities under the proposed project, with increases as high as 48% for the 10 year recurrence interval storm.[76] An independent review of the Project and an independent HEC-RAS model of the existing vs proposed conditions likewise emphasized the increase in velocity under the proposed conditions and the elevated risk for significant erosion downstream: "Given the shift of the stream channel by as much as 17.25 feet to the west of its current alignment and the average velocities in excess of 9.5 feet per second, increases in erosion downstream will result."[77]

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[72] *See, e.g.*, Joint Permit Application, Environmental Assessment Figure 1, Erosion and Sediment Control Plan, Hydrologic & Hydraulic Analysis and Report.

[73] DRN 2020 "Visualizations of Riparian Corridor & Stream Channel Impact from PennDOT Proposal for Headquarters Road Bridge"

[74] *See* Headquarters Road Bridge Renderings, https://www.penndot.gov/RegionalOffices/district-6/Pages/Headquarters-Road-Bridge-Renderings.aspx (last visited July 16, 2020).

[75] Joint Permit Application, Hydrologic & Hydraulic Study.

[76] Joint Permit Application, Hydrologic & Hydraulic Study, Table 11 Summary Data Sheet.

[77] Rippled Waters Engineering 2020 at 11

It is important to again highlight that the submitted Hydrologic & Hydraulic Study by Urban Engineers for PennDOT is both outdated and lacks sufficient and consistent technical details to assess the erosion impacts of the Project (see previous discussion). Perhaps most critical to the erosional impacts on the downstream riparian corridor is the failure to model the flow velocities at the level of detail that is needed to assess the impacts of the proposal. The current Hydrologic & Hydraulic Study is a simple 1-dimensional HEC-RAS study that provides coarse measurements of flow, such as average flow velocity, and fails to provide location-specific velocities that would be relevant to answer questions on the specific increase in velocity at each position across the stream cross sections, including near-bank along the downstream western stream bank of Tinicum Creek. Clearly, PADEP has the authority to require such location-specific detail be included in the Hydrologic & Hydraulic Study.[78] In this instance, it is impossible to completely and accurately assess the full extent of the erosion of the bed and bank downstream of the bridge without this two-dimensional model and the location-specific estimates of flow under existing conditions vs proposed conditions. Thus, while the Hydrologic & Hydraulic Study from PennDOT confirms the downstream risks to the stream bed and banks, it fails to properly document existing and future conditions in a manner that allows PADEP and the public to fully assess these impacts.

Together, these comments, documents, and submissions establish the extreme risks for erosion of the stream bed and the stream banks downstream of the proposed bridge because of the shift in the bridge abutment to put the downstream RiverRight corridor directly in harm's way. Despite the clear risks, however, PennDOT and its consultants consistently fail to acknowledge this risk in all of the submissions to PADEP for environmental permits. Their failure to acknowledge these erosion risks, however, do not eliminate the risks. Instead, it increases the likelihood for catastrophic environmental impacts as PennDOT both fails to acknowledge the risks and fails to plan or manage these risks.

The failure to acknowledge the risks permeates PennDOT's submissions for this project. The places where these risks need to be acknowledged but are not articulated or quantified are too numerous to list individually. Here we highlight important and representative failures by PennDOT to identify the risks of erosion to the stream bed and stream banks.

In the Environmental Assessment, the clearest example of PennDOT's failure is in section S3.D on page 14 of the report:

> *The upstream and downstream riparian properties consist of forested areas, dense herbaceous vegetation, pasture, and residential lawn. As discussed below, the impacts from the subfacilites are not anticipated to affect or change the use, aesthetics, hydrologic, biogeochemical, or ecology of the upstream or downstream riparian properties.*

Here, the resources at risk are directly highlighted and acknowledged. Yet the applicant categorically denies any effect or change in use for the stream bed, stream banks, and riparian corridor downstream from the shifted bridge abutments. The Environmental Analysis also repeatedly fails to acknowledge any length or area of indirect temporary or permanent impacts in all tables and quantitative summaries from the shift in the bridge abutments 15 feet to the west. In each instance, the indirect impacts are stated as "Zero" in these tables of environmental impacts. Again, PennDOT repeatedly and consistently fails to acknowledge the significant and clear risks.

[78] 25 Pa. Code § 105.151(4).

The narrative summaries likewise make broad statements that demonstrate a failure to understand and address the downstream risks. Statements include "there will be no long-term water quality impacts of the proposed structure"[79] and "there will be no long-term water quality impacts."[80] As documented here, the risks of erosion and collapse of the downstream stream bank and riparian corridor are significant and remain unaddressed. Such impacts will lead to long-term increases in sediment, turbidity, water temperature, and other water quality impacts associated with this damage. Throughout the Environmental Assessment, perhaps the greatest environmental risk from the PennDOT proposal is categorically denied.

Like in the Environmental Analysis, the Hydrologic & Hydraulic Study fails to acknowledge and document the risks of erosion to the stream bed, the stream banks, and the riparian corridor. In part (as described above) this arises from a one-dimensional model instead of a two-dimensional model that could pinpoint the specific increases in velocity and flow directed at the river-right stream bank. More broadly, the Hydrologic & Hydraulic Study concentrates only on scour and risks to the bridge structure itself. The Scour Calculations[81] state this explicitly in their objectives. In the end, the Hydrologic & Hydraulic Study concludes:

> *The proposed bridge has been designed to minimize impacts of flood flows, minimize environmental impact, and meet or exceed the safety standards that currently exist at the site. These were accomplished by decreasing the number of piers and shifting the bridge to allow better channel alignment.*[82]

Once again, PennDOT and its consultant fail to acknowledge the clear risks to the downstream stream bed, stream banks, and riparian corridor. Moreover, they contend that moving the bridge abutments decreases the environmental impact, a clear contradiction to the incredible risks this movement creates.

Only in the most recent correspondence and meetings regarding the project does PennDOT itself finally acknowledge these risks and impacts downstream, while failing to acknowledge them in the actual required permitting documents and environmental assessments submitted to PADEP directly.[83] In this recent acknowledgement, PennDOT cites the inconvenience and time delays for comprehensively addressing these significant environmental risks, including those articulated at 25 Pa. Code. § 105.161(a)(4) with respect to stream bank erosion:

> *Ryan Whittington indicated that outside of the limits of the project, there was nothing immediately planned to address the riparian corridor up or downstream. In addition to the time required to obtain additional Right-of-way to complete this work, it is further complicated by the property directly downstream being owned by a bank and not an individual. However, PennDOT would be interested in continuing the conversation about the stability of the stream banks and working with the local Wild & Scenic River sub-committee to identify grant, long-term stewardship, temporary leases etc. to address the downstream bank.*[84]

As clearly articulated at 25 Pa. Code. § 105.161(a)(4), preventing erosion of downstream stream banks is not an optional project activity anywhere in the Commonwealth that can be dealt with in a voluntary fashion

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[79] Joint Permit Application, Environmental Assessment at 3.
[80] Joint Permit Application, Environmental Assessment at 15.
[81] Joint Permit Application, Hydrologic & Hydraulic Study, Appx. H.
[82] Joint Permit Application, Hydrologic & Hydraulic Study at 19.
[83] *See*, *e.g.*, PennDOT Meeting Minutes from National Park Service Meeting, labeled in application materials as "NPS Follow-up Correspondence [sic] 2020_05_21.pdf"
[84] *Id.*

based on possible funding and agreements at some unspecified point in the future. Instead, preventing erosion of stream banks is an obligatory requirement for obtaining the necessary permits for a bridge restoration, rehabilitation, or construction project such as this. In addition, the anti-degradation provisions of Chapter 93 require additional planning, design, and implementation to maintain and protect the water quality of an EV stream such as Tinicum Creek.[85] The erosion of downstream stream banks, the damage to the riparian zone (and all attendant water quality impacts such as increased water temperature), the increase in turbidity and suspended sediment loads, and the ecological impacts to the aquatic life must be addressed during the permitting phase and not at some indefinite point in the future.

It is worth repeating: prevention is the best solution. Rehabilitating the existing piers and abutments in their current locations and configurations would prevent the extreme risks to the downstream banks and riparian corridor. Even the best remedies, once the bridge abutments were to be moved 15 feet westward, would fail to protect the stream banks and riparian corridor as well as preventing this damage in the first place.

As stated earlier, PennDOT fails on two important fronts with the assessment and response to the erosion of bed and banks. The downstream risks are clear and significant, and PennDOT fails to recognize and acknowledge these risks throughout their permitting submissions. The second important point to document is that PennDOT fails to propose appropriate measures to reduce and/or mitigate the environmental impacts that are so clearly demonstrated with the PennDOT proposal. The absence of efforts to address the impacts exist throughout all submissions:

- The project plans show only 25 feet of downstream scour protection
- The Environmental Assessment mentions not a single effort in the Mitigation Plan to address the erosion of the bed and banks downstream of the bridge
- The Hydrologic & Hydraulic Study doesn't even model the scour, much less include scour protection, beyond the immediate bridge structures
- As quoted above, PennDOT acknowledges that "nothing [is] immediately planned" in the meeting minutes of National Park Service discussions from May-2020

It is not surprising, given the failure to acknowledge the downstream risks, that such risks would not be adequately and appropriately addressed through either selection of the protective alternative (Alternative 3; see comments below) or inclusion of specific and proportional mitigation measures to address the threat. Yet this failure to both acknowledge the risk and address the risk only heightens the risk itself and increases the likelihood that the worst possibilities will become reality if the Project is permitted and built as proposed. Our documentation clearly shows that the Project as submitted is not in compliance with Pennsylvania regulations and the Project cannot be approved.

V. PADEP Cannot Issue a 401 Certification Because the Project Will Degrade Water Quality of an Exceptional Value Stream

Multiple components of the Project will directly and indirectly affect the water quality of Tinicum Creek. As an Exceptional Value stream in Pennsylvania, however, the water quality must be maintained and protected. The increase in impervious cover and stormwater volumes will increase pollutant loadings to the creek, and will elevate water temperatures from stormwater runoff. Likewise, the clearing of additional trees for a wider bridge and for the demolition and replacement of the bridge will result in reduced shading of the stream channel and further increases in water temperatures. Just as importantly, the significant

[85] *See, e.g,* 25 Pa. Code § 93.4c(b).

erosion of the downstream stream bed, stream banks, and riparian corridor caused by moving the abutments 15 ft westward will lead to a series of cascading problems that will degrade, rather than maintain and protect, Tinicum Creek's water quality. The erosion of bed and banks will initiate greater sediment loading to the creek, elevating turbidity and decreasing water clarity. The progression of this erosion will then undermine and eliminate the narrow riparian corridor on the western downstream bank. This reduction in forested canopy for an extended distance downstream, and the potential creation of a new stream channel through the adjacent pasture, will greatly decrease shading of the stream and increase light penetration. These will again lead to increases in water temperature, and the high-light conditions will risk inducing filamentous algal blooms in Tinicum Creek. These water quality changes fail to meet the requirements of Chapter 105.[86] Under Chapter 93 anti-degradation protections, these multifaceted water quality impacts are also not permissible and the Project must be denied a 401 certification.

VI. PADEP Cannot Grant PennDOT Coverage Under PASPGP-5 Until the United States Army Corps of Engineers Completes a Project Specific Review.

The United States Army Corps of Engineers ("Corps") issued PASPGP-5[87] in July 2016 pursuant to Section 404(e) of the Clean Water Act.[88]. This allows Pennsylvania to administer the statewide 404 general permit in conjunction with its own regulatory programs to protect water resources, for projects that impact less than one acre of waters of the United States or 1000 linear feet or less of permanent loss to stream channels, so long as they comply with the terms, conditions, and processing procedures identified in PASPGP-5.[89] In addition, PASPGP-5 "does not obviate the need to obtain other Federal, State, or local authorizations required by law."[90]

A project can obtain coverage under PASPGP-5 as either: a non-reporting activity; or as a reporting activity, so long as "the Corps determines no more than minimal adverse environmental effects to the aquatic environment, both individually and cumulatively will occur."[91] Reporting activities relevant to this Application include: projects impacting more than 0.50 acre of waters of the United States,[92] projects permanently impacting greater than 250 linear feet of watercourses,[93] any activity which may adversely affect cultural resources listed in the National Register of Historic Places,[94] or any activity which occurs in a component of the National Wild and Scenic River System, specifically Tinicum Creek.[95] The Headquarters Road Bridge Project is a reporting activity because it occurs in Tinicum Creek. In addition, the Project will adversely affect cultural resources listed in the National Register of Historic Places, namely, Headquarters Road Bridge and its irreplaceable contribution to the Ridge Valley Rural Historic District.[96]

"Applications for projects identified as Reporting Activities will be forwarded to the Corps for review and, when applicable, be coordinated with any other Federal and State resource agency to determine eligibility

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86 incl. 25 Pa Code § 105.243
87 U.S. Army Corps of Eng'rs, Pennsylvania State Programmatic General Permit-5 (PASPGP-5) (July 2016, rev. July 2018) (hereinafter "PASPGP-5")
88 *See* 33 U.S.C. § 1344(e).
89 PASPGP-5 at 3.
90 PASPGP-5 at 4.
91 PASPGP-5 Part III.B.1 at 15.
92 PASPGP-5 Part IV.B.2.a.
93 PASPGP-5 Part IV.B.2.b.
94 PASPGP-5 Part IV.B.7.
95 PASPGP-5 Part IV.B.8.e.
96 *See* Headquarters Road Bridge Determination of Eligibility.

for verification under PASPGP-5."[97] As explained in Section VI of this Comment, *infra*, the National Park Service is a federal resource agency that must also review the Project under the Wild and Scenic Rivers Act.[98] "Prior to the Corps issuing a project specific PASPGP-5 verification, any Federal or State resource agency may notify the appropriate Corps District of their objection for authorization by the PASPGP-5."[99] The Corps also retains discretionary authority to require a Section 404 individual permit review for a project "based on concerns for the aquatic environment or for any other factor of the public interest."[100]

In sum, PADEP cannot grant PennDOT coverage under PASPGP-5 until the Application is forwarded to the Corps, and the Corps issues a determination that: (a) the Project is eligible for verification under PASPGP-5 without special conditions; (b) the Project is eligible for verification under PASPGP-5 with added special conditions; (c) the Project is not eligible for verification under PASPGP-5 and requires an alternative form of Section 404 authorization; or (d) authorization under Section 404 is not required for the Project at all.[101]

VII. PADEP Cannot Grant PennDOT Coverage Under PASPGP-5 Until the National Park Service Completes its Wild and Scenic Rivers Act Section 7 Review.

As noted in the previous section, the National Park Service has an important role in the authorization of the Project under Section 404 of the Clean Water Act.[102] Section 7 of the Wild and Scenic Rivers Act states that "no department or agency of the United States shall assist by loan, grant, license, or otherwise in the construction of any water resources project that would have a direct and adverse effect on the values for which such river was established, as determined by the Secretary charged with its administration."[103] Here, the Secretary charged with the administration of Tinicum Creek is the Secretary of the Interior, through the National Park Service.[104] The regulations implementing the Wild and Scenic Rivers Act include Section 404 permits as federal assistance in the construction of water resources projects.[105] Therefore, because the Headquarters Road Bridge Project requires authorization under Section 404 of the Clean Water Act, the National Park Service's obligation to review the Project has been triggered.

The National Park Service must analyze the Project to determine if it will "have a direct and adverse effect on [Tinicum Creek's] free-flowing condition, water quality, or 'outstandingly remarkable values.'"[106] The National Park Service will evaluate "all projects triggering section 7 review . . . regardless of their NEPA pathway. Categorical exclusion does not eliminate the need for a section 7 determination."[107] In addition, "[c]ompensating for an impact on a [Wild and Scenic River] resource by improving the condition of other resources is not sufficient to allow a project to proceed if the appropriate standard would still be violated."[108]

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[97] PASPGP-5 Part V.B.3
[98] 16 U.S.C. §§ 1271-1287.
[99] PASPGP-5 Part V.C.
[100] PASPGP-5 Part V.E.
[101] PASPGP-5, Part V.B.3.
[102] 33 U.S.C. § 1344.
[103] 16 U.S.C. § 1278(a).
[104] 16 U.S.C. § 1274(a)(165)(B).
[105] 36 C.F.R. § 297.3; *see also* Nat'l Park Serv., U.S. Dep't of the Interior, Director's Order #46: Wild and Scenic Rivers, at 3 n.3 (May 1, 2015) (hereinafter "Director's Order #46").
[106] Director's Order #46 at 3.
[107] *Id.* at 4.
[108] *Id.* at 4.

In October 1992, Congress authorized a study of the Lower Delaware River and its tributaries for possible inclusion in the Wild and Scenic River System.[109] Pursuant to that authorization, the Lower Delaware Wild and Scenic River Study Task Force prepared the Lower Delaware River Management Plan in August of 1997.[110] The Lower Delaware River Management Plan identifies six goals: water quality, natural resources, historic resources, recreation, economic development, and open space preservation.[111] The objective of the water quality goal is to "[m]aintain existing water quality in the Delaware River and its tributaries from measurably degrading and improve it where practical," in part by "manag[ing] . . . storm water non-point runoff to minimize degradation of the river."[112] To further the natural resources goal, the Lower Delaware River Management Plan directs authorities to "[p]reserve and protect the river's outstanding natural resources, including . . . buffer areas in the river corridor and along the tributaries" by "[p]romot[ing] steam corridor preservation, as well as protection of steep slopes, floodplains and wetlands."[113] "[T]he character of historic structures, districts and sites, including landscapes, in the river corridor" are to be preserved and protected, specifically "[s]tructures, districts or sites, including landscapes, that are listed on the State of National Register of Historic Places . . . are important to the character of the river corridor and should be preserved."[114]

In November 2000, Congress enacted the Lower Delaware Wild and Scenic Rivers Act.[115] That act added Tinicum Creek "as a scenic river" as a component of the National Wild and Scenic Rivers System.[116] Section 4 of the Act directs that the designated river segments, including Tinicum Creek, are to be managed in accordance with the Lower Delaware River Management Plan.[117] Specifically, the Act requires that "[i]n determining under section 7(a) of the Wild and Scenic Rivers Act . . . whether a proposed water resources project would have a direct and adverse effect on the value for which a segment is designated as part of the Wild and Scenic Rivers System, the Secretary of the Interior . . . shall consider the extent to which the project is consistent with the management plan."[118]

The National Park Service first became involved in the Headquarters Road Bridge project in 2006, after the United States Department of the Interior's Keeper of the National Register determined that the Headquarters Road Bridge was "eligible for the National Register of Historic Places as a contributing property in the National Register-listed Ridge Valley Rural Historic District."[119] The Keeper concluded that the "bridge is historically significant in the context of the development of the township, regional transportation, and the operation of local mills, and is of engineering significance both for its early 19th century construction and its sensitive modernization in 1919."[120] The National Park Service was a consulting party throughout the National HIstoric Preservation Act ("NHPA")[121] Section 106 consultation process, and as a part of the Design Advisory Committee formed as a result of the Section 106 Memorandum of Agreement.[122]

On January 12, 2017, the National Park Service provided its comments on the Draft Categorical Exclusion Evaluation for the Project, which was prepared during PennDOT's and the Federal Highway

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[109] *See* Wild and Scenic River Study: Delaware River, Pennsylvania and New Jersey, Pub. L. No. 102-460, 106 Stat. 2270 (1992).
[110] *See* Lower Delaware River Wild and Scenic River Study Task Force, Lower Delaware River Management Plan (Aug. 1997).
[111] *Id.*
[112] *Id.* at 27.
[113] *Id.* at 36.
[114] *Id.* at 40.
[115] Pub. L. 106-418, 114 Stat. 1817 (2000).
[116] *Id.* at § 3.
[117] *Id.* at § 4(a).
[118] *Id.* at § 4(c)(1).
[119] Headquarters Road Bridge Determination of Eligibility.
[120] *Id.*
[121] 54 U.S.C. §§ 300101, *et seq.*
[122] Section 106 MOA.

Administration's National Environmental Policy Act ("NEPA")[123] process. In that letter, the National Park Service stated that "[a] determination under Section 7 [of WRSA] will be provided once the project is in its final review form."[124] The Application purports to be the final proposal for the Project, despite missing and inadequate information, thus, the National Park Service must review the Application and obtain additional information before the Section 404 permit can be issued.

A. The Project will Have an Adverse Effect on Tinicum Creek's Free-Flowing Condition

The definition of "free flowing" in the Wild and Scenic Rivers Act means "existing or flowing in natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the waterway."[125] While existing structures within a scenic river such as Tinicum Creek do not destroy its free-flowing condition, additional construction should be avoided.[126] Indeed, in 2001, the National Park Service requested that PennDOT rehabilitate rather than replace the existing Geigel Hill Road Bridge, one of the historic bridges along Tinicum Creek in the Ridge Valley Rural Historic District, because replacement would "inhibit the free flowing character of the stream" by "increas[ing] scouring above and below the bridge and increas[ing] stream bank erosion."[127]

In the National Park Service's January 2017 letter to PennDOT, it expressed concern that the draft categorical exclusion "[did] not reference any data regarding the potential downstream streambank impacts of the proposal to move the western abutment landward by a significant distance."[128] Three and a half years later, PennDOT's Application is still missing this essential information. Thus, an evaluation of downstream impacts must be provided to the National Park Service in order to complete the Section 7 review, which is a prerequisite to the issuance of the Section 404 permit.

B. The Project Will Have an Adverse Effect on Tinicum Creek's Water Quality

The National Park Service has recognized the value of Tinicum Creek's "good hard-bottom aquatic habitat with limited fine sediment deposition that creates conditions for a good representation of native warm water aquatic species."[129] Indeed, Pennsylvania has designated the "maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat" as an existing use of Tinicum Creek.[130] Pennsylvania's water quality regulations command that the water quality of exceptional value waters such as Tinicum Creek "be maintained and protected."[131] The regulations also state that "[w]ater may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life."[132] Yet the direct threats of demolishing the historic structure and rebuilding a larger bridge will cause water quality impacts and removal of additional trees for the construction activities. Increases in impervious surface will increase stormwater runoff and the pollutant loading from this runoff. Water temperatures will

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[123] 42 U.S.C. §§ 4321-4370h.
[124] Joint Permit Application, Other Documents: NPS Letter.
[125] 16 U.S.C. § 1286(b).
[126] *See id.* ("The existence, however, of . . . other minor structures at the time any river is proposed for inclusion in the national wild and scenic rivers system shall not automatically bar its consideration for such inclusion: Provided, That this shall not be construed to authorize, intend, or encourage future construction of such structures within components of the national wild and scenic rivers system.")
[127] Letter from William Sharp, Project Manager, Stewardship and Partnerships, Nat'l Park Serv., Dep't of the Interior, to Robert Eppley, Jr., Pa. Dep't of Transp., Region 6 (June 21, 2001) (hereinafter "Geigel Hill Road Bridge Opinion").
[128] Joint Permit Application, Other Documents: NPS Letter.
[129] *See* Nat'l Park Serv., U.S. Dept. of the Interior, Delaware River Basin Wild and Scenic River Values 6 (Sept. 2012).
[130] *See* 25 Pa. Code. § 93.9e, 93.3.
[131] 25 Pa. Code § 93.4a(d).
[132] 25 Pa. Code § 93.6(a).

increase from the suite of direct and indirect effects of the Project. In particular, the significant erosion of the downstream stream banks and riparian corridor will largely eliminate the narrow stand of mature hardwood trees, increase light penetration to the stream and significantly increase water temperatures for Tinicum Creek. The extensive erosion caused by moving the bridge abutments 15 ft westward will, of course, increase sediment loads and concentrations in the stream and increase overall water turbidity. These many and significant water quality degradations would be largely or wholly eliminated with a rehabilitation approach to the Headquarters Road Bridge.

C. The Project Will Have an Adverse Effect on Tinicum Creek's Outstandingly Remarkable Values

The outstandingly remarkable values assigned to Tinicum Creek by the National Park Service include its cultural, geological, and scenic values.[133] Tinicum Creek contains many cultural resources such as the Del Haven Paleo-Indian site, the origin point of the Walking Purchase of 1737, and the Ridge Valley Rural Historic District. The scenic values of Tinicum Creek can be attributed to a "dramatic rolling landscape of fields and woods," and valleys including "a mix of smaller historic farms and villages linked by stone-arch and covered wooden bridges."[134] In its January 2017 letter to PennDOT, the National Park Service expressed that it was "very concerned with protection of the Ridge Valley Rural Historic District," especially since "[t]he specific setting and character of the Headquarters Road Bridge and its surrounding environment (within the viewshed of the bridge) is exemplary in its contribution to the overall character and purpose of the Ridge Valley district."[135] The National Park Service explained that the replacement of Headquarters Road Bridge would be an "adverse effect" on the district, and hoped that design of the new bridge would minimize that adverse effect.[136] However, concerns remained regarding the cumulative effects of transportation improvement within the Ridge Valley Rural Historic District, due to the unique collection of historic bridges listed as contributing to the district.

In fact, in June 2001, the National Park Service opined on the impact of PennDOT's replacement of the Geigel Hill Bridge, another historic bridge within the Ridge Valley Rural Historic District that crosses Tinicum Creek.[137] In that opinion, the National Park Service stated that replacement of the bridge would "significantly and adversely affect values and resources for which the Tinicum Creek was designated" as a scenic river, since replacement would "remove[] a contributing resource from the Ridge Valley Rural Historic District."[138] Fortunately, such an adverse impact can be avoided today by reconstructing Headquarters Road Bridge as envisioned in Alternative 3, as discussed in more detail in the following section.

VIII. PennDOT's Alternatives Analysis Relies on Specious Arguments to Dismiss a Viable Rehabilitation Option

It is abundantly clear, even obvious, that rehabilitation of the existing 1812 piers and abutments combined with a replacement of the bridge superstructure is the most complete and efficient approach for protecting the Exceptional Value of the Tinicum Creek water quality, protecting the public resources of the historic bridge and the creek's ecosystem (including the intact riparian zone), and preserving all of the

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[133] *See* Nat'l Park Serv., U.S. Dept. of the Interior, Delaware River Basin Wild and Scenic River Values 6 (Sept. 2012).
[134] *Id.*at 63.
[135] Joint Permit Application, Other Documents: NPS Letter.
[136] Joint Permit Application, Other Documents: NPS Letter.
[137] Geigel Hill Road Bridge Opinion.
[138] *Id.*

Outstandingly Remarkable attributes that play a key role in Tinicum Creek's Wild & Scenic status. Yet this greatest-protection alternative has been routinely dismissed by PennDOT since the project's inception over 15 years ago using a series of specious and fallacious arguments which have changed through time as the inaccuracies of earlier arguments have been uncovered.

In the current iteration of the PennDOT Alternatives Analysis, the primary rehabilitation alternative (designated as Alternative 3) is again dismissed by compiling a list of inaccurate statements and artificial constraints that PennDOT does not adhere to in other settings, including a 2018 rehabilitation of a similar and much higher-traffic highway bridge on Route 32 within Tinicum Township. In our submission and attachments, we document point-by-point that all of PennDOT's reasons for dismissal are inaccurate or downright fallacious. The rehabilitation of the Headquarters Road piers and abutments combined with a new one-lane superstructure is indeed feasible and fulfills the purpose and need of restoring this bridge completely and safely.

We summarize here the main rebuttals to the PennDOT arguments for dismissing Alternative 3. We provide more complete documentation of the safety, the engineering compliance, and feasibility of the one-lane bridge rehabilitation in the enclosed supporting documents. PADEP cannot accept fallacious statements, disproven by licensed professionals, as a reason to abandon a solution that protects the water quality of an EV stream, protects all natural resources in this historic setting, and retains the key elements for this Wild & Scenic stream.

First, PennDOT insists that its Design Manual requires a 24-foot wide bridge at this location. Yet PennDOT willfully ignores its own doctrinal mandates for flexibility in applying design standards, Context Sensitive Design, and collaborative planning of projects, as stated in the Design Manual itself and in its Smart Transportation Guidebook. These documents, in turn, reference the flexibility doctrine included in the "Green Book" design manual of the American Association of Highway and Transportation Officials (AASHTO) and other publications. In fact, even in the Alternatives Analysis document, PennDOT acknowledges that a one-lane bridge could be built to meet all of the township's needs, if only the township would take ownership of the bridge.[139]

More importantly, PennDOT through its official programs and through its actions in Tinicum Township, in Bucks County, and throughout the state demonstrates that the 24-ft bridge width is "required" only when PennDOT wants to eliminate other alternatives. Under PennDOT's Stone Arch Bridge program, which addresses stone masonry bridges similar to the Headquarters Road Bridge, one-lane bridges with widths far less than 24 feet are routinely rehabilitated. In addition, PennDOT fails to acknowledge that half of the PennDOT-owned bridges in Tinicum Township are currently one-lane bridges. Clearly, PennDOT has the ability and the practice of maintaining and repairing one-lane bridges locally and throughout the state. In fact, only nineteen months ago, PennDOT repaired a much higher traffic volume highway bridge (Route 32, aka, River Road, at what is commonly known as the Golden Pheasant Bridge) by exactly executing what it says it cannot do for Alternative 3: historic bridge abutments were rebuilt, the stone work was capped with concrete to accommodate a modern superstructure, and a one-lane bridge superstructure was installed on the historic stone abutments. As documented in the enclosed attachments, the parallels between Headquarters Road Bridge and the Golden Pheasant Bridge are extraordinary, and the restoration techniques used on Route 32 are completely applicable and viable approaches for the Headquarters Road Bridge.[140,141] It is worth noting that this rehabilitation work was completed in three short months. Clearly, PennDOT can rehabilitate and re-open high-traffic one-lane bridges on the Commonwealth's highways. It has demonstrated that fact just

139 Joint Permit Application, Alternatives Analysis at 9.
140 Letter report from Douglas E. Bond, P.E., McMullen Consulting Engineers; January 16, 2019
141 DRN slide presentation from January-2020 (untitled)

within the last two years here in the township, and for decades elsewhere with stone arch bridges. Rehabilitating a much lower-traffic Neighborhood Collector Road in a similar fashion is a fast and cost-effective way to re-open Headquarters Road. A two-lane, 24-foot constraint is clearly not an inflexible requirement. PennDOT is applying different standards to this bridge than it does elsewhere in order to inappropriately disqualify the rehabilitation option.

Second, PennDOT acknowledges in the Alternative 3 discussion their ability to rehabilitate one-lane bridges where safety concerns are not an overriding concern. PennDOT then fabricates safety issues and a history of traffic accidents to claim it must not rehabilitate the one-lane bridge in this setting. Our independent analysis of the crash history shows lower-than-average traffic issues and accident rates for this bridge, with nearly all of the PennDOT-cited problems occurring outside the limits and influence of the bridge and only minor incidents (e.g., a car scraping against the bridge rail in icy conditions) on the bridge.[142,143,144] PennDOT even acknowledges in their Alternatives Analysis that the police records fail to link accidents to the bridge: "the police do not report that the accidents were directly caused by the bridge."[145] Likewise, in Tinicum Township, in Bucks County, and throughout the Commonwealth, bridges with much higher average traffic volumes and crash records are rehabilitated as one-lane bridges. For their "safety" issue, PennDOT is reduced to arguing that there is a "site-specific safety problem" at the bridge because they have recorded random, unsubstantiated comments to that effect and because the approach roadways have "substandard" horizontal and vertical curvature—notwithstanding the fact that all of rural Tinicum Township is characterized by hilly, winding roads and further notwithstanding the fact that PennDOT plans to do nothing about these conditions in its preferred alternative! Again, PennDOT raises these specious arguments at their convenience as a means of dismissing an alternative with little to no environmental impact.

Third, PennDOT incorrectly asserts that emergency vehicle access would be constrained in Alternative 3. This assertion is not supported by the facts. As DRN's supporting documents show, statements in public and on the record from the fire chief, Township officials, and the Township Roadmaster all affirm that the largest fire truck would be able to make all emergency moves in a single move with a one-lane bridge, at the current location, with only an adjustment in the northeast wingwall.[146] Furthermore, additional improvements can be made to enhance turning ease without impeding historic preservation.[147] In fact, emergency vehicles and the town's largest fire truck were able to use the bridge without problem before it was closed, even after PennDOT narrowed the travel lane to ten feet with the Jersey Barriers. Again, PennDOT raises a potential issue to eliminate Alternative 3 from consideration, but a careful examination of that issue shows that PennDOT's assertions are incorrect and Alternative 3 fulfills the full purpose and need.

Fourth, PennDOT has consistently rejected Alternative 3 in a perfunctory fashion, suggesting that it is merely a theoretical option, when in fact detailed design plans for Alternative 3 have been developed by a Pennsylvania certified Professional Engineer affiliated with an engineering firm with a national reputation for

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142 Mark L. Stout Consulting "Comments on the PennDOT Determination of Effects Report;" report issued December 15, 2015 (hereinafter "Stout 2015")

143 Mark L. Stout Consulting memorandum regarding "Supplement to my 14 December 2015 'Comments on the PennDOT Determination of Effects Report on the Headquarters Road Bridge' report;" dated January 18, 2016

144 Mark L. Stout Consulting "Site-Specific Safety Issues at the Headquarters Road Bridge;" report issued July 7, 2016 (hereinafter "Stout 2016")

145 Joint Permit Application, Alternatives Analysis at 8.

146 Stout 2015 and Stout 2016

147 Roberts Engineering "Preliminary Design for Intersection Improvements at Headquarters Road Bridge and Sheephole Road;" report issued June 21, 2016

rehabilitating stone masonry bridges.[148,149,150,151] These design plans demonstrate that Alternative 3 is just as feasible—while being cheaper, quicker, less disruptive, and protective of both the built and natural environment – than the demolish-and-replace option.

Finally, PennDOT even raises the obviously exaggerated and inaccurate possibility of water quality problems with a rehabilitation option. As documented earlier, the real threats to the water quality of this EV stream arise from an engineering approach that moves the bridge, directs erosive flows directly at the downstream stream bank and riparian zone, and threatens to have catastrophic damage to the downstream properties and stream banks. Likewise, PennDOT claims that 2 piers in the stream create an impairment to the free-flowing nature of Tinicum Creek compared to a bridge with 1 pier in the stream. However, PennDOT's own Hydrologic & Hydraulic Analysis documents that both the existing 2-pier configuration and the proposed 1-pier configuration both pass the 25-year storm without over-topping.[152] Tinicum Creek at the Headquarters Road Bridge is equally free-flowing under both 2-pier and 1-pier configurations. Here, again, PennDOT will clearly raise any and all issues regardless of applicability and relevance to dismiss a viable rehabilitation option, Alternative 3, from consideration.

The option to repair the Headquarters Road Bridge piers and abutments, and replace only the superstructure, is a viable approach that fully meets the purpose and needs for this rural stream crossing. Only the proposed PennDOT approach triggers the "extraordinary magnitude" of environmental impacts that PennDOT attempts to use to dismiss the viable Alternative 3. The rehabilitation alternative is indeed feasible because it can be constructed in accordance with sound engineering practices. Furthermore, this alternative is prudent since it meets the project needs while resulting in no unique traffic problems while minimizing environmental impacts.

IX. Conclusion

The extent and magnitude of PennDOT's failure to protect all of the resources and values are enormous. We have detailed here the greatest and most significant threats and violations of Pennsylvania regulations. We have also attached the relevant citations, documents, and reports that provide an even more complete evaluation and assessment of PennDOT's failures and the imminent damage this Project will bring to the natural, cultural, and historic resources of the Commonwealth.

PADEP must not issue a Chapter 105 permit, Section 401 Certification, or grant coverage under PASPGP-5 for the Headquarters Road Bridge over Tinicum Creek Replacement Project. First, PennDOT's Application is administratively incomplete. Second, PADEP is prohibited from approving a permit for a project that will have an adverse impact upon the public natural resources by Chapter 105. Third, approval of the Project would be a breach of PADEP's constitutional duty to conserve and maintain the public natural resources. Fourth, the destruction of Headquarters Road Bridge would violate the people's right to the preservation of the natural, scenic, historic and esthetic values of the environment. Fifth, Chapter 105 prohibits the construction of bridges that would cause erosion of stream beds and banks. Sixth, the Project cannot be covered by PASPGP-5 until both the Corps and the National Park Service review it. Finally, all of the above

[148] "State Route 1012 (Headquarters Road) Headquarters Road Bridge Rehabilitation, Preliminary Plans;" 12 sheets; prepared by Douglas E. Bond, P.E. (McMullen Associates, Inc.) in 2017 (not dated as they are preliminary plans)
[149] McMullen & Associates, Inc. "Headquarters Road Bridge: Preliminary Condition Assessment and Proposed Rehabilitation;" report issued March 6, 2012
[150] McMullen & Associates "Headquarters Road Bridge – Coring Tests;" report issued March 18, 2014
[151] letter from Douglas E. Bond, P.E., to Kitty Henderson, Historic Bridge Foundation, dated February 23, 2018
[152] Joint Permit Application, Hydrologic & Hydraulic Study at 168

barriers to providing the community with a working bridge can be removed by simply rehabilitating Headquarters Road Bridge, thereby preserving its historic value and protecting Tinicum Creek from erosion and water quality degradation.

For these reasons, DRN requests that PADEP deny PennDOT's Application.

Respectfully,

Maya K. van Rossum
the Delaware Riverkeeper

Attachments

1. Ridge Valley Rural Historic District Listing and Registration, 1992
2. US Department of Interior Determination of Eligibility of Headquarters Road Bridge to National Register of Historic Places, April 28, 2006
3. Letter from Pennsylvania State Historic Preservation Office to Pennsylvania Department of Transportation, July 22, 2016
4. Email with attached letter from Delaware Riverkeeper Network to PA Department of Environmental Protection, June 15, 2020
5. Email response from PA Department of Environmental Protection to Maya van Rossum regarding June 15 letter, June 17, 2020
6. Rippled Waters Engineering report, July 16, 2020
7. Color map- "Ridge Valley Rural Historic District, Contributing Parcels, Bridges, and Fords (Tinicum Township, Bucks County, Pennsylvania)"
8. *Visualizations of Riparian Corridor & Stream Channel Impacts from PennDOT Proposal for Headquarters Road Bridge*, Delaware Riverkeeper Network, July 2020
9. Letter from National Park Service to PennDOT, June 21, 2001
10. *Delaware River Basin Wild and Scenic River Values*, National Park Service, 2012
11. Letter report from Douglas E. Bond, P.E., McMullan Consulting Engineers; January 16, 2019
12. DRN 2020; slide presentation on Headquarters Road Bridge
13. Mark L. Stout Consulting report, December 15, 2015
14. Mark L. Stout Consulting memorandum, January 18, 2016
15. Mark L. Stout Consulting report, July 7, 2016
16. Roberts Engineering report, June 21, 2016
17. State Route 1012 (Headquarters Road) Headquarters Road Bridge Rehabilitation, Preliminary Plans;" 12 sheets; prepared by Douglas E. Bond, P.E. (McMullen Associates, Inc.) in 2017

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18. McMullen & Associates, Inc. Report, March 6, 2012
19. McMullen & Associates report, March 18, 2014
20. Letter from Douglas E. Bond, P.E., to Kitty Henderson, Historic Bridge Foundation, February 23, 2018

Supplemental Attachments

1. *Site-Specific Safety Issues at the Headquarters Road Bridge*, Mark Stout Consulting, July 7, 2016
2. *Draft Individual Section 4(f) Evaluation,* A.D. Marble, January 2017
3. Letter to Historic Bridge Foundation from McMullan & Associates, February 23, 2018
4. Letter to Delaware Riverkeeper Network from McMullan & Associates, January 16, 2019
5. Delaware Riverkeeper Network presentation to Bucks County Commissioners, January 2020
6. *Preservation of Stone Masonry Bridges, Lessons Learned by the Delaware River Joint Toll Bridge Commission (DRJTBC)*, George G. Alexandridis, PE
7. Email from PADEP to Delaware Riverkeeper Network, July 6, 2020
8. July 25, 2006 Letter to Harrower to PHMC
9. Letter from Meliora Design to the Delaware Riverkeeper Network regarding potential impacts of construction on Tinicum Creek, May 2012
10. Letter from Rob Reynolds to Delaware Riverkeeper Network regarding impacts of bridge rehabilitations and replacement, June 14, 2013
11. Comments of McMullan & Associates to Maya van Rossum regarding the June 17, 2013 meeting, July 19, 2013
12. Letter from Delaware Riverkeeper Network to PennDOT, July 30, 2013
13. Letter from Delaware Riverkeeper Network to PennDOT, October 29, 2013
14. Letter from Delaware Riverkeeper Network to National Park Service, March 31, 2014
15. Letter from Delaware Riverkeeper Network to PennDOT, March 31, 2014
16. *Headquarters Road Bridge Coring Test,* McMullan & Associates, April 2, 2014
17. Letter from Delaware Riverkeeper Network to Ottsville Fire Department, June 3, 2014
18. Letter from Delaware Riverkeeper Network to Ottsville Fire Department, June 10, 2014
19. Letter from Delaware Riverkeeper Network to PennDOT, July 22, 2014
20. Delaware Riverkeeper Network notes from CP Meeting, April 2, 2014
21. Letter from Delaware Riverkeeper Network to PennDOT, August 5, 2014

22. Letter from Delaware Riverkeeper Network to PennDOT, August 26, 2014
23. Letter from Delaware Riverkeeper Network to PennDOT, August 26, 2014
24. Letter from Delaware Riverkeeper Network to PennDOT, August 27, 2014
25. Letter from Delaware Riverkeeper Network to PennDOT, August 27, 2014
26. Letter from Delaware Riverkeeper Network to PennDOT, September 23, 2014
27. *Headquarters Road Bridge as a Contributing Resource,* Letter from Delaware Riverkeeper Network to PennDOT, September 26, 2014
28. Letter from Delaware Riverkeeper Network to PennDOT, October 30, 2014
29. Letter from Delaware Riverkeeper Network to PennDOT, December 2014
30. Letter from Delaware Riverkeeper Network to FHWA, April 15, 2015
31. Letter from Delaware Riverkeeper Network to PA Gov. Wolf, May 1, 2015
32. Letter from Delaware Riverkeeper Network to PennDOT, May 13, 2015
33. Letter from Delaware Riverkeeper Network to PennDOT, July 6, 2015
34. August 7, 2015 package for Richards meeting
35. Letter from Delaware Riverkeeper Network to FHWA, August 13, 2015
36. *The Bridges of Tinicum Township*, prepared for the Delaware Riverkeeper Network by Robert Reynolds, August 13, 2015
37. Comments of the Delaware Riverkeeper Network on PennDOT Determination of Effects Report, December 15, 2015
38. Letter from Rob Reynolds to Maya van Rossum, December 15, 2016
39. Letter from Delaware Riverkeeper Network to Ottsville Fire Company Chief, January 8, 2016
40. Letter from Delaware Riverkeeper Network to FHWA, January 11, 2016
41. Letter from Delaware Riverkeeper Network to Tinicum Township Supervisors, January 15, 2016
42. Letter from Delaware Riverkeeper Network to PennDOT Secretary Richards, February 9, 2016
43. Response of Delaware Riverkeeper Network to FHWA, February 16, 2016
44. Letter from Delaware Riverkeeper Network to PennDOT, February 23, 2016
45. Letter from Delaware Riverkeeper Network to PennDOT, February 24, 2016
46. Letter from Delaware Riverkeeper Network to Auditor General, February 25, 2016
47. Letter from Delaware Riverkeeper Network to PennDOT, April 20, 2016
48. Letter from Delaware Riverkeeper Network to Auditor General, May 6, 2016
49. *Preliminary Design for Intersection Improvements at Headquarters Road Bridge and Sheephole Road,* Roberts Engineering for Mark L. Stout Consulting, June 21, 2016
50. Letter from Delaware Riverkeeper Network to PennDOT, July 6, 2016

51. Letter from Delaware Riverkeeper Network to PennDOT, July 8, 2016
52. Response of Delaware Riverkeeper Network to PennDOT, October 2016
53. Letter from Cultural Heritage Partners to USACE, November 18, 2016
54. Comments of Delaware Riverkeeper Network, Palisades High School Public Hearing, December 13, 2016
55. Comments of Delaware Riverkeeper Network on Draft CE, January 12, 2017
56. *Response to PennDOT Comments on Sheephole Bridge Replacement,* Princeton Hydro, January 12, 2017
57. Letter from Delaware Riverkeeper Network to National Park Service re comments on Draft CE, March 1, 2017
58. Letter from Cultural Heritage Partners to PennDOT, June 21, 2017
59. Comments of Robert Reynolds to Maya van Rossum regarding Draft CE, July 13, 2017
60. Comments of Meliora Design to Maya van Rossum regarding Draft CE, January 12, 2017
61. Comments of Delaware Riverkeeper Network on Draft CE, July 27, 2017
62. *Comments on the Draft Categorical Exclusion Evaluation,* Princeton Hydro, January 9, 2017
63. *Headquarters Road Bridge Rehabilitation Preliminary Plans,* Bond, January 11, 2017
64. *Draft Categorical Exclusion Evaluation*, Meliora Design, January 12, 2017
65. *Headquarters Road Bridge Rehab Analysis,* McMullen and Associates, April 2, 2014
66. *Headquarters Road Bridge – Coring Tests, McMullan & Associates Report,* March 18, 2014
67. Letter dated March 25, 2003 to Tinicum Township from PennDOT
68. *National Register Amendment,* Ridge Valley Rural Historic District, May 5, 2005
69. US Department of Interior Determination of Eligibility of Headquarters Road Bridge to National Register of Historic Places, April 28, 2006
70. Letter Dated August 13, 2015 written by Maya van Rossum, the Delaware Riverkeeper, to Jon Crum, FHWA
71. Letter dated August 26, 2015 written by Jon Crum, FHWA, to Maya van Rossum, the Delaware Riverkeeper
72. Letter dated June 14, 2013 written by Robert Reynolds to Ed Rodgers, Delaware Riverkeeper Network
73. Letter dated December 15, 2016 written by Robert Reynolds to Maya van Rossum, the Delaware Riverkeeper
74. *The Bridges of Tinicum Township*, prepared for the Delaware Riverkeeper Network by Robert Reynolds, August 13, 2015

75. *Determination of Effects Report,* Pennsylvania Department of Transportation for PADEP, November 2015
76. Letter dated June 21, 2001 written by NPS to PennDOT regarding Geigel Hill Road Bridge
77. Letter dated July 7, 2016 written by Meliora Design to Maya van Rossum, the Delaware Riverkeeper
78. *Expert Report on PennDOT Determination of Effects Report,* Meliora Design, December 14, 2015
79. *Report on potential stream impacts from Sheep Hole Road Bridge Replacement,* Princeton Hydro, July 7, 2016
80. *Response to PennDOT Comments on Sheephole Bridge Replacement,* Princeton Hydro, January 12, 2017
81. *Impacts of new highways and subsequent landscape urbanization on stream habitat and biota, Reviews in fisheries science, 13(3), 141-164.* A. P. Wheeler, P. L. Angermeier, & A. E. Rosenberger
82. *Section 106 Mitigation and Minimization Memo,* FHWA and PennDOT, November 15, 2016
83. PennDOT Public Hearing minutes, December 13, 2016
84. *Comments on PennDOT DOE Report,* Mark L. Stout Consulting, December 14, 2015
85. *Supplement to Dec. 14, 2015 Comments on PennDOT DOE Report,* Stout Consulting, January 18, 2016
86. *Determination of Effects Report Comment Response Document,* June 23, 2016
87. *Preliminary Design for Intersection Improvements at Headquarters Road Bridge and Sheephole Road,* Roberts Engineering for Mark L. Stout Consulting, June 21, 2016
88. Tinicum Twp. Board of Supervisors Meeting Minutes, October 20, 2015
89. *Review of Headquarters Road Bridge Project- Determination of Effects Report*, McMullan and Associates, December 7, 2015
90. *Headquarters Road Bridge Over Tinicum Creek,* PennDOT Response to DRN July 8 Comment, July 27, 2016
91. *Existing Structure Condition Evaluation Report,* Urban Engineers for PennDOT, August 18, 2006
92. Pennsylvania Department of Transportation Project Specific Agreement, March 23, 2005
93. PennDOT Purpose and Need Statement with Consulting Party Meeting Minutes, June 17, 2013
94. Delaware Riverkeeper Network Newsletter, Summer/Fall 2014

NPS Form 10-900
(Rev. 8-86)

OMB No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations of eligibility for individual properties or districts. See instructions in *Guidelines for Completing National Register Forms* (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. If an item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, styles, materials, and areas of significance, enter only the categories and subcategories listed in the instructions. For additional space use continuation sheets (Form 10-900a). Type all entries.

1. Name of Property

historic name Ridge Valley Rural Historic District
other names/site number Sheep Hole Road and Vicinity

2. Location

street & number Encompassing all of Sheep Hole Road and parts of Headquarters, Geigel Hill, Red Hill, Tabor and Bunker Hill Roads. ☐ not for publication N/A
city, town Ottsville (Tinicum Township) ☐ vicinity N/A
state Pennsylvania code PA county Bucks code 017 zip code 18942

3. Classification

Ownership of Property
- [X] private
- [ ] public-local
- [ ] public-State
- [ ] public-Federal

Category of Property
- [ ] building(s)
- [X] district
- [ ] site
- [ ] structure
- [ ] object

Number of Resources within Property

Contributing	Noncontributing	
44	9	buildings
7	-	sites
15	1	structures
1	--	objects
67	10	Total

Name of related multiple property listing: N/A

Number of contributing resources previously listed in the National Register 0

4. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this ☐ nomination ☐ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ☐ meets ☐ does not meet the National Register criteria. ☐ See continuation sheet.

Signature of certifying official Date

State or Federal agency and bureau

In my opinion, the property ☐ meets ☐ does not meet the National Register criteria. ☐ See continuation sheet.

Signature of commenting or other official Date

State or Federal agency and bureau

5. National Park Service Certification

I, hereby, certify that this property is:

- [ ] entered in the National Register.
  - [ ] See continuation sheet.
- [ ] determined eligible for the National Register. ☐ See continuation sheet.
- [ ] determined not eligible for the National Register.
- [ ] removed from the National Register.
- [ ] other, (explain:)

Signature of the Keeper Date of Action

6. Function or Use

Historic Functions (enter categories from instructions)

Domestic / Single Dwelling
Agriculture / Agricultural Outbuilding
Agriculture / Storage
Agriculture / Agricultural Field

Current Functions (enter categories from instructions)

Domestic / Single Dwelling
Agriculture / Agricultural Outbuilding
Agriculture / Storage
Agriculture / Agricultural Field

7. Description

Architectural Classification
(enter categories from instructions)

Other: Vernacular Southeast Pennsylvania

Materials (enter categories from instructions)

foundation Stone
walls Stone
Weatherboard
roof Slate
other

Describe present and historic physical appearance.

The Ridge Valley Rural Historic District contains approximately 575 acres of land in Tinicum Township. The setting of this district in a valley is visually interesting. The name "Ridge Valley" is descriptive. Exposed shale, steep slopes, creeks, winding roads, open fields, woods, and historic resources combine to create this area's sense of place. The name for this historic district comes from the 1891 Atlas, in which this area was labeled Ridge Valley School District.

The Ridge Valley Rural Historic District contains a total of 77 resources. Sixty-seven resources are contributing and ten resources are non-contributing. Of the contributing resources there are forty-four buildings, seven sites, fifteen structures, and one object. Of the forty-four buidlings, there are fourteen houses, twelve barns, eighteen agricultural or residential out-buildings. Of the seven sites, there are one archaeological farm site, one blacksmith shop site, one barn ruin, one privy foundation, and two fords and one hay barn ell site. Of the fifteen structures there are six bridges, four corn cribs, four chicken coops, and one twentieth century pottery kiln. The object is a kerosene pump.

Of the non-contributing buildings there are three houses, two garages, four buildings associated with horses, and one non-contributing structure, a swimming pool. Not a single noncontributing house is visible from a public right of way. Access to all three noncontributing houses was down long lanes that were posted against trespassing. No other information about these houses was available. Since they are not visible, they have no negative impact on the district's integrity. The two garages are modest frame structures that fit in scale and material with the buildings on those properties. Three horse related buildings, which are only ten to twenty years old, are built of wood in a simple design. They also contribute to the context because they shelter horses, whose presence is an attribute of this area. The other horse related building is a large stable that is an intrusion on the district. On the property that has the swimming pool, the pool and the house are far enough apart that the integrity is not badly compromised.

The historic district consists mostly of farmsteads. The standard Ridge Valley farmhouse is built of red shale, stands 2 1/2 stories, is between two and five bays wide, and is vernacular in style. Most farms retain their bank barns, and

[X] See continuation sheet

several farms have fine collections of agricultural outbuildings including wagon houses, pig pens, milk houses, and chicken coops. Another important element of this district is the fine collection of six bridges.

The Ridge Valley Rural Historic District is made up of a group of farms united by Tinicum Creek and three of its tributaries which, due to topography, form a region visually and physically distinct from the surrounding landscape. Approximately a mile from the district in most directions the land is gently rolling and sections of road frontage have been recently developed. As the district is approached on Geigel Hill Road, Headquarters Road, and Tabor Road, the topography changes. Suddenly these roads begin to drop downhill at a sharp angle. The roads generally follow streams and much of the scenery is made up of exposed stone ledges and rocks. Beyond this area is densely wooded and until recently, little development had occurred. Near the Tinicum Creek, the land becomes flat again and forms the center of the district. This topography helped define which land could be farmed. All the properties within the proposed district are oriented to the south off roads that parallel the waterways.

The Ridge Valley Historic District began to be settled in the fourth quarter of the eighteenth century. The 1798 Federal Direct Tax documents the late eighteenth century appearance of this area. Nearly every house and barn recorded in the tax list was built of log, with the exception of Christian Fretz's stone house. Mr Fretz owned a grist mill located near his house. The mill, which no longer remains, was a major enticement that lured other Scotch-Irish and German farmers to settle here and develop their properties. By the 1830s most log houses and log barns had been replaced by stone houses and stone or stone and frame barns. Today, no log buildings survive. Subsequent changes and additions to buildings in the district, most of which are over fifty years old, have been sympathetic in material and scale with a low impact to architectural integrity.

The resources on Sheep Hole Road retain the highest degree of architectural integrity of the whole district. The road is named for the pool in the creek where farmers used to herd their sheep to wash them before shearing. Historic resources along Sheep Hole Road and resources radiating out around the industrial areas are contained within the district boundary. Although the buildings in this district represents a modest level of prosperity, people who appreciated the seclusion and beauty of this area began to buy up the farms in the 1920s and 1930s as farmers were selling out. Many of these new people were instilled with a strong preservation ethic which has gone far to maintain a high degree of architectural integrity here.

The district has one remaining industrial area where roads and creeks converge. This site contains a blacksmith shop ruin (burned in 1988), the site of a bank barn ruin, and a long stone building of undetermined use (44-5-33). The stone building was probably powered by water. It is located at the junction of two creeks providing an excellent source for water power. In the twentieth century the stone building was used as an ice house, and later as a slaughter house.

The majority of the buildings in this district were constructed to serve the needs of agriculturalists. Most houses are simple vernacular structures with little or no ornamentation. The integrity is generally good, but a few houses have had substantial additions made in the twentieth century that are reflective of the increased wealth of recent owners. Overall, in the context of this rural setting, the alterations to the buildings are minor. They do not disrupt the historic development pattern.

There are thirteen stone houses and one frame house in the district. Three farmhouses consist of an early nineteenth century main block with an attached rear stone kitchen (44-5-10, 44-5-20 and 44-5-38). One stone bank house, which appears to date to the nineteenth century, was documented (44-14-3-1). The north side of the building stands 2 1/2 stories high. On the south side the basement is fully exposed which makes the house appear to be 3 1/2 stories. Access through a central door leads to a basement kitchen. A majority of the farmhouses are three bay design with a central door and were constructed in the first quarter of the nineteenth century. In the mid-nineteenth century three stone, four bay wide houses were constructed (44-5-6-1, 44-5-34 and 44-14-9). These houses all featured twin front doors. During the period that these houses were being built, a frame addition to one of the earlier stone farmhouses was built which also featured twin front doors (44-11-21-1). A subsequent addition to one of the stone twin front door houses was built in the Victorian style (44-5-6-1).

A majority of the resources in this district are outbuildings. All twelve barns are bank barns. Five barns are built entirely of stone and six barns have stone stabling with frame upper levels above (one of which has been converted into residential use). One barn is built of stone with frame gables while the remaining two barns are ruins. Remaining agricultural or residential outbuildings include: one early twentieth century garage, one milk house, one root cellar, one carriage houses, two piggeries, two sheds, two smoke houses, two wagon houses, four chicken coops, four corn cribs, and four privies.

The presence of several creeks in this district strongly influenced the road network. In the northern portion of the district the Rapp Creek and Beaver Creek come together to form the Tinicum Creek which flows through the center of the district to its southern boundary. In the southern part of the district Headquarters Run flows west into Tinicum Creek. This network of creeks is paralleled by a road network. Tabor Road and Clay Ridge Road parallel Rapp Creek and Beaver Creek. Sheep Hole Road and Red Hill Road parallel the Tinicum Creek. Headquarters Road follows the Headquarters Run. With the exception of Red Hill Road which is paved, all north-south roads are dirt, while all east-west roads are paved. There are eight places in the district where a creek intersects with a road. Six areas currently have bridges while two crossings are still forded.

On Geigel Hill Road, at the confluence of Rapp and Beaver Creeks where Tinicum Creek is formed, there exists a late nineteenth century deck bridge with stone abutments and concrete walled approaches (adjoins 44-5-33). On Headquarters Road, near the point where the Tinicum Creek and Headquarters Run meet, is the second early bridge site (adjoins 44-14-8). The current bridge bears a 1919 datestone and appears to be built on earlier, nineteenth century, bridge supports. Judging from the design of the the stone supports, the older bridge may have been a wooden covered bridge. Geigel Hill Road and Headquarters Road were the primary main roads through the district.

Until the early twentieth century all six remaining crossings were forded. The change from horse drawn transportation to the automobile resulted in the improvement of roads and the construction of bridges. During the period between 1909 to 1936, four bridges were built at previously forded crossings. There are two bridges on Clay Ridge Road. The oldest is built of reinforced cement and is a single arch with a 1909 datestone (adjoins 44-5-20). The second bridge (adjoins 44-5-22) was engineered by A. Oscar Martin, a noted Bucks County architect. Martin who served as county engineer for twenty-five years, was responsible for designing county owned bridges. This bridge bears a 1917 datestone and is constructed of cement with a pipe railing and one mid span support. The remaining two bridges are built of welded steel with concrete decks and were completed in 1936 with WPA funding (adjoins 44-5-7 and adjoins 44-5-8). The two surviving fords are located on Tabor Road approximately a quarter mile apart (adjoins 44-5-3 and 44-5-3-1).

The area to the west of Rapp Creek includes a historic archaeological site (44-5-3-1) and a potential site (44-5-3). Both properties had houses, and presumably farm outbuildings, according to the 1891 Bucks County Atlas. On one of the parcels stands the ruin of one of the stone farmhouses. All other above ground traces of these two farms are gone. Other sites not already discussed include a privy foundation, and a hay barn ell.

The Ridge Valley Rural Historic District contains scenic waterways paralleled by man made roads that lead to historic buildings. Individual houses and small farmsteads, obscured from each other by the topography and foliage, are situated between folds in the land. The district is an unusually well preserved example of modest farmsteads that retains outstanding integrity.

RIDGE VALLEY RURAL HISTORIC DISTRICT
PROPERTY INVENTORY

44-5-3 (ADJ)

1 C. Site
Bunker Hill Road

This ford remains unchanged since new.

44-5-3-1

1 C. Site
Bunker Hill Road

The 1876 Scott Atlas and the 1891 Noll Atlas of Tinicum indicates the existence of buildings on this property. Along an overgrown abandoned farm lane stands the ruins of the nineteenth century farmhouse. Other historic resources on this site are archaeological.

44-5-3-1 ADJ

1 C. Site
Bunker Hill Road

This ford exhibits excellent integrity. After heavy rain fall portions of the ford are deep enough to submerge the exhaust system of automobiles which causes the vehicle to stall out. Care should be taken to know where the shallowest route through the ford is located to ensure safe passage.

44-5-6-1
44-5-22

2 C. Buildings & 1 C. Structure

Geigel Hill Road

The farmhouse was built in two sections. The earlier circa 1845 section is built of plastered stone. It stands 2 1/2 stories and is four bays wide. A circa 1885 frame addition was added to the primary elevation of the first section. Built in the Victorian style, this addition has decoratively cut shingles on the front gable and porches extends along three elevations. The bank barn has stone stabling with frame upper levels. The barn was extended on both gable ends with frame additions built on stone foundations. A small early twentieth century chicken coop faces south across the lane from the barn.

44-5-6-1 (ADJ)

1 C. Structure
Geigel Hill Road

This deck bridge is made of steel and it carries Geigel Hill Road over Tinicum Creek. This bridge is threatened with replacement.

44-5-7

4 C. Buildings
2 C. Structures
Sheephole Road

The farmhouse is built of stone and it has been pointed. Standing 2 1/2 stories, this four bay house has 9/6 first floor windows and 6/6 second floor windows. A porch extends along the entire primary elevation. A kitchen added to the southerly elevation in the mid twentieth century was constructed of native red shale which matches the existing main block. The large bank barn is built of stone. Front and rear eaves wall frame extensions were added to the barn. Although the barn has been adapted to a new use, the integrity of the structure remains good. Other related agricultural outbuildings include a frame wagon house, a frame milk house, and two corn cribs.

44-5-7 ADJ

1 C. Structure
Sheephole Road

This steel truss deck bridge was built by the WPA in 1938. It is in good condition and it exhibits excellent integrity.

44-5-8 ADJ

1 C. Structure
Sheep Hole Road

This steel truss deck bridge was built by the WPA in 1938. It is in good condition and it exhibits excellent integrity.

44-5-10

3 C. Buildings
1 N.C. Building
1 N.C. Structure
Bunker Hill Road

This modest sized farm house remains in good condition and it exhibits good integrity. The original house consists of a 2 1/2 story two bay main block with a rear 1 story kitchen ell. An 1807 datestone is located in the east gable. Additions built of native red shale blend with the original portions of the house. A bank barn ruin was rebuilt as a residence. A frame nineteenth century privy is located on the property. Two resources, a built in swimming pool and a horse stable do not contribute to the historic district.

44-5-12

3 C. Buildings
Bunker Hill Road

This farmstead is in good condition and it exhibits good integrity. The plastered stone house is 2 1/2 stories tall and three bays wide and was constructed circa 1840. In the 1930s a 2 1/2 story frame addition was made to the rear of the main block. The bank barn has stone stabling with frame upper levels. The original vertical wood siding was covered in the 1940s with asbestos shingle siding. A well preserved frame privy retains its slate gable roof.

44-5-20

44-5-20-1

4 C. Buildings
1 C. Structure
1 N.C. Building

Clay Ridge Road

This 2 1/2 story plastered stone farmhouse was built circa 1825. In the mid-nineteenth century stone additions were made that are sympathetic to the main block. Outbuildings include a bank barn, pig pen, garage and a root cellar

44-5-20 ADJ

1 C. Structure
Clay Ridge Road

The early example of a concrete arch bridge bears a datestone which reads "County Bridge 30 1909." This bridge has an appearance extremely similar to the stone arch bridges which have been constructed in southeastern Pennsylvania since the seventeenth century. The use of concrete as a building material allowed for the continuation of the construction of arched bridges into the twentieth century.

44-5-21

1 N.C. Building
Bunker Hill Road

This house is non-contributing due to age.

44-5-22 ADJ

1 C. Structure
Clay Ridge Road

This concrete deck bridge bears a datestone that reads "County Bridge 1917." The bridge is supported mid-span by a concrete piling. The side railing are constructed of pipes. According to other information on the datestone, A. Oscar Martin, a local architect of note, served as engineer for this project.

44-5-24

2 C. Buildings
Clay Ridge Road

This farmstead is in good condition and it exhibits fair integrity. The farmhouse is built of wood. It stands 2 1/2 stories tall and is three bays wide. A frame addition extends from the north gable. The bank barn has stone stabling with frame above.

44-5-33

2 C. Sites
1 C. Building
Geigel Hill Road

The ruin of a large blacksmith shop that was recently burned by an arsonist stands astride Geigel Hill Road. Discussion with the owner and on site investigation revealed that this building was designed as a two story shop. The first floor was entered on the street side, while a bank in the rear allowed entry to the second floor. It is possible that in addition to basic blacksmith work, repair or construction of wagons and carriages may have taken place here. Adjoining the ruin is the foundation remains of a bank barn. A mid nineteenth century plastered stone building stands on the bank where the Rapp Creek and Beaver Creek join to form the Tinicum Creek. Historic research did not reveal the original use of this building. It is assumed that based on its location, the building probably utilized the water as a source of power.

44-5-34

4 C. Buildings
1 C. Object
Geigel Hill Road

This property is historically associated with parcel 44-5-33 which stands across the street. The house is built of plastered stone and dates to circa 1850. The double front doors and corinthian porch post capitals subtly reflect a classical influence. A porch extends along the primary elevation and a dormer appears to date to the 1910s. The side porch has been enclosed with window sash. A banked stone smoke house is located behind the house. A one bay early twentieth century garage has been sided with asbestos shingles. A small frame shed and a kerosene pump dating from the first quarter of the twentieth century reflect the change from horse power to gas engine power and the fall of blacksmiths and the rise of mechanics.

44-5-38

44-5-9

5 C. Buildings
1 C. Site
1 C. Structure

Sheep Hole Road

The circa 1800 stone house is a rare example of a five bay house in this region. The 2 1/2 story building is a remarkably well preserved example of a vernacular farmhouse. A 1 1/2 story stone kitchen extends from the rear of the main block, and according to the current owner, may pre-date the larger five bay section. Inside the house early nineteenth century wallpaper and original paint colors remain intact. The house was purchased in the 1920s by Charles and Lorraine Rudy who reluctantly added modern conveniences in a conservative manner. After living in the house for thirty years an indoor bathroom was installed on the second floor of the kitchen. Mr. Rudy, a well known sculptor, converted the second floor of the large bank barn into a studio and placed a kiln within the foundation remains of a demolished hay barn ell. Other buildings on the property include a carriage house, privy, and a shed.

44-5-39

44-5-8

2 C. Buildings
1 N.C. Building

Sheephole Road

This 2 1/2 story three bay stone house bears a datestone which reads "J & M Rufe 1856." A circa 1940 addition was added to the original section of the house. The main block retains many original features including window sash, first floor shutters, flooring, moldings, and doors. The first floor was originally divided into two rooms, but the partition between the kitchen and parlor was removed. A frame chicken coop and a non-contributing frame garage are located on this property.

44-5-40
44-5-6-2

4 C. Buildings

Sheephole Road

The original portion of the John Wexley house is a 2 1/2 story three bay stone farmhouse. During the 1930s Wexley added a large addition to the house that doubled the square footage. The new addition was constructed of native red shale and many of the details reflect local building traditions. A small smokehouse stands in front of the house. The bank barn is built of stone with a frame forebay. A one story frame ell with a stone foundation extends from a gable wall of the barn. A frame chicken coop is sited in a pasture several hundred feet from the main house.

44-14-1
44-14-2

1 C. Building
1 C. Building
2 N.C. Buildings
Headquarters Road

This property was built by Christian Fretz. Although the house bears a 1740 datestone, it does not seem likely that the house was constructed until the last quarter of the eighteenth century. Mr. Fretz ran the grist mill that was located across the road from this site (the mill no longer stands). In the 1930s the building was added to in a sympathetic manner utilizing native stone with the detailing consistent with local building traditions. In addition to the house and mill site, a stone bank barn (44-14-2) stands across Headquarters Road. The barn is built of stone and has been sympathetically converted into a residence. A non-contributing horse stable and horse shelter is located on this parcel.

44-14-3

1 N.C. Building
Headquarters Road

This house is non-contributing due to age.

44-14-3-1

2 C. Buildings
2 C. Structure
1 C. Site
Headquarters Road

This stone house is built of plastered stone and is the only example of a banked house in the district. The building is 2 1/2 stories on one elevation and 3 1/2 stories on the opposing elevation. The house was constructed circa 1790 and the interior features a significant amount of surviving historic fabric. Of note are several fireplace mantels with gouge carving and drill work. Local tradition suggests that an itinerant carver wondered through this area and exchanged these mantels for lodging and food. A bank barn with stone stabling and frame upper levels is sited down from the house along Headquarters Road. The barn was covered with asphalt shingles in the 1930s. Other agricultural outbuildings include a single corn crib and a chicken coop. The concrete foundation of a privy is located near the house.

44 - 14 - 8

1 N.C. Building
Headquarters Road

A non-contributing horse shed is located on this parcel.

44-14-8 (ADJ)

1 C. Structure
Headquarters Rd.

This bridge carries Headquarters Road over Tinicum Creek. The deck of the bridge is made of concrete and the side railings were made from pipe. A datestone in one of the terminal post supports reads "No. 286 Rebuilt 1919." The massive stone bridge approaches and middle support suggest that the earlier bridge may have been a wooden covered bridge.

44-14-9

2 C. Buildings
Headquarters Road

The stone farmhouse dates to circa 1850 and features double front doors. A porch extends along the primary elevation. Recently, the stucco was removed from the outside of the house and the red shale was pointed. The bank barn is built of stone and has been adapted into living space. No other outbuildings survive.

44-14-21-1

44-11-43-1

5 C. Buildings
1 C. Structure

Red Hill Road

The farmhouse consists of a five bay 2 1/2 story stone section that dates to circa 1835 with a wood frame three bay addition that dates to circa 1855. The first floor door openings on the stone section appear to have been changed from the original design, but the window sash, porches, and slate roofs have all survived in good condition. The outbuildings are a good collection of nineteenth century farm buildings. The bank barn is built entirely of stone and it retains an exterior stucco finish. Other outbuildings include a double drive through corn crib, a wagon house, a privy and a piggery that was converted into an apartment.

44-11-43-2

1 N.C. Building
Red Hill Road

This house is non-contributing due to age.

8. Statement of Significance

Certifying official has considered the significance of this property in relation to other properties:

☐ nationally ☐ statewide ☒ locally

Applicable National Register Criteria ☒ A ☐ B ☒ C ☐ D

Criteria Considerations (Exceptions) ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G

Areas of Significance (enter categories from instructions)
Architecture
Agriculture

Period of Significance
1790-1940

Significant Dates
N/A

Cultural Affiliation
N/A

Significant Person
N/A

Architect/Builder
Unknown

State significance of property, and justify criteria, criteria considerations, and areas and periods of significance noted above.

The proposed Ridge Valley Rural Historic District, located in Tinicum Township, Bucks County is locally significant under Criterion A in the area of Agriculture as an example of farming in small stream valleys in the county. This type of farm forms a distinctive subset of traditional Bucks County agricultural development. It is also eligible under Criterion C for its architecture which is representative of southeast Pennsylvania rural vernacular architecture from the late 18th to the early 20th century. Throughout the Ridge Valley Historic District winding dirt roads, stone farmsteads and outbuildings, fields and meadows are found in visual harmony with the intact and undisturbed wetlands and woodlands. These features provide an outstanding context for the district's architecture. The period of significance is circa 1790 to circa 1940.

Architecturally, the Ridge Valley Rural Historic District contains representative examples of late eighteenth and early nineteenth century vernacular architecture of the region. These represent second generation buildings. No houses from the original settlement period have survived. The earliest houses were small one story log structures which were later replaced by the current stone ones. The 1798 Federal Direct Tax bears this out indicating that many of the original houses and barns in the district were log. After the log houses of the settlement period, stone became the predominant building material and remained so well into the mid nineteenth century. This was probably more due to the availability of easily quarried and easily worked shale than the relative wealth of the builders. Like much of the region, houses in Ridge Valley built in the second quarter of the nineteenth century were usually three bays wide. By the 1850s stone houses with twin front door became common. Post Civil War outbuildings and additions to houses were built of wood frame. The progression from small log houses in the settlement period to stone houses built after the farm was better established, to frame construction after the Civil War is representative of the vernacular Bucks County building tradition.

☒ See continuation sheet

The generally small size of houses and their lack of ornamentation suggests a more modest income level for this valley's farmers. Although most barns are of typical size, most stone farm houses are two or three bays (for example TMP 44-5-10 and 44-5-40). But a few larger houses were built. The largest house in the district (TMP #44-5-38) is a full five bay vernacular house. [A second five bay house (TMP#44-11-21-1) appears to have been built in two sections]. The only other large house within the district was constructed by Christian Fretz (TMP #44-14-1). Fretz' substantial house seems directly related to his wealth as the area's saw and grist mill owner. This house was considerably enlarged in 1932.

Agricultural outbuildings also contribute to this district's architectural significance. Several properties have well preserved farmsteads consisting of a range of outbuildings in addition to the house and barn (TMP 44-5-20, 44-5-40, 44-5-38, 44-5-7, 44-14-3-1, and 44-14-21-1). The presence of corn cribs, wagon houses, chicken coops, pig pens and privies creates a strong vernacular farmscape in several areas of the district. On a few farms lesser outbuildings that have not been maintained have been taken down.

The topography of the land in this area limited the economic viability of many of these farms in the twentieth century. Farming was successfully pursued in the entire area when the source of power for basic farm machinery was the horse. But as farming became more dependent on machines and less labor intensive, the hillier farms could not successfully compete. The transition to dairy farming and the widespread adoption of the tractor after World War II limited successful farming in this district to those farms with the least hilly ground. The fact that steep slopes were more difficult to cultivate by machinery than flat or gently rolling farm land made these farms less successful.

Evidence of this decline in the number of operating farms takes several forms. In the most hilly parts of the districts are two farms that were abandoned and only remain as archaeological sites and much of the formerly cultivated hilly farm land has grown back into woodlands. During the first quarter of the twentieth century while many Bucks County farms specialized in dairy farming, the bank barns on the moderately hilly farms within the district show no sign of being adapted to milk production. There is no evidence of cow stanchions or the stabling level of bank barns having been whitewashed for sanitary reasons. Unlike much of central Bucks County, these farms lack twentieth century dairying outbuildings such as milk houses attached to the barns or silos.

The region's lack of twentieth century agricultural methods had two distinctive consequences. These farms, without large equipment sheds, modern silos, grain bins, milk houses, pole barns and large dairy additions retain a more nineteenth century appearance than the farms in other parts of upper Bucks County that remained in operation through the 1960s. Secondly, few farms weathered the Great Depression, making them ripe for purchase by members of the New York artistic community. The influx of this group, who fell in love of with the rugged beauty of the area, is a major factor in how well preserved the Ridge Valley area is today.

In the late 1920s artist Charles Rudy purchased a farm on Sheep Hole Road. (TMP 44-5-38) Several years later he was joined by screenwriter John Wexley who bought a neighboring farm on Sheep Hole Road (44-5-40). Much of Bucks County attracted artists and entertainment personalities during this period. Tinicum boasted actress Miriam Hopkins, song writer Jerome Kern, humorist Dorothy Parker, and playwright S. J. Pearlman.

Rudy converted the bank barn of his farm into a studio. Light for his second floor workspace came from a large slanted dormer he built. During the warm weather he worked under the forebay, when it turned cold he went into the barn. A large hay barn in poor condition was removed and the foundation served as walls for Rudy's kiln. Wexley added a substantial stone addition to his farmhouse circa 1940. The stone matched the existing house, and the addition was faithful to traditional Bucks County architecture. While the individual significance of Rudy and Wexley is not being claimed because most of their accomplishments occurred within the last fifty years, they are representative of a trend in the region's development.

The Ridge Valley Rural Historic District compares well to other Bucks County Rural Historic Districts in terms of integrity and its ability to convey its period of significance. Bucks County has two other rural historic districts: The Upper Aquetong Valley Historic District (which includes portions of the Honey Hollow National Historic Landmark; a rural historic landmark designated prior to the “Rural Historic District” concept) in Solebury Township, and the Gardenville - North Branch Rural Historic District in Plumstead Township.

The Ridge Valley Rural Historic District is an impressive illustration of nineteenth century agricultural growth, and serves as an excellent example of farming in small stream valleys in Bucks County. Ridge Valley represents a more modest level of rural life than that seen in other National Register rural areas in Bucks County. The poorer soils had strong bearing on the built environment.

Comparison of this district to designated districts in Solebury, Plumstead and Tinicum Townships reveals three areas of rural development with strong differences and shows how better soils yielded more prosperous farmers who were able to build more substantial farm houses. The General Soil Map of Bucks and Philadelphia Counties compiled by the U. S. Department of Agriculture Soil Conservation Service notes that the soils in Solebury are nearly level to sloping and moderately well drained. In Gardenville the soils are nearly level and gently sloping, poorly to moderately well drained. In Ridge Valley the soils range from nearly level to moderately steep, poorly drained to well drained soils on uplands. Comparatively, the Solebury soils are excellent, in Gardenvile they are good, and in Ridge Valley they are fair. The prosperity of the farms correlates to the size and ornamentation of buildings and undoubtedly influenced the period of settlement. The best lands were settled early. The value of the land for farming was the single most important factor in how these areas developed. Better soils produced higher yields which translated into more profit which allowed for construction of more substantial buildings. The better lands remain as viable farm land to the present day. In the Aquetong Valley a majority of traditionally farmed fields remain in cultivation. In Gardenville there is some continuance of farming, but much formerly cultivated ground has been subdivided from the farmsteads for suburban housing or remains untended. In Ridge Valley there is very little farming. Growing hay and cutting fields to stop reforestation is the major agricultural pursuit.

The Upper Aquetong Valley Historic District and the Honey Hollow National Historic Landmark overlap. Both are both located in Solebury Township, in central Bucks County. The Honey Hollow Landmark's period of significance is the late 1930s. It represents the first small upland watershed to be brought totally under water, soil, and wildlife conservation practices in the United States. The Upper Aquetong Valley, and the historic resources of Honey Hollow, show the mid eighteenth to late nineteenth century Quaker settlement pattern spanning a period of significance of 1750 to 1900.

Solebury was originally settled by English Quakers in the mid eighteenth century. The Ridge Valley area was settled by Scotch-Irish Presbyterians in the eighteenth century with a strong influx of Germans at the turn of the nineteenth century. Unlike the Ridge Valley area, the majority of farmsteads in the Solebury districts were large, 100 to 200 acres, and the farmsteads tended to be centered on the property down a lane from the main road. In Ridge Valley the acreage of farms average between 60 and 80 acres and nearly all the farms were near the main road. The Solebury farms were initially developed fifty to seventy five years earlier than the farms in Ridge Valley. The better lands in Solebury created more prosperous farmers than those of Ridge Valley. Aided by the advantages of the limestone belt which passes under the soil in that region, the more prosperous farmers built substantial farm houses that were larger and more formal than those in Ridge Valley. In the late 1930s, when many Ridge Valley farmers were selling out their farms to newcomers, farmers in Solebury were pursuing means to enhance and preserve their rich soils.

The Gardenville - North Branch Rural Historic District in Plumstead Township is significant as an example of the convergence of the English and German settlement patterns in Central Bucks County. Despite significant infill and loss of working farms, the district provides insight into nineteenth century agricultural land use. While the Gardenville and Ridge Valley areas share common German ethnicity, the differences in soils and topography has resulted in a level of prosperity higher in Gardenville than Ridge Valley. The prosperity of Solebury was highest of all. The higher level of prosperity resulted in more substantial farm buildings. Unlike Ridge Valley, the gently sloping Gardenville area farms made the transformation into large scale dairy farming in the first half of the twentieth century.

There are few areas in Bucks County that directly compare to Ridge Valley. The Deep Run area along Deep Run Creek in Bedminster Township is an example of a more prosperous group of farms located in a valley along a creek. This area was settled in the mid-eighteenth century by Scotch-Irish. Later, Germans moved in. The farms have substantial stone houses that strongly reflect the Federal style. A grist mill and stone quarry served as local industry. The prosperity here was better than in Ridge Valley. Unlike the Ridge Valley area, this area made the transition into dairy farming and it continues to remain strongly agricultural.

The Cabin Run area of Plumstead and Bedminster developed in a similar pattern. The area was initially settled in the same period. The first owners were English, and the land was tenanted. Dwellings were mostly log cabins which gave the stream its name. By the early nineteenth century, the area had undergone growth and development by a large number of German immigrants. The valley is broader than the Ridge Valley area and consequently the farms were larger and more prosperous.

Since Bucks County remained very strongly agricultural until the mid twentieth century, it is very difficult to find other similar regions. West Rockhill Township, particularly along Tower Road, where most of the land is covered with rocks. Farmable areas are sites where a stream came through and pushed the stones off of a piece of ground large enough to farm. The houses are modest vernacular homes including a stone end log house and several small stone houses. There is no evidence that these farms made it to dairy farming. These types of areas have mostly been subdivided and developed, making the Ridge Valley Rural Historic District's preservation more significant.

The Ridge Valley Historic District is a fine collection of historic resources that are important for their architecture and as a well preserved example of farming in small stream valleys.

9. Major Bibliographical References

County of Bucks, Recorder of Deeds Office. Bucks County Deed Books.

Federal Direct Tax of 1798. Microfilm copies available at the Spruance Library, Bucks County Historical Society.

MacReynolds, George. Place Names in Bucks County, Pennsylvania. Easton, PA: John S. Correll Publishing Company. 1942.

Noll, E.P. Atlas of Bucks County, Pennsylvania. Philadelphia, PA: E.P. Noll & Company, 1891.

Scott, J.D. Combination Atlas Map of Bucks County, Pennsylvania. Thomas Hunter, Printer, 1876.

U.S. Department of Agriculture Soil Conservation Service. Soil Survey of Bucks and Philadelphia Counties. 1975.

[ ] See continuation sheet

Previous documentation on file (NPS):

- [X] preliminary determination of individual listing (36 CFR 67) has been requested
- [ ] previously listed in the National Register
- [ ] previously determined eligible by the National Register
- [ ] designated a National Historic Landmark
- [ ] recorded by Historic American Buildings Survey # ______
- [ ] recorded by Historic American Engineering Record # ______

Primary location of additional data:

- [ ] State historic preservation office
- [ ] Other State agency
- [ ] Federal agency
- [ ] Local government
- [ ] University
- [X] Other

Specify repository: Bucks County Conservancy

10. Geographical Data

Acreage of property Approximately 575 acres.

UTM References

	Zone	Easting	Northing
A	1 8	4 8 7 4 9 5	4 4 8 2 1 2 0
B	1 8	4 8 8 0 1 0	4 4 8 0 8 8 0
C	1 8	4 8 8 6 2 0	4 4 7 9 0 8 0
D	1 8	4 8 7 9 1 0	4 4 7 9 5 9 5

[ ] See continuation sheet

Verbal Boundary Description

[X] See continuation sheet

Boundary Justification

[X] See continuation sheet

11. Form Prepared By

name/title Robert W. Reynolds / Architectural Historian

organization Bucks County Conservancy date March 10, 1992

street & number Bucks County Conservancy 85 Old Dublin Pike telephone (215) 345-7020

city or town Doylestown state PA zip code 1890[illegible]

VERBAL BOUNDARY DESCRIPTION

The following verbal boundary description is based on current Bucks County Tax Parcel Maps and is for reference use only. Courses and distances are approximate.

BEGINNING at a point in the NE corner of the intersection of Red Hill Road (Route LR 09139) and Frankenfield Road (T427);
Thence along the southerly line of parcel 44-11-43-1 westerly 550' to a corner of parcel 44-11-43;
Thence along the easterly side of parcel 44-11-43 northerly 900' to a corner
Thence by same westerly 600' to a corner;
Thence by parcel 44-11-44 the three following courses and distances N 600', NE 175', N 550';
Thence by parcel 44-11-42 and 44-11-42-1 600' to a corner of parcel 44-11-42-1 and the SE side of Headquarters Road (SR 1012) NW 450'
Thence by 44-1-45-5 and along the SE side of Headquarters Road, NE 500' to a corner;
Thence crossing Headquarters Road and by parcel 44-1-45-1, and 44-1-45-4 NW 800' to a corner
Thence by 44-1-45-4 W 500';
Thence by 44-1-45-4 and 44-1-45 NW 1300' to 44-1-43;
Thence by same NE 350' to a corner;
Thence by same NW 900' to a corner in 44-1-41-10;
Thence by parcels 44-1-41-10, 44-5-5 and 44-5-6 NE 1225';
Thence by parcel 44-5-6 N 500';
Thence by same and 44-5-6-3 and crossing Geigel Hill Road (SR 09138) NE 1100';
Thence along N side of Geigel Hill Road W 200' to 44-5-4-2;
Thence by same in a line curving to the west approximately 800' to 44-5-4-1;
Thence by same N 200' to 44-5-3-2;
Thence by same E 400' to a point where the easterly line of 44-5-3-1, if extended southerly would strike parcel 44-5-3;
Thence by said line if extended to parcel 44-5-3-1 and crossing Tabor Road (T 447) 1400' to a point on the N side of said road;
Thence along same W 250' to parcel 44-5-10-2;
Thence along same N approximately 1000' to 44-5-10-1;
Thence along same the following three courses and distances: E 350', S 500' and E 350';

Thence along same, 44-5-11-1 and along the SE side of Bunker Hill Road (T 441) NE 1800' and along 44-5-12-2 E 500';
Thence by 44-5-13-1 and 44-5-13 SE 1150' to a corner;
Thence by 44-5-13 NE 300';
Thence by 44-5-19-1 SE 400';
Thence by 44-5-19-1 and 44-5-12-1 S 400';
Thence by 44-5-12-1 NW 200';
Thence by same and crossing Beaver Creek SW 700';
Thence by same SE 300' to the W side of Clay Ridge Road;
Thence along same SW 1200' to a point where the N line of parcel 44-5-24-2 if extended would cross said road;
Thence along said line if extended and 44-5-24-2 SE 450' to 44-5-32-2 ;
Thence along same S 600';
Thence by 44-5-33-2 SW 400',
Thence by same SE 150';
Thence by 44-5-33-1 SW 450' to S side of Geigel Hill Road E 1300 ' to 44-5-32;
Thence crossing Geigel Hill Road and by 44-5-37 1050' to a corner;
Thence by 44-5-37, 44-14-5-2 and 44-14-5-3 crossing Headquarters Run and crossing Headquarters Road SE 2550';
Thence along N side of Headquarters Road SW 800' to a point on the S line of 44-14-10; if extended across Headquarters Road
Thence along the line between 44-14-10 and 44-14-9 by various courses approximately 3200' to 44-14-11;
Thence by 44-14-11, 44-14-12, 44-14-9-1 SW 800';
Thence by 44-14-9-1 NW 150';
Thence by same SW 700' to 44-14-19;
Thence by same SW 1200' to a corner;
Thence by same along Tinicum Creek 450' to a corner;
Thence by same SW 600' to the POINT OF BEGINNING.

Total area is approximately 575 acres.

BOUNDARY JUSTIFICATION

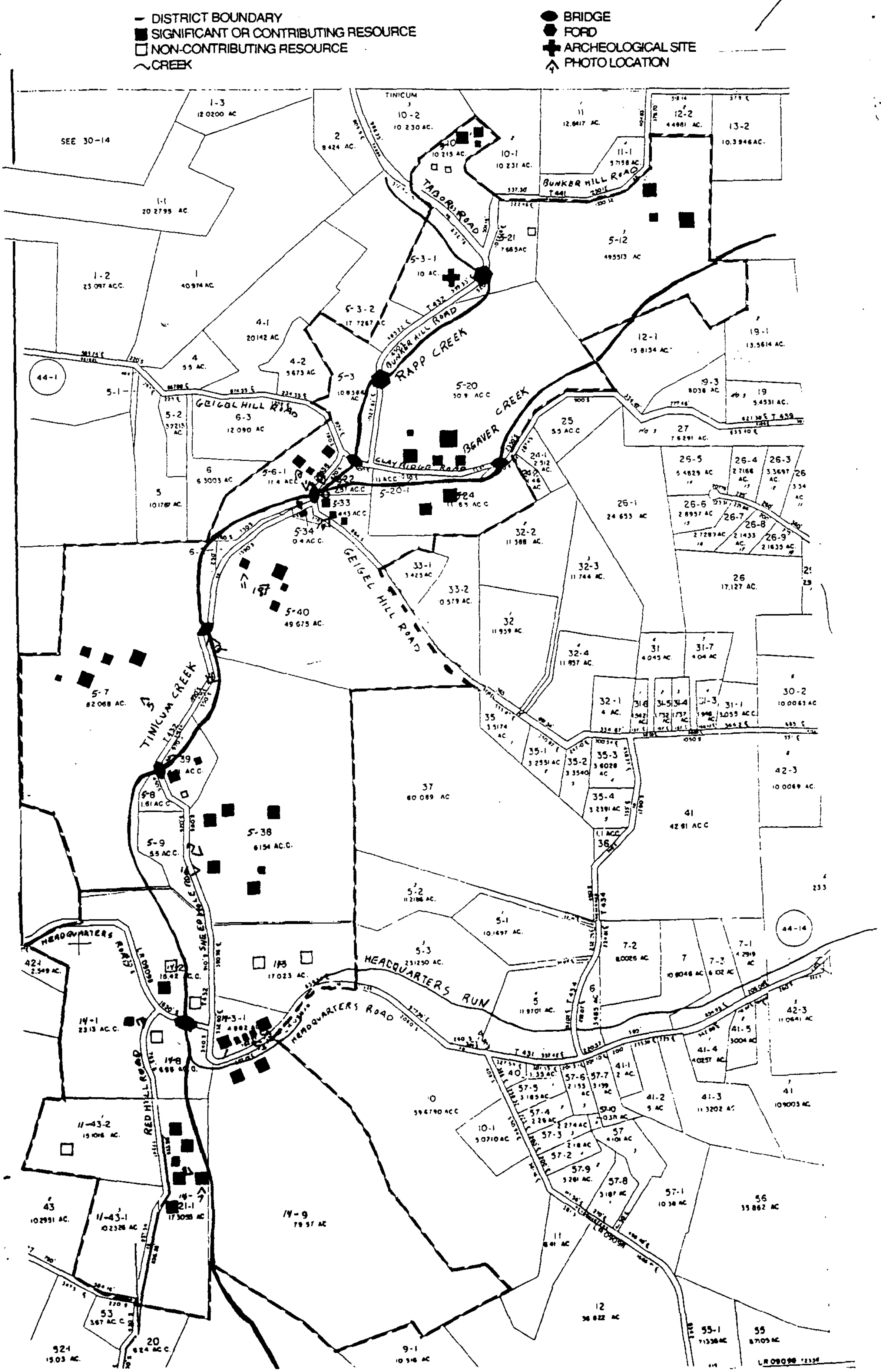
The core of the Ridge Valley Rural Historic District is the valley cut by the Tinicum Creek through which Sheep Hole Road travels. All farmsteads, bridges and significant sites on properties adjoining this road are in the district with their legal property lines serving as the district boundary. The farmland gently rolls from the creek up to the horizon on the east and west sides forming a strong sense of rural seclusion.

South of Sheep Hole Road Headquarters Road begin to climb out of the valley to the east and west. The farmsteads included in this area are located within the valley. Along Red Hill Road one farmstead was included because it forms a strong entry point and because it forms a significant portion of the Tinicum Creek viewshed.

North of Sheep Hole Road Rapp Creek and Beaver Creek combine to form the Tinicum Creek. Rapp Creek is followed by Bunker Hill Road. After passing through two fords Rapp Creek turns west and flows outside the district while Bunker Hill Road climbs out of the valley.

On Clay Ridge Road and Red Hill Road the boundary was drawn to cut the district off from development that was not fifty years or older.

RIDGE VALLEY RURAL HISTORIC DISTRICT
TINICUM TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA



BEDMINSTER QUADRANGLE
PENNSYLVANIA—BUCKS CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

5965 II SE
(FRENCHTOWN)

Ridge Valley Rural Historic District
Bucks County - Zone 18 - Bedminster Quad.
A E487495 N4482120 C E486620 N4417080
B E488010 N4480880 D E487910 N447595

United States Department of the Interior

NATIONAL PARK SERVICE
1849 C Street, N.W.
Washington, D.C. 20240

IN REPLY REFER TO:

DETERMINATION OF ELIGIBILITY NOTIFICATION

National Register of Historic Places
National Park Service

Name of Property: Headquarters Road Bridge (AKA Burnt Mill Bridge)

Location: Bucks County **State:** Pennsylvania

The Headquarters Road Bridge was listed in the National Register of Historic Places on July 24, 1992, as a contributing property in the Ridge Valley Rural Historic District, Bucks County, Pennsylvania. The bridge consists of early 19th century stone abutments and piers carrying an early 20th century replacement concrete deck supported on concrete-encased steel I beams. Both its original construction and alteration occurred within the historic district's defined Period of Significance (1790-1940). The bridge is historically significant in the context of the development of the township, regional transportation, and the operation of local mills, and is of engineering significance both for its early 19th century construction and its sensitive modernization in 1919. Although the concrete deck shows signs of considerable deterioration and the deck has been altered with the removal of the 1919 railings, the bridge retains sufficient historic integrity to continue to contribute to the Ridge Valley Rural Historic District.

Patrick Andrus
Historian
National Register of Historic Places
4/28/2006

22 July 2016

Brian Thompson, Director
Bureau of Project Delivery
Attn: Monica Harrower
PA Department of Transportation
P O Box 2966
Harrisburg, PA 17105

Re: ER# 2005-8029-017-CCC (MPMS 13716)
Headquarters Road over Tinicum Creek (S.R. 1012, Section BRC)
Tinicum Township, Bucks County
Determination of Effect Report Addendum

Dear Mr. Thompson:

Thank you for submitting information concerning the above referenced project. The Bureau for Historic Preservation (the State Historic Preservation Office) reviews projects in accordance with state and federal laws. Section 106 of the National Historic Preservation Act of 1966, and the implementing regulations (36 CFR Part 800) of the Advisory Council on Historic Preservation, is the primary federal legislation.

We are in receipt of the additional information, including alternatives analysis, provided in response to our comments on the Determination of Effects Report for the above listed project. It is our opinion that there has been sufficient consideration of designs that accommodate project purpose and need while avoiding/minimizing effects to the National Register listed Ridge Valley Rural Historic District. The proposed project will result in the physical destruction of a contributing resource and introduction of a two-lane bridge; therefore we are in agreement with the finding of Historic Properties Adversely Affected. We anticipate additional consultation with FHWA, PennDOT and the consulting parties regarding relevant minimization and mitigation efforts including visual compatibility of the new bridge with the surrounding historic district.

Please contact Barbara Frederick at (717) 772-0921 for further information regarding this review.

Sincerely,

Douglas C. McLearen, Chief
Division of Archaeology and Protection

DELAWARE
RIVERKEEPER
NETWORK

June 15, 2020

Patrick Patterson, Southeast Regional Director
Pennsylvania Department of Environmental Protection
2 East Main Street
Norristown, Pennsylvania 19401
Email: Patrick Patterson patpatters@pa.gov

Submitted for the record to: *ra-epww-sero@pa.gov*

Regional Director Patterson:

Regarding the PennDOT District 6 Headquarters Road Bridge project (MPMS 13716) Permit No. E0901120-026 in Tinicum Township, Bucks County, in addition to the requests in my June 12, 2020 letter regarding the tolling of the public comment period and securing public access to project application materials, I would like to request that the PADEP hold a public hearing pursuant to 25 Pa. Code § 93.4c(b)(1)(ii) which requires PADEP to hold a public hearing on a "proposed new, additional or increased discharge to Exceptional Value Waters when requested by an interested person on or before the termination of the public comment period on the discharge."

Please contact Ed Rodgers with our organization at ed@delawareriverkeeper.org when you are able to make the documents available. Thank you for your time and assistance.

Respectfully,

Maya K. van Rossum

Maya K. van Rossum
the Delaware Riverkeeper

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215)369-1181
drn@delawareriverkeeper.org
www.delawareriverkeeper.org

From:	Patterson, Patrick
To:	Maya van Rossum
Cc:	Ed Rodgers; Kacy Manahan; Bridget Brady; Cain, Virginia; White, Douglas G; Hohenstein, John
Subject:	RE: [External] Public hearing request for Permit No. E0901120-026 in Tinicum Township, Bucks County
Date:	Wednesday, June 17, 2020 10:34:12 AM
Attachments:	image001.png image002.png

Maya –

I was copied on your email to Doug White acknowledging the posting of the requested application documents electronically and asking that the comment clock start today. I feel this is a more than reasonable request and have directed the program to do just that. I hope that meets with your satisfaction and gives you and other interested stakeholders ample opportunity to submit comments.

As far as the public hearing request goes, we are subject to the following statewide guidance at this time:
To prevent the further spread of COVID-19, public meetings and hearings, unless required under the regulations, have been suspended until further notice in order to protect the health of those in attendance. Those required under regulations are being conducted virtually where possible. The regulations guiding this permit do not call for a mandatory public hearing, so therefore, one will not be scheduled.
It is important to note that while public hearings are formal, structured proceedings that afford the public the opportunity to provide <u>verbal</u> testimony, submitted <u>written</u> testimony and comments carry equal weight and consideration with DEP. You may submit your comments by mail at 2 E. Main St., Norristown, PA 19401 Attn. Waterways and Wetlands or by email at RA-EPWW-SERO@pa.gov, noting the application name in the subject line.
I hope this information is helpful. As always, if you have any questions, please contact me directly.
Regards,
Pat

Patrick L. Patterson | Regional Director
Department of Environmental Protection|Southeast Regional Office
2 East Main Street | Norristown, PA 19401
Phone 484.250.5942 | Fax 484.250.5943
www.dep.pa.gov

From: Maya van Rossum <Keepermaya@delawareriverkeeper.org>
Sent: Monday, June 15, 2020 8:32 AM
To: EP, WW-SERO <RA-EPWW-SERO@pa.gov>; Patterson, Patrick <patpatters@pa.gov>
Cc: Ed Rodgers <Ed@delawareriverkeeper.org>; Kacy Manahan <Kacy@delawareriverkeeper.org>; Bridget Brady <Bridget@delawareriverkeeper.org>
Subject: [External] Public hearing request for Permit No. E0901120-026 in Tinicum Township, Bucks

County

ATTENTION: *This email message is from an external sender. Do not open links or attachments from unknown sources. To report suspicious email, forward the message as an attachment to CWOPA_SPAM@pa.gov.*

Dear Regional Director Patterson,

Please see attached requesting a public hearing regarding the Headquarters Road Bridge project.

Maya

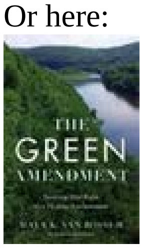
Maya K. van Rossum
the Delaware Riverkeeper
* Leader of the Delaware Riverkeeper Network
* Author of *The Green Amendment, Securing Our Right to a Healthy Environment*.
* Founder of the national Green Amendment For The Generations movement

Pronouns: she, her, hers

Delaware Riverkeeper Network
925 Canal Street, Suite 3701, Bristol, PA 19007
215 369 1188 ext 102

Website: www.delawareriverkeeper.org
Twitter: @MayaKvanRossum

Order *The Green Amendment* at : http://bit.ly/TheGreenAmendment
Or here:



From: "Maya K. van Rossum" <Keepermaya@delawareriverkeeper.org>
Date: Friday, June 12, 2020 at 10:52 AM
To: "ra-epww-sero@pa.gov" <ra-epww-sero@pa.gov>, Patrick Patterson <patpatters@pa.gov>
Cc: Ed Rodgers <Ed@delawareriverkeeper.org>, Kacy Manahan <Kacy@delawareriverkeeper.org>, Bridget Brady <Bridget@delawareriverkeeper.org>

Subject: Unable to access documents - documents & comment extension requested -- Permit No. E0901120-026 in Tinicum Township, Bucks County

Dear RD Patterson,
I hope you and yours are safe and well.
I ask you to please review the attached letter regading Permit No. E0901120-026 in Tinicum Township, Bucks County, our inability to access documents and the need, therefore, for a comment period extension.
With regards,
Maya

Cc: to the public comment record for Permit No. E0901120-026 in Tinicum Township, Bucks County

Maya K. van Rossum
the Delaware Riverkeeper
* Leader of the Delaware Riverkeeper Network
* Author of ***The Green Amendment, Securing Our Right to a Healthy Environment***.
* Founder of the national Green Amendment For The Generations movement

Pronouns: she, her, hers

Delaware Riverkeeper Network
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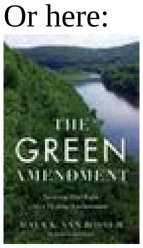
Order *The Green Amendment* at : http://bit.ly/TheGreenAmendment
Or here:



Rippled Waters
Engineering, LLC

16 July 2020

<u>VIA EMAIL</u>
Mr. Ed Rodgers
Delaware Riverkeeper Network
925 Canal Street, Suite 3701
Bristol, PA 19007

Re: Technical Expert Report regarding Environmental Impacts related to the Headquarters Road Bridge Replacement Tinicum Township, Bucks County, Pennsylvania

Dear Mr. Rodgers,

In response to your request, this letter serves as my expert opinion regarding the environmental implications of the PennDOT Headquarters Road Bridge replacement as proposed and submitted.

In preparation of this report, I reviewed the following materials made available by DRN:

- Correspondence and photographs:
  - Letter from Delaware Riverkeeper Network dated January 6, 2020 relaying comments on the Soil Erosion and Sediment Control application.
  - Letter from Bucks County Conservation District dated February 3, 2020 indicating that the submitted plan is adequate with comments.
  - Photograph of flood debris in Salerno's pasture seen from Red Hill Road after a Tinicum Creek flood around 1980. The blacktop in the photo is from Headquarters Road as per Bruce Wallace.
- Permit Applications and Review Comments:
  - Memo from PennDOT dated September 19, 2019 regarding comments on the Hydrologic & Hydraulic Report Submission.
  - Chapter 105 Joint Permit Application for Headquarters Road Bridge over Tinicum Creek dated December 11, 2019, 3798 pages.
  - Application for Soil Erosion and Sediment Control Plan Certification to Bucks County Conservation District, dated January 3, 2020.
  - Application for Chapter 105 Joint Permit Authorization (3798 pages) as obtained on June 2, 2020.
  - Design Review Comments received from Jason Maurer, Erosion and Sediment Control Technician, Bucks County Conservation District dated December 24, 2019, received December 30, 2019 as outlined by Urban Engineers

Rippled Waters Engineering, LLC
420 Woolf Road, Milford, NJ 08848
732.735.3440
mary@rippledwatersllc.com
www.rippledwatersllc.com

- Reports:
    - "Determination of Effects Report S.R. 1012, Section BRC Headquarters Road Bridge Project," dated November 2015.
    - "Erosion & Sedimentation Pollution Control Narrative," dated November 2019, last revised January 2020, as prepared by Urban Engineers.
    - "Hydrologic and Hydraulic Study – SR1012 (Headquarters Road) over Tinicum Creek," dated July 2019, as prepared by Urban Engineers.
    - "The Dangers of Moving the Headquarters Road Bridge," undated.

Drawings:

- Drawings entitled "Commonwealth of Pennsylvania Department of Transportation Bucks County S.R. 1012, SEC BRC – Type, Size, and Location," two sheets, plotted July 16, 2019.
- A drawing in PDF format entitled, "Urban Engineers PennDOT Bridge Drawing Stages 1 and 2.pdf"
- A drawing in PDF format entitled, "Urban Engineers PennDOT Bridge Drawing Stages 3, 4, 5, and 6.pdf"
- Plans entitled, "Erosion and Sediment Pollution Control Plan," 10 sheets, as prepared by Urban Engineers, Inc., dated May 4, 2020.
- Official "Site Specific Drawings or Standard Drawings" dated April 22, 2020 with plot dates of 5/13/2020 and 5/20/2020.
- Drawing entitled, "Commonwealth of Pennsylvania Department of Transportation Bucks County S.R. 1012, Sec BRC, Wing Extension Plan and Elevation"
- 90% Drawing entitled, "Commonwealth of Pennsylvania Department of Transportation Bucks County S.R. 1012, Sec BRC, General Plan and Elevation" dated June 8, 2020.

This report serves as a summation of the environmental impacts associated with the proposed project as it relates to the proposed bridge modification.

Project Location and Site Characteristics

Existing Site Characteristics. The project site is located near the intersection of Headquarters Road and Sheep Hole Road in Tinicum Township, Bucks County, Pennsylvania approximately 5.5 miles upstream from the confluence with the Delaware River. The existing bridge, which was originally built in 1812 and has a superstructure that was replaced in 1919, is currently a 78-foot span single lane bridge with two piers crossing the Tinicum Creek with normal flows passing only through the river right cell of the bridge facing downstream. The E&S Narrative prepared by Urban Engineers incorrectly states that "the project site has been used as a two-lane public highway since its construction in the early 1800's." The current bridge has been a single lane since it was constructed.

The Tinicum Creek flows for a total length of 6.40 miles with an overall elevation drop from 240 feet at the headwaters to an elevation of 100 feet at the confluence with the Delaware. The average slope of the stream reach in the project area is ranges between 0.002 and 0.01 feet per foot.

Geomorphology. The Tinicum Creek naturally meanders; the meanders are generally linked to the bedrock outcrops which exist in the river valley. Meander bends in the Tinicum Creek are constrained by the geologic features which exist and there has been recent evidence of channel migration in the watershed within its floodplain. That being said, no significant change to the sinuosity of the creek has been noted by local residents or evidenced in available aerial maps of the project site.

The stream bed at the project site is laden with gravel and cobble. There are gravel bars that have formed both upstream and downstream of the existing bridge. The channel at the project site is entrenched with a moderate width to depth ratio and moderate sinuosity.

The banks of the channel upstream of the bridge are 5H:1V (the eastern bank) along the edge of Sheep Hole Road and then increase to approximately 3H:1V after crossing over the roadway. The banks of the channel on river right are approximately 5H:1V (the western bank) and connect to a floodplain area that is currently a meadow with a forested riparian edge that ranges in width from 12 to 20 feet within 200 feet of the bridge and then increases to 35 to 45 feet at the downstream end of the pasture to a point approximately 570 feet below the bridge. The meadow floodplain area extends for approximately 275 feet before the elevations steeply increase to the west.

Downstream of the bridge, the stream banks are similar to upstream. River left (east) remains 5H:1V before the Headquarters Road section and then rises more steeply into the slope. River right (west) maintains a 375-foot wide meadow floodplain with a 40 feet wide riparian forest corridor before the floodplain corridor slope gets steeper.

Normandeau Associates conducted a Pennsylvania Riverine Condition Level 2 Rapid Assessment (RCA) on February 19, 2020 for the proposed bridge project. The assessment focused on 100 feet upstream and downstream of the bridge crossing. The RCA completed focused on five condition indices including channel/floodplain, riparian vegetation, riparian zone of influence, instream habitat, and channel alteration. The results yielded condition index values between 0.56 and 0.85 with an overall RCA value of 0.69. The Riverine Assessment Form prepared by Normandeau indicates that the floodplain area to the west of the creek may be "slowly side cutting into the legacy sediment deposits (mapped alluvial soils) that fill the historic floodplain. An active floodplain connection would be present at bank full and higher flows as indicated by the wide 100-year floodplain that extends west of the creek channel. This area is mapped as alluvial soil (Rowland) which indicates that it is likely formed from legacy sediment." The potential for the stream to meander into the alluvial material increases under proposed conditions when the bridge itself is moved 15-feet to the west from its current configuration.

Soils and Geology. As part of this report, RWE reviewed the United States Department of Agriculture Natural Resource Conservation Service (USDA NRCS) Web Soil Survey. The area upstream and downstream of the bridge located on river right was the primary focus of the review and the soil series in the area consist primarily of Bowmansville-Knauers silt loams and Rowland silt loam. Both Rowland silt loams and Bowmansville-Knauers silt loams parent materials are recent alluvium derived from sandstone and shale. Typical soil profiles for Rowland silt loam and Bowmansville-Knauers silt loams are included below for reference.

Typical Profile of Bowmansville-Knauers silt loam

0-7 inches silt loam

7-26 inches silty clay loam

26-43 inches fine sandy loam

43-65 inches stratified gravel to sand

65 inches+ inches lithic bedrock

Typical Profile of Rowland silt loam

0-12 inches silt loam

12-46 inches silty clay loam

46-61 inches stratified gravel to sand

61 inches + lithic bedrock

Given the large percentage of silts in the primary soils onsite, there is significant potential for erosion. According to the USDA NRCS, soils with high silt content are the most erodible of all soils. Silts are easily detached and tend to crust and produce high rates of runoff. Values of K_f (the soil erodibility factor) for silts tend to be greater than 0.4. Based on the report generated from the Web Soil Survey for the Rowland and Bowman soil types, the K_f values range from 0.32 to 0.43.

The mapped soils and RUSLE characteristics for these soils as obtained from the Web Soil Survey are included as Attachment A of this report.

The site is underlain by Brunswick Formation geology, which is a sedimentary layer of rock consisting of mudstone, siltstone, and beds of green, brown, and red-brown shale. As noted in the soil profiles for the primary soil types onsite, it can be anticipated that gravel and sand layers exist between 43 and 65 inches below existing grade. Given the Tinicum Creek has a channel invert at roughly the same elevation, it can be surmised that the alluvium and gravel layers may be indicative of former stream channels in the floodplain area on river right. Since no soil borings or test pits were completed in the adjacent fields, it is not possible to verify the presence of stream channel remnants, however, the geomorphology of the stream supports the meandering of the channel over time.

Review of Another PennDOT Bridge Replacement in Tinicum Township

To better understand the potential impacts of the bridge replacement, RWE reviewed a recent bridge replacement on the nearby Little Tinicum Creek to understand the potential impacts of PennDOT's bridge replacements. Details of the bridge reviewed are noted below:

Cafferty and Headquarters Road Bridge. The Little Tinicum Creek travels through the bridge opening and makes a 90-degree bend to the left immediately downstream as shown in Figure 1 below.

Figure 1. Aerial view of Cafferty Bridge.

The preliminary concept shared for the project indicated that the span would be the only portion of the bridge replaced and no modification was proposed to the stream channel. As evidenced in the as-built photo shown as Figure 2 below, the bridge was replaced with a nearly 200' long retaining wall on the left bank. The edge of the wall was buried with some rocks and fill.

Figure 2. Cafferty Road As-built Photograph circa 2017.

Since the bridge was installed, it is my understanding that numerous efforts have been made to stabilize the new streambank with riprap as erosion has increased along the river left bank. Given the typical soils and geology in the watershed, the surficial soils are prone to erosion and attempts to stabilize a straightened reach of the stream will be ongoing. The riprap placed on the streambank since

Hydrology and Hydraulics Review & Analysis

During preparation of this report RWE conducted a detailed review of the report prepared by Urban Engineers and completed an independent analysis of the hydrology and hydraulics at the bridge site. The results of that review and analysis are detailed herein.

Hydrology

As part of the preparation of this report, RWE reviewed materials associated with stream flows in Tinicum Creek. Available sources of stream flow data included the United States Geologic Survey (USGS), the Act 167 Plan for Delaware River (North) Watershed, and the Hydrologic and Hydraulic study conducted by Urban Engineers for the bridge replacement. The USGS stream gage located at the site (Station 01458900) recorded heights and peak flow values during its operation. The gauge was operated between 1962 and 1980, however, the gauge was not continuously operational during that time period. The gauge operated continuously from December 11, 1990 to January 11, 1993. The Urban Engineers study included an analysis completed in Watershed Modeling System (WMS) software and HEC-1. RWE confirmed the drainage area to the bridge using USGS StreamStats and found the drainage area to the bridge to be approximately 14.5 square miles (refer to Attachment B), which is consistent with the Urban Engineers report. The flow values used by Urban Engineers were reasonable and as such, RWE utilized the peak flow values in Table 1 below in the analysis.

Table 1. Peak Flow Rates

Design storm	2-year	10-year	25-year	50-year	100-year	500-year
Peak flow (cfs)	1,871	3,842	4,937	6,344	7,864	12,150

Hydraulics

To understand potential scour, erosion, and water surface impacts resulting from the bridge replacement, RWE reviewed the hydraulic assessment conducted by Urban Engineers. RWE also conducted a HEC-RAS analysis of the existing bridge and proposed bridge as well. Details of the areas where the modeling deviated from the assumptions made by Urban Engineers are summarized herein. Generally, modifications were made to the bridge geometry and the channel dimensions in the vicinity of the bridge itself under existing and proposed conditions.

<u>Manning's n values.</u> RWE conducted a review of the Manning's n values selected for the HEC-RAS model and noted that Urban Engineers used Manning's n values as follows: channel – 0.040, medium to dense brush - 0.070, pasture and short grass – 0.030, woods – 0.100, paved surfaces – 0.013, and dirt roads – 0.020. Based on a review of the USGS "Guide for selecting Manning's n roughness coefficients for natural channels and floodplains," the selected Manning's n values are reasonable for the stream and its floodplain.

<u>Bridge geometry and alignment</u>. RWE reviewed the existing and proposed bridge section information provided in the Urban Engineers report for consistency with measurement data available and the information depicted on the design plans available.

Existing Bridge Characteristics. A review of the existing bridge opening was completed to ensure the existing bridge opening was modeled accurately. The review yielded inconsistent information depending on the methodology used to determine the bridge opening size. First, existing bridge opening information was obtained from the existing conditions plans shown in Figure 3 in the Determination of Effects report dated November 2015.

Then, RWE reviewed the existing conditions opening modeled in HEC-RAS by Urban Engineers as it relates to the bridge measurements available. The Urban Engineers report notes an existing hydraulic opening of approximately 525 square feet; however, insufficient information exists to verify whether that is an accurate representation of the existing conditions and opening at the bridge. According to the report, each of the two piers are approximately 5'7" wide and the model data provided by Urban refers to a pier width of 5.6 feet. When compared to each other, there are discrepancies between the modeled existing conditions and the existing conditions plan shown in Figure 3.

The variation in the existing conditions bridge openings are shown in Table 2 below:

Table 2. Urban Engineers Existing Bridge Hydraulic Opening Comparison.

	East Opening Width (ft)	Central Opening Width (ft)	West Opening Width (ft)
Existing Conditions Plan	21.54	21.4	20.36
HEC-RAS Data Input	21.87	19.06	21.87

It can be assumed that the hydraulic analysis conducted by Urban Engineers may not be accurately depicting existing conditions hydraulics given that the opening widths in the roadway/deck editor do not reflect the measured conditions noted on the existing conditions plan. The inconsistent data evidenced in Table 2 is one of many examples why RWE was unable to conduct a thorough review of the potential hydraulic and environmental impacts of the proposed bridge replacement. Urban Engineers should review all of their data for consistency and accuracy and revise the modeling and design as necessary to ensure the project does not result in degradation of the creek and resubmit the applications for technical review.

Based on measurements taken by Delaware Riverkeeper Network scientific staff in 2020, the openings of the existing bridge are as noted in Table 3 below with an estimated hydraulic opening of 535 square feet.

Table 3. Existing Conditions Bridge Openings as measured by DRN.

Bridge Face	Average East Opening Width (ft)	Average Central Opening Width (ft)	Average West Opening Width (ft)
Upstream	21.38	20.88	20.13
Downstream	21.60	21.45	21.20

RWE utilized the DRN measurements and openings in the existing conditions analysis included in Attachment C of this report for reference.

Proposed Bridge Characteristics. The proposed bridge replacement is a two-lane bridge 80-foot span with a single central pier over the Tinicum Creek with spans of 40 feet as measured from the center of the abutment walls to the center of the proposed pier. The channel opening will be armored with R-8 riprap on the side slopes and R-6 riprap around the proposed pier. The grading of the proposed channel in the creek itself is unclear as there is no proposed grading depicted and the existing piers are not noted to remain upon completion of construction.

Channel modification. Based on the proposed design depicted on the sheet entitled, "Bucks County S.R. 1012, Sec BRC General Plan and Elevation", the proposed bridge opening will be shifted between 15.75 and 17.25 feet to the west of its current alignment over Tinicum Creek. The western bridge opening has a beginning station of 13+02.63 (or potentially 1.5 feet from this station as scaled from the drawing) under proposed conditions whereas the existing conditions shown on page 3597 of the PADEP Chapter 105 application document PDF notes a station of 13+19.88 for the eastern bridge abutment. The eastern bridge abutment shifts eastward into the Tinicum Creek by 10.09 to 11.59 feet under proposed conditions. The eastern bridge opening has an existing station of 13+94.29 noted at the edge of the existing abutment on page 3597 of the PADEP Chapter 105 application document PDF whereas the proposed station for the eastern abutment is 13+82.70 (or potentially 1.5 feet from this station as scaled from the drawing entitled, "Bucks County S.R. 1012, Sec BRC General Plan and Elevation." Given the uncertainty in the information provided, it is unclear what the actual proposed bridge alignment modification is from existing conditions. To analyze proposed conditions, RWE assumed that the channel shifted by 17.25 feet to the west and by 11.59 feet at the eastern abutment for the proposed conditions HEC-RAS analysis included in the report, however, this is another example of inconsistent and deficient information in the submitted materials.

As part of the channel alignment modification, the proposed conditions plan indicates grading on the western bank downstream of the bridge that will be stabilized with R-6 and R-8 modified rock scour protection choked with natural stream bed material and riparian plantings to a point where the proposed grading ties into existing streambank grading approximately 25 feet downstream of the bridge opening. Further, the eastern bank downstream of the bridge has proposed grading extending more than 50 feet downstream[1] associated with construction of the downstream abutment wall and a proposed R-4 rock apron as noted on the General Plan and Elevation sheet.

To determine what impacts the channel modification might have on predicted water surface elevations, velocities, and shear stresses downstream of the bridge, RWE modified the bridge opening under proposed conditions to reflect the full channel width depicted on the sheet entitled, "General Plan and Elevation for Bucks County, S.R. 1012, Sec BRC" which was measured to be approximately 36.8 wide on either side of the central pier. The proposed bridge and modified

[1] The grading extends beyond the viewport shown so the exact extent of regrading is unknown.

channel were analyzed in HEC-RAS and the results of that analysis are included in Attachment D of this report.

Key Findings

Figure 3 below depicts the cross-section locations modeled by RWE. The cross-sections are numbered measured based on the distance from the downstream end of the Tinicum Creek reach

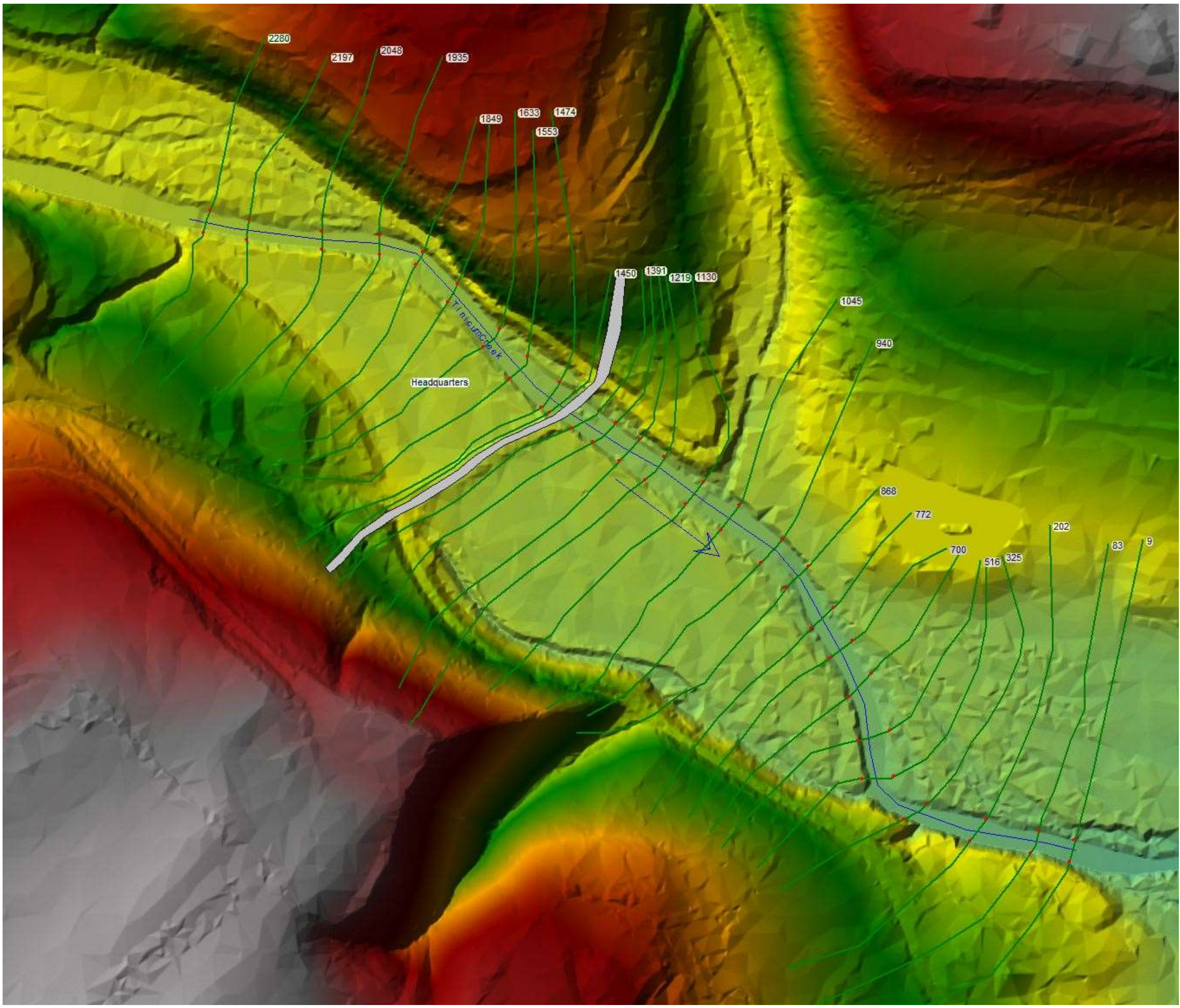


Figure 3. HEC-RAS Cross-section locations.

modeled starting with Station 9 and ending with Station 2280. The Headquarters bridge is shown in grey in the center of the figure. The cross-sections shown were establishing using LiDAR data available for the project area in combination with the data obtained from DRN for the project. The cross-sections are generally spaced every 100 feet with more cross-sections in areas where the channel geometry varies and around the bridge itself.

Without complete information from Urban Engineers on the channel itself, it is difficult to understand the proposed channel bed elevations in the vicinity of the bridge. RWE used the stationing previously discussed for the proposed bridge opening and the channel inverts identified at the bridge crossing to update the upstream (RS1450) and downstream cross-sections (RS1391) to reflect the elevation information shown on the sheet entitled, "Bucks County S.R. 1012, Sec BRC General Plan and Elevation." The results of the HEC-RAS analysis RWE completed indicate that average total velocities in the downstream cross-section located approximately 25 feet downstream of the bridge (RS1391) will range between 5.31 and 9.5 feet per second under proposed conditions with the largest velocity occurring during the 10-year recurrence interval. The anticipated velocities in the channel downstream under proposed conditions are summarized in Table 4 below.

Table 4. Predicted Peak Velocities at RS1391.

Storm event	Proposed velocity (fps)
2-year	5.31
10-year	9.5
25-year	6.72
50-year	7.16
100-year	7.66
500-year	9

Given the shift of the stream channel by as much as 17.25 feet to the west of its current alignment and the average velocities in excess of 9.5 feet per second, increases in erosion downstream will result. Under existing conditions, the downstream cross-section is subject to velocities under 9 feet per second during all of the modeled recurrence intervals. The velocity during the 10-year event increases by more than 3 feet per second under proposed conditions. If this increase in velocity occurs downstream of the bridge, it will have negative impacts on the water quality of Tinicum Creek. Further, the proposed velocities are such that it raises the likelihood that the channel will migrate into the floodplain area to the west of the existing stream. This migration has already been seen upstream of the bridge in question at the Geigel Hill Road bridge when a dam failed nearly 50 years ago as noted in the report entitled, "The Dangers of Moving the Headquarters Road Bridge."

Stormwater Conveyance System Review and Analysis

Limited information was available on the proposed stormwater conveyance system; however, RWE evaluated the stormwater system for potential changes in peak discharge to the two existing outfalls located in the project area. The systems are referred to as East (for the system at the intersection with Sheep Hole Road) and West (for the system along Headquarters Road adjacent to the bridge). RWE used the Rational Method based on rainfall intensity from the NOAA Precipitation Frequency Data Server, runoff coefficients from PennDOT's Drainage Manual, and assumed Times of Concentration of 10 minutes. The software used to analyze the drainage system was Stormwater Studio 2020 version 3.0.0.18.

The West drainage system consists of an existing catch basin is located at Station 12+25 and discharges to the south via a 24" corrugated metal pipe outfall with an invert of 194.72 with an existing drainage area of approximately 1.31 acres. Under proposed conditions, this catch basin is proposed to be replaced with a new catch basin located at Station 12+05 and discharge via a 14"x19" elliptical concrete pipe at the same outfall location with a drainage area of approximately 1.44 acres (an increase of approximately 6,000 square feet of roadway surface). Because information on the inverts for the newly proposed catch basins was unavailable, an assumption was made that the proposed pipe slope would remain the same as existing conditions. Since the location of the catch basin has changed from existing conditions and the bridge deck itself will be wider under proposed conditions, the proposed discharge to the catch basin and the outfall increases as well. The change from a 24" diameter round pipe to the 14" x 19" elliptical pipe also impacts capacity. The analysis of the west drainage system found that the velocity from the discharge pipe may increase from 1.16 feet per second to 3.37 feet per second during a 25-year storm event. As such, there is potential for increased erosion at the outfall and no information has been provided on any stabilization measures at this location. As has been noted elsewhere in this report, silt soils are prone to erosion.

The existing East drainage system consists of an 18" diameter reinforced concrete pipe with an outlet invert into the creek to the east of 200.38'. Under proposed conditions, a series of three catch basins are proposed with a manhole connection into the existing 18" pipe. The drainage area to the system overall did not increase and remains approximately 1.42 acres. The proposed design information was again incomplete, so RWE assumed that the slope of the 18" pipe remained the same as existing conditions and assumed that the slope of each of the other three pipes was approximately 1%. The velocity at the outfall does not increase under proposed conditions during the 25-year storm, however, the proposed design depicted on the sheet entitled, ""Bucks County S.R. 1012, Sec BRC General Plan and Elevation" includes a rock lined channel proposed to convey the discharge downslope into the creek. Calculations for this channel and the pipe discharges were not provided to RWE so an analysis of this channel was not conducted by RWE. It is worth noting that the information depicted on the sheet entitled, "Bucks County S.R. 1012, Sec BRC General Plan and Elevation" printed June 8, 2020 is inconsistent with the plans submitted to the Bucks County Conservation District entitled, "Erosion and Sediment Pollution Control Plan" depicting Stages 1 through 3 of construction. These drawings were printed January 3, 2020 and do not depict the riprap slope on the eastern side of the bridge, nor do they depict the entirety of the grading proposed downstream of the bridge. It is my opinion that the full plans and calculations should be resubmitted to the Conservation District for a new review to ensure that the design is in compliance with the Chapter 102 standards.

Refer to Attachment E of this report for the stormwater pipe analysis RWE completed.

Chapter 105 Joint Permit Application Review

Wild and Scenic River Impacts. The proposed project may have detrimental impacts on the stream from a water quality standpoint. The stormwater management system on the western side of the bridge collects runoff from new impervious surfaces resulting from the bridge widening and no water quality treatment measures are proposed. In addition, no vegetative bank stabilization measures are proposed downstream of the new bridge to address potential erosion as described elsewhere in this report.

PennDOT Antidegradation Policy. The proposed project is inconsistent with PennDOT's antidegradation policy. PennDOT's antidegradation policy states that vegetative alternatives for slope and channel erosion protection should be considered and no vegetative bank stabilization or channel protection measures are proposed. In addition, the antidegradation policy states that "advances in erosion control technologies in recent years has made it possible for vegetated lining to be used in channels that may experience moderate to high velocities and shear stresses. In fact, some products offer higher shear stress resistance than riprap lining. Vegetated channels also provide water quality benefits, such as filtering and adsorption of pollutants, which riprap channels do not." In addition, the use of riprap banks does not provide any environmental or ecological benefits to the EV stream. Further, potential erosion of the streambanks downstream of the proposed bridge replacement is not addressed by PennDOT through the use of preventative nor curative measures such as rehabilitation of the existing piers and abutments, vegetated bank stabilization, or other streambank stabilization measures.

Stream Erosion Impacts. According to 25 Pa. Code. § 105.161(a)(4), "the structure may not so increase velocity or direct flow in a manner which results in erosion of stream beds and banks." In the case of the proposed bridge replacement, PennDOT is proposing to shift the alignment of the bridge to the west by as much as 17.25 feet and by as much 11.509 feet from the existing east abutment. The bridge opening is proposed to be regraded with a flat channel bottom elevation of 192.00 and riprap lining the streambanks on both sides of the channel downstream of the new bridge. The HEC-RAS analysis discussed previously in this report indicates that there are increases in velocity in the channel as a result of the bridge modifications that are significant. Given the erosive nature of the soils onsite, there is potential for the streambanks and bottom to erode downstream of the bridge when it is completed and for the channel to migrate into the floodplain area located west of the existing stream channel. As such, the proposed bridge replacement does not meet the requirements outlined at 25 Pa. Code. § 105.161(a)(4).

Project Limit of Disturbance Review

In both the soil erosion and sediment control submission and the Chapter 105 Joint Permit submission, the proposed disturbance limits for the project do not seem to be complete.

In the impact summary included with the Chapter 105 Joint Permit submission, the proposed direct impacts were identified as 2,271 square feet of temporary impact to the watercourse and 3,302 square feet of permanent impact to the watercourse. No indirect impacts were noted. In addition, 3,138 square feet of direct temporary impacts were identified to the floodway and 4,223 square feet of permanent impacts were identified to the floodway. The explanation included notes that "approximately 74 linear feet on the west side of the bridge and 43 linear feet on the east side of the creek will be permanently impacted."

For the soil erosion submission, Urban Engineers stated that the anticipated limit of disturbance for the project is 0.44 acres. On sheets 8 through 10 of 10 prepared by Urban Engineers, the limit of disturbance is not clearly shown and appears to overlap and intersect with other lines shown on the sheets making it difficult to see. The LOD as shown does not include the following anticipated additional areas of disturbance that would be necessary to construct the bridge:

- Equipment staging areas
- Material stockpile areas[2]
- Sufficient area around the diversion dike systems depicted on Sheets 8 and 10 of 10 to properly construct the diversion dike as the dike itself appears to be very close to the limits of the LOD
- The compost filter sock extends beyond the LOD and the Start Work station 11+05.00 as depicted on Sheet 8 of 10
- The compost filter sock extends beyond the LOD and the Stop Work station 15+00.00 on the southern end of Headquarters Rd on Sheet 10 of 10
- The limit of work at the western edge of Headquarters Road (Station 10+05.00) appears to be beyond the LOD as depicted on Sheet 8 of 10

[2] Note #3 on Sheet 7 of 10 of the plans states "Maintain stockpile of AASHTO No. 1 coarse aggregate," however, no stockpiles are noted on the submitted plans. In addition, Note #10 indicates that "all sediment deposited on roadways shall be removed and returned to the construction site immediately," which seems to infer that a stockpile area would be necessary to collect this material, however, none is shown or described in the narrative or on the plans.

- The limit of work shown on the southern end of Headquarters Road (Station 16+00.00) appears to be beyond the LOD boundary. It is unclear why this area is not included in the LOD.

In addition, the plan does not specify the length of the temporary 24" diameter pipes to be utilized during Stage 2 of construction and the detail shown for the temporary pipes is not to scale so it is impossible to determine whether these will be constructed to remain within the depicted LOD. The LOD boundary does not appear to close on the western edge of the project along Headquarters Road and that should be corrected before any approval is issued. No measures are proposed to address turbidity in the stream channel during construction. Given the sensitive nature of the EV-CF stream, it is my opinion that some form of turbidity control should be installed during Stages and 2 and 3 of the proposed construction.

Given the uncertainty in the area the missing features may take up, it is impossible to establish an accurate Limit of Disturbance for the project site without more information from Urban Engineers. It is my professional opinion that the LOD could be considerably underestimated and should be recalculated accounting for these elements to ensure that the project is not subject to additional regulatory requirements. Given the unknown additional measures necessary to stage and stockpile equipment and materials and address potential turbidity in the stream channel as a result of construction, it is possible that the potential Limit of Disturbance could exceed one acre.

Soil Erosion and Sediment Control Application Review

1. Urban Engineers notes that the project will comply with the following criteria:
   a. Maximize the protection of existing drainage features and vegetation.

      Based on the submitted plans, there are no erosion and sediment control measures proposed that would protect the existing vegetation. In fact, vegetation is noted on the existing conditions plans in the vicinity of the existing bridge crossing within the Limit of Disturbance, however, the tree removal is not noted on the drawings and no tree protection details are provided.

      In addition, given the proposed bridge is a realignment of the roadway at the crossing and a shift in the overall alignment of the creek, the drainage features that exist currently will not be protected. The riparian vegetation downstream of the bridge crossing will be more vulnerable to erosion post construction and no measures are proposed in the downstream area to protect the banks under proposed conditions.

   b. Utilize other measures or controls that prevent or minimize generation of increased stormwater runoff.

Based on the submitted plans, there are no measures that were specifically added to the plans to prevent or minimize generation of increased stormwater runoff. In addition, no measures to control turbidity within the creek in and around the temporary pipes and no measures are proposed for when the central piers are removed during Stage 2.

2. Sheet 2 of 10 includes Note #16 which states that "sediment removed from BMPs shall be disposed of on-site in landscaped areas outside of steep slopes, wetlands, floodplains or drainage swales and immediately stabilized or placed in soil stockpiles and stabilized." There are no areas onsite that are outside of floodplains and no stockpiles are noted on the plans, so compliance with this requirement is not possible based on the submitted plans. Additional details on locations of stockpiles should be provided to ensure compliance with this note and to provide protection to the Tinicum Creek.
3. The construction sequence shown on Sheet 3 of 10 is insufficient for a project of this scale. It lacks detail regarding the soil erosion and sediment control measures and how the stream will be protected from sediment and debris. For example, Stage 1 (West Approach) includes #2 which states "Protect the stream from any debris resulting from the demolition." No measures are noted on the plans or in the submitted narrative detailing how the stream will be protected. Additional detail is necessary to ensure the stream will be protected as the construction contractor does not have information on how to accomplish this. In addition, the piers are noted to be removed during Stage 2 (Piers), however, no mention of how debris will be kept from entering the waters of the creek is provided during this stage. #5 in Stage 2 simply states, "Remove causeway" without any regard to how that will be done to restore the creek bottom or to address turbidity that this activity will generate in the creek.
4. The plans include details for slope stabilization using erosion control blankets and seeding on Sheets 3 and 6 of 10, however, the plan views for Stages 1 through 3 do not depict any locations where erosion control blankets and seeding will occur. Additional detail is necessary to ensure that these measures will be installed were necessary and appropriate.
5. The submitted plans indicate that the concrete washout for Stage 1 of the project will be within 50 feet of the existing and proposed catch basins on the northern side of the roadway. The details shown on Sheet 7 of 10 include Note 3 which states that "Washout facilities should not be placed within 50 feet of storm drains, open ditches, or surface waters." This should be corrected.
6. A proposed catch basin and outlet pipe are noted on the western side of Headquarters Road bridge located at approximate station 12+05.00. No information about the catch basin is included and no outfall protection measures are noted for the discharge. The catch basin appears to replace an existing catch basin and crossing located slightly closer to the existing bridge, however, insufficient information is included to confirm that the catch basin has sufficient capacity for the water being directed to it and the rate of

discharge from the proposed pipe is not included in the narrative or on the drawings to confirm that the discharge won't cause erosion on the southern side of Headquarters Road post construction. More detail is needed.

7. The proposed temporary causeway noted during Stage 2 on Sheet 9 of 10 appears to be constructed without any erosion control measures in the creek itself. The detail for the causeway on Sheet 4 of 10 indicates that the causeway will be constructed on the stream bottom, however, the elevations noted for the upstream and downstream ends of the pipes are inconsistent with the elevation information noted in the plan view on Sheet 9 of 10. Additional information on the causeway installation should be provided.
8. No calculations were provided documenting that the five 24" diameter pipes have sufficient capacity such that the normal flow depth in the channel is less than or equal to half the diameter of the pipes in accordance with the Pennsylvania Erosion and Sediment Control Manual last updated March 2012. The rock filter and a temporary dam are not depicted on Sheet 9 of 10 of the submitted plans.
9. Stage 2 as depicted on sheet 9 of 10 shows compost filter sock through the proposed causeway. Additional clarification should be provided on how the compost filter sock will be constructed in and around the causeway during this stage.
10. The submitted plans indicate that the concrete washout for Stage 3 of the project will be within 50 feet of the Tinicum Creek and the washout facility is closer than 50 feet to the proposed catch basins. The details shown on Sheet 7 of 10 include Note 3 which states that "Washout facilities should not be placed within 50 feet of storm drains, open ditches, or surface waters."
11. Three proposed catch basins and connecting pipes are noted on the eastern side of Headquarters Road bridge located around the intersection of Headquarters Road and Sheep Hole Road. No information about the catch basins is included and it is unclear where the pipes discharge. Sheet 10 of 10 appears to possibly show a manhole connection with an existing 18" diameter RCP pipe, but that connective is unclear. Insufficient information is included to confirm that the catch basin has sufficient capacity for the water being directed to it and the rate of discharge from the proposed pipe is not included in the narrative or on the drawings to confirm that the discharge won't cause erosion on the southern side of Headquarters Road post construction. More detail is needed.
12. A rock filter detail was requested by Bucks County Conservation District in December 2019, and Urban Engineers provided it, however, there is no rock filter proposed for the project based on the drawings submitted. The rock filter should be used with the causeway and noted on the drawings based on the Pennsylvania E&S Manual as previously noted in this report.

Recommendations

It is my professional opinion that the project as designed has the potential to increase erosion in the Tinicum Creek and create instabilities in the channel bottom and streambanks downstream of the bridge. As indicated elsewhere in this report, the key concerns related to the information reviewed and analyzed are as follows:

- The inconsistent data provided by Urban Engineers on various drawings and in various reports made the review conducted by RWE difficult. RWE was unable to conduct a thorough review of the potential hydraulic and environmental impacts of the proposed bridge replacement and utilized the best information and assumptions to prepare this report. As stated elsewhere in this report, Urban Engineers should review all of their data for consistency and accuracy and revise the modeling and design as necessary to ensure the project does not result in degradation of the creek and resubmit the applications for technical review.
- Given the large percentage of silts in the primary soils onsite, there is significant potential for erosion of the floodplain and bank soils. According to the USDA NRCS, soils with high silt content are the most erodible of all soils. Silts are easily detached and tend to crust and produce high rates of runoff and are susceptible to erosion when disturbed.
- As noted in the report, the average velocity during the 10-year event increases by more than 3 feet per second under proposed conditions to approximately 9.5 feet per second in the cross-section located downstream of the proposed bridge replacement. If this increase in velocity occurs downstream of the bridge, it will have negative impacts on the water quality of Tinicum Creek. Further, the proposed velocities are such that it raises the likelihood that the channel will migrate into the floodplain area to the west of the existing stream. To understand velocities more accurately in the downstream reach given the large floodplain area, it is recommended that a 2-D unsteady flow model be completed in HEC-RAS. The 2-D model offers the opportunity to review potential channel migration through the site and velocities in the channel and overbank during various storm events.
- It is my opinion that the full plans and calculations should be resubmitted to the Bucks County Conservation District for a new review to ensure that the design is in compliance with the Chapter 102 standards. The plans approved by the Conservation District were inconsistent with the latest plans provided to RWE for review and all information and documentation should be re-reviewed.

Additional information is necessary to ensure that the proposed project does not have a negative environmental impact on the Tinicum Creek and that the proposed bridge construction does not result in impacts to the water quality of this Exceptional Value stream.

I have attached a copy of my resume (Attachment F of this document) outlining my background and qualifications. Should you have any questions or would like to discuss this report further, please do not hesitate to reach out to me directly at 732.735.3440 or by email mary@rippledwatersllc.com.

Sincerely,

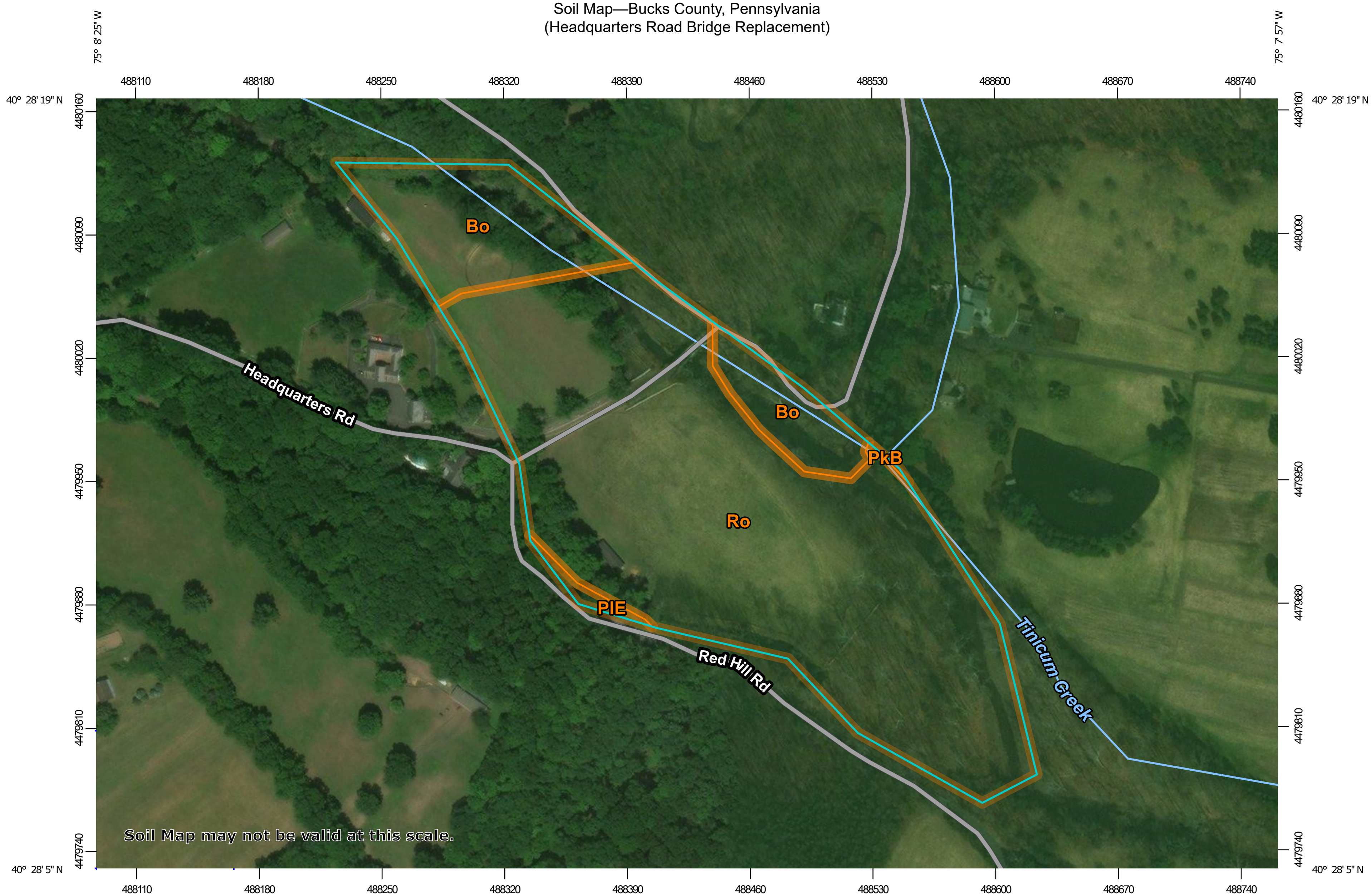
Mary L. Paist-Goldman, P.E.
PA Professional Engineer PE-078834-E
Founder, Principal

Attachments
Attachment A – USDA NRCS Web Soil Survey Excerpts
Attachment B – USGS StreamStats Drainage Area Output
Attachment C – HEC-RAS Existing Conditions Analysis
Attachment D – HEC-RAS Proposed Conditions Analysis
Attachment E – Stormwater Studio Analysis
Attachment F – Resume

Attachment A

USDA NRCS Web Soil Survey Excerpts

Soil Map—Bucks County, Pennsylvania
(Headquarters Road Bridge Replacement)



Map Scale: 1:3,080 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 45 90 180 270

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bucks County, Pennsylvania
Survey Area Data: Version 17, Jun 4, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 31, 2014—Apr 2, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Bo	Bowmansville-Knauers silt loams	2.7	19.1%
PkB	Penn-Klinesville channery silt loams, 3 to 8 percent slopes	0.0	0.0%
PlE	Penn-Klinesville channery silt loams, 25 to 45 percent slopes, extremely stony	0.1	0.8%
Ro	Rowland silt loam	11.3	80.0%
Totals for Area of Interest		**14.1**	**100.0%**

Bucks County, Pennsylvania

Bo—Bowmansville-Knauers silt loams

Map Unit Setting

National map unit symbol: l7nk
Elevation: 150 to 900 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 45 to 57 degrees F
Frost-free period: 150 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Bowmansville and similar soils: 41 percent
Knauers and similar soils: 39 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bowmansville

Setting

Landform: Flood plains
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Parent material: Recent alluvial deposits weathered from sandstone and siltstone

Typical profile

Ap - 0 to 7 inches: silt loam
Bg - 7 to 26 inches: silty clay loam
Cg - 26 to 43 inches: fine sandy loam
2Cg - 43 to 65 inches: stratified gravel to sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 72 to 99 inches to lithic bedrock
Natural drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D

Hydric soil rating: No

Description of Knauers

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Recent alluvium derived from sandstone and shale

Typical profile

A - 0 to 8 inches: silt loam
Bg1 - 8 to 17 inches: silt loam
Bg2 - 17 to 24 inches: gravelly sandy loam
2Cg - 24 to 60 inches: stratified sand to gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 72 to 99 inches to lithic bedrock
Natural drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Occasional
Frequency of ponding: Frequent
Available water storage in profile: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Rowland

Percent of map unit: 20 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bucks County, Pennsylvania
Survey Area Data: Version 17, Jun 4, 2020

Bucks County, Pennsylvania

Ro—Rowland silt loam

Map Unit Setting

National map unit symbol: l7s9
Elevation: 150 to 1,000 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 48 to 57 degrees F
Frost-free period: 150 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Rowland and similar soils: 82 percent
Minor components: 14 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rowland

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Alluvium derived from sandstone and shale

Typical profile

A - 0 to 12 inches: silt loam
B - 12 to 34 inches: silty clay loam
Cg - 34 to 46 inches: silty clay loam
2Cg - 46 to 61 inches: stratified gravel to sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 60 to 99 inches to lithic bedrock
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 12 to 36 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Knauers

Percent of map unit: 8 percent
Landform: Flood plains
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: Yes

Abbottstown

Percent of map unit: 6 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: No

Data Source Information

Soil Survey Area: Bucks County, Pennsylvania
Survey Area Data: Version 17, Jun 4, 2020

RUSLE2 Related Attributes

This report summarizes those soil attributes used by the Revised Universal Soil Loss Equation Version 2 (RUSLE2) for the map units in the selected area. The report includes the map unit symbol, the component name, and the percent of the component in the map unit. Soil property data for each map unit component include the hydrologic soil group, erosion factor Kf for the surface horizon, erosion factor T, and the representative percentage of sand, silt, and clay in the mineral surface horizon. Missing surface data may indicate the presence of an organic layer.

Report—RUSLE2 Related Attributes

Soil properties and interpretations for erosion runoff calculations. The surface mineral horizon properties are displayed or the first mineral horizon below an organic surface horizon. Organic horizons are not displayed.

RUSLE2 Related Attributes–Bucks County, Pennsylvania								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
Bo—Bowmansville-Knauers silt loams								
Bowmansville	41	—	C/D	.43	4	30.5	56.0	13.5
Knauers	39	—	C/D	.43	5	30.1	54.9	15.0
Rowland	20	—	C	.37	4	30.1	54.9	15.0
PkB—Penn-Klinesville channery silt loams, 3 to 8 percent slopes								
Penn	70	410	C	.37	2	23.3	59.9	16.8
Klinesville	20	410	D	.43	1	24.0	60.6	15.4
Croton	5	298	D	.43	3	11.7	63.3	25.0
Readington	5	298	C	.43	3	14.6	68.2	17.2
PlE—Penn-Klinesville channery silt loams, 25 to 45 percent slopes, extremely stony								
Penn, extremely stony	65	—	B	.37	2	30.1	54.9	15.0
Klinesville, extremely stony	20	—	D	.28	1	29.1	53.4	17.5
Klinesville	5	—	D	.43	1	29.1	53.4	17.5
Penn	3	—	B	.43	2	30.1	54.9	15.0
Croton	1	—	D	.32	3	9.1	65.9	25.0
Readington, extremely stony	1	—	C	.43	3	29.1	53.4	17.5

RUSLE2 Related Attributes–Bucks County, Pennsylvania								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
Ro—Rowland silt loam								
Rowland	82	—	C	.37	4	30.1	54.9	15.0
Knauers	8	—	C/D	.43	5	30.1	54.9	15.0
Abbottstown	6	—	D	.32	3	29.1	53.4	17.5

Data Source Information

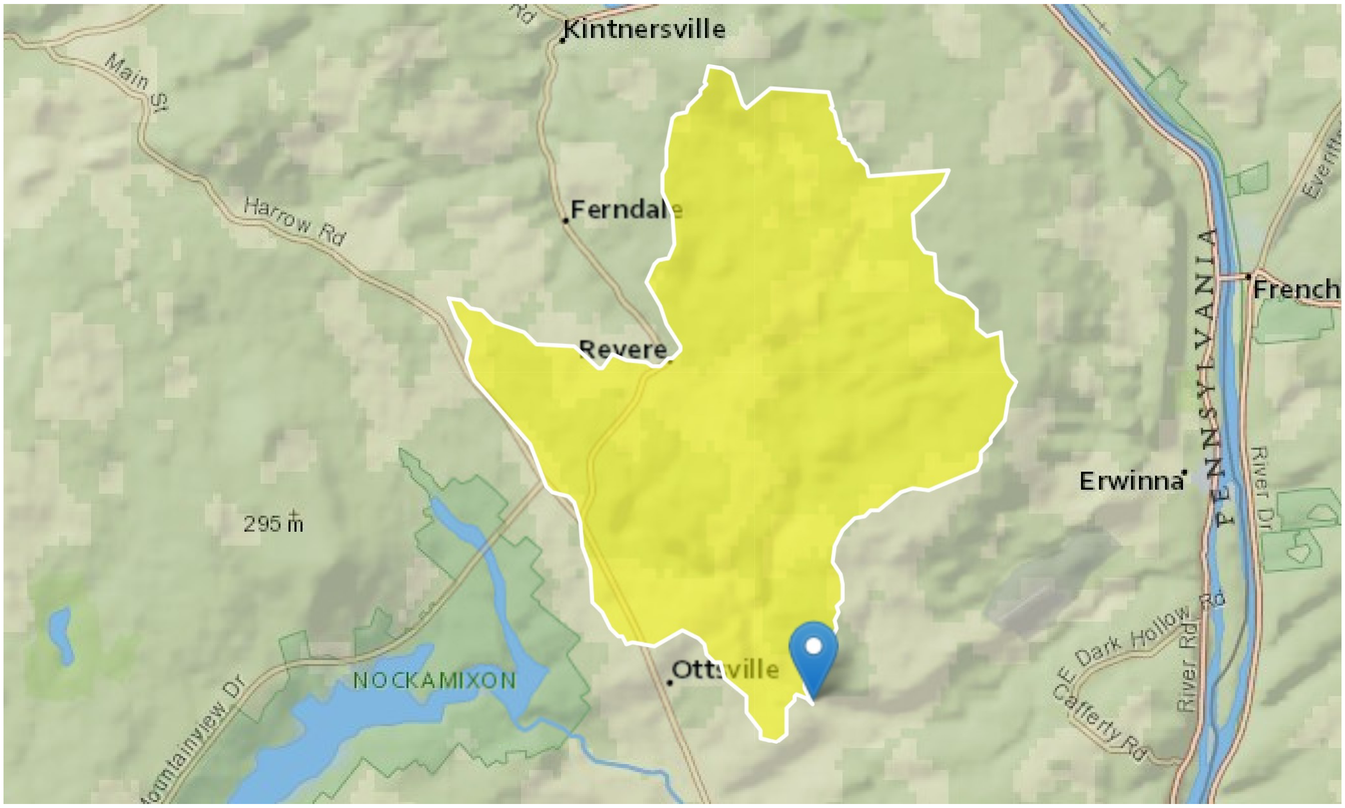
Soil Survey Area: Bucks County, Pennsylvania
Survey Area Data: Version 17, Jun 4, 2020

Attachment B

USGS Stream Stats Drainage Area Information

StreamStats Report

Region ID: PA
Workspace ID: PA20200503172254018000
Clicked Point (Latitude, Longitude): 40.47065, -75.13657
Time: 2020-05-03 13:23:11 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	14.5	square miles
BSLOPD	Mean basin slope measured in degrees	3.7	degrees
ROCKDEP	Depth to rock	4.6	feet
URBAN	Percentage of basin with urban development	1	percent
ELEV	Mean Basin Elevation	507	feet
PRECIP	Mean Annual Precipitation	45	inches
FOREST	Percentage of area covered by forest	80	percent

Parameter Code	Parameter Description	Value	Unit
CARBON	Percentage of area of carbonate rock	0	percent
STORAGE	Percentage of area of storage (lakes ponds reservoirs wetlands)	2	percent
STRMTOT	total length of all mapped streams (1:24,000-scale) in the basin	22.22	miles
STRDEN	Stream Density -- total length of streams divided by drainage area	1.53	miles per square mile
LC01DEV	Percentage of land-use from NLCD 2001 classes 21-24	2	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	8.97	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	1.11	percent
LONG_OUT	Longitude of Basin Outlet	-75.13654	degrees
MAXTEMP	Mean annual maximum air temperature over basin area from PRISM 1971-2000 800-m grid	60	degrees F
OUTLETXA83	X coordinate of the outlet, in NAD_1983_Albers,meters	242765	meters
OUTLETYA83	Y coordinate of the outlet, in NAD_1983_Albers, meters	167245	meters
BSLOPDRAW	Unadjusted basin slope, in degrees	3.93	degrees
CENTROXA83	X coordinate of the centroid, in NAD_1983_Albers, meters	241814.8	meters
CENTROYA83	Basin centroid horizontal (y) location in NAD 1983 Albers	171719.8	meters
DRN	Drainage quality index from STATSGO	4.1	dimensionless

Low-Flow Statistics Parameters[Low Flow Region 1]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.5	square miles	4.78	1150
BSLOPD	Mean Basin Slope degrees	3.7	degrees	1.7	6.4

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
ROCKDEP	Depth to Rock	4.6	feet	4.13	5.21
URBAN	Percent Urban	1	percent	0	89

Low-Flow Statistics Flow Report[Low Flow Region 1]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	SEp
7 Day 2 Year Low Flow	1.92	ft^3/s	46	46
30 Day 2 Year Low Flow	2.65	ft^3/s	38	38
7 Day 10 Year Low Flow	0.812	ft^3/s	51	51
30 Day 10 Year Low Flow	1.16	ft^3/s	46	46
90 Day 10 Year Low Flow	2.04	ft^3/s	41	41

Low-Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (http://pubs.usgs.gov/sir/2006/5130/)

Annual Flow Statistics Parameters[Statewide Mean and Base Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.5	square miles	2.26	1720
ELEV	Mean Basin Elevation	507	feet	130	2700
PRECIP	Mean Annual Precipitation	45	inches	33.1	50.4
FOREST	Percent Forest	80	percent	5.1	100
URBAN	Percent Urban	1	percent	0	89
CARBON	Percent Carbonate	0	percent	0	99

Annual Flow Statistics Flow Report[Statewide Mean and Base Flow]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	SEp
Mean Annual Flow	22.7	ft^3/s	12	12

Statistic	Value	Unit	SE	SEp
Harmonic Mean Streamflow	6.39	ft^3/s	38	38

Annual Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (http://pubs.usgs.gov/sir/2006/5130/)

Base Flow Statistics Parameters[Statewide Mean and Base Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.5	square miles	2.26	1720
PRECIP	Mean Annual Precipitation	45	inches	33.1	50.4
CARBON	Percent Carbonate	0	percent	0	99
FOREST	Percent Forest	80	percent	5.1	100
URBAN	Percent Urban	1	percent	0	89

Base Flow Statistics Flow Report[Statewide Mean and Base Flow]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	SEp
Base Flow 10 Year Recurrence Interval	10.6	ft^3/s	21	21
Base Flow 25 Year Recurrence Interval	9.45	ft^3/s	21	21
Base Flow 50 Year Recurrence Interval	8.8	ft^3/s	23	23

Base Flow Statistics Citations

Stuckey, M.H.,2006, Low-flow, base-flow, and mean-flow regression equations for Pennsylvania streams: U.S. Geological Survey Scientific Investigations Report 2006-5130, 84 p. (http://pubs.usgs.gov/sir/2006/5130/)

Peak-Flow Statistics Parameters[Peak Flow Region 1]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.5	square miles	1.72	1280

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
STORAGE	Percent Storage	2	percent	0	21.2

Peak-Flow Statistics Flow Report[Peak Flow Region 1]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	SEp	Equiv. Yrs.
2 Year Peak Flood	641	ft^3/s	33	33	3
5 Year Peak Flood	1110	ft^3/s	31	31	6
10 Year Peak Flood	1480	ft^3/s	31	31	9
50 Year Peak Flood	2490	ft^3/s	36	36	13
100 Year Peak Flood	3000	ft^3/s	38	38	13
500 Year Peak Flood	4390	ft^3/s	46	46	14

Peak-Flow Statistics Citations

Roland, M.A., and Stuckey, M.H.,2008, Regression equations for estimating flood flows at selected recurrence intervals for ungaged streams in Pennsylvania: U.S. Geological Survey Scientific Investigations Report 2008-5102, 57p. (http://pubs.usgs.gov/sir/2008/5102/)

Bankfull Statistics Parameters[Statewide Bankfull Noncarbonate 2018 5066]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.5	square miles	2.62	207
CARBON	Percent Carbonate	0	percent		

Bankfull Statistics Flow Report[Statewide Bankfull Noncarbonate 2018 5066]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE
Bankfull Area	103	ft^2	64
Bankfull Streamflow	461	ft^3/s	74
Bankfull Width	48.8	ft	59
Bankfull Depth	2.15	ft	56

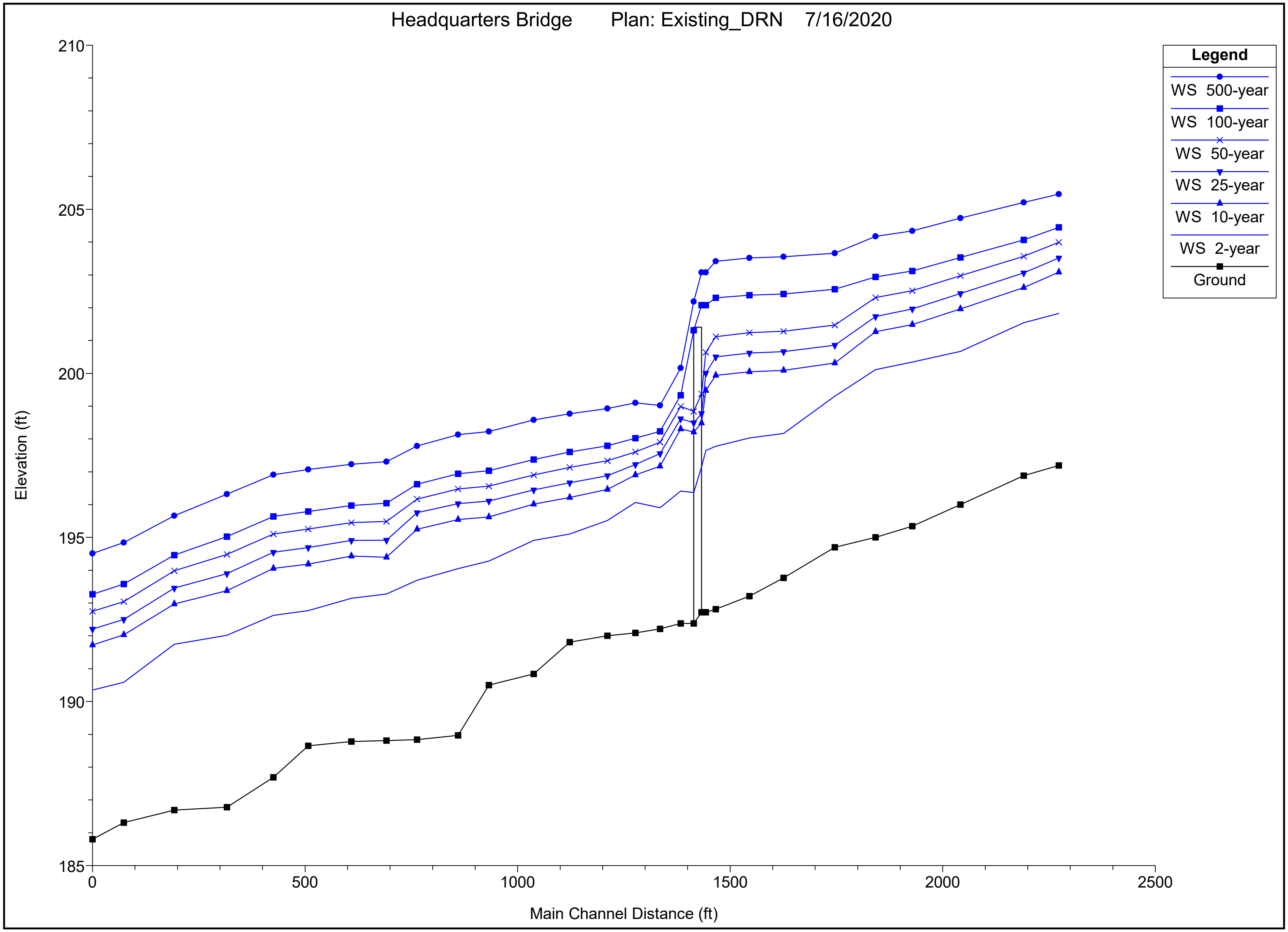
Bankfull Statistics Citations

Clune, J.W., Chaplin, J.J., and White, K.E.,2018, Comparison of regression relations of bankfull discharge and channel geometry for the glaciated and nonglaciated settings of Pennsylvania and southern New York: U.S. Geological Survey Scientific Investigations Report 2018–5066, 20 p. (https://doi.org/10.3133/sir20185066)

Application Version: 4.3.11

Attachment C

HEC-RAS Existing Conditions Analysis


Headquarters Bridge Plan: Existing_DRN 7/16/2020
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Elevation (ft)
Main Channel Distance (ft)
210
205
200
195
190
185
0
500
1000
1500
2000
2500

HEC-RAS Plan: Ex-DRN River: TinicumCreek Reach: Headquarters

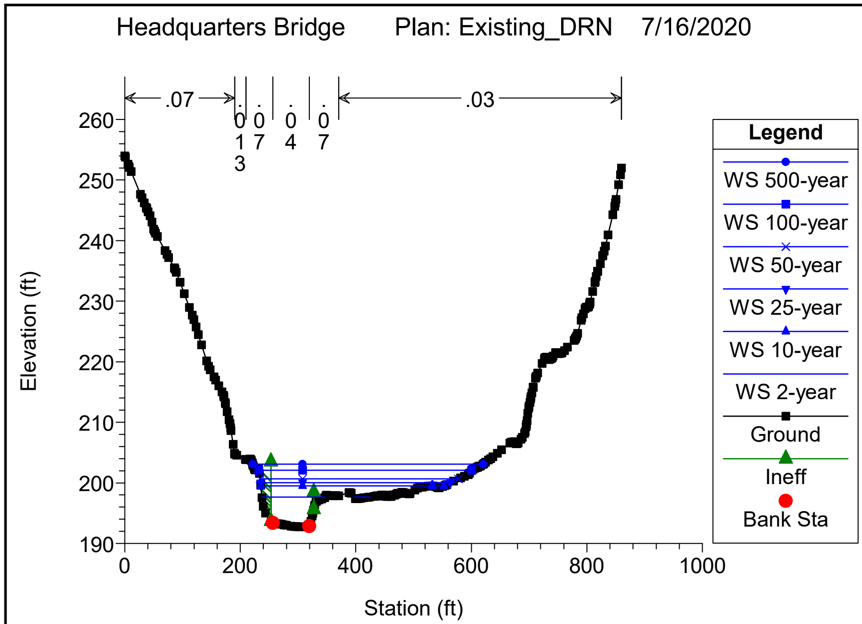
Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	Vel Chnl	Vel Total	Vel Left	Vel Right	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(sq ft)	(ft)	
Headquarters	2280	2-year	1871.00	201.83	201.36	7.98	5.36	1.63	4.49	348.74	216.09	0.67
Headquarters	2280	10-year	3842.00	203.08	203.08	9.85	5.71	2.95	6.13	673.26	276.30	0.73
Headquarters	2280	25-year	4937.00	203.52	203.52	10.71	6.21	3.63	6.66	794.38	281.24	0.76
Headquarters	2280	50-year	6344.00	204.00	204.00	11.60	6.82	4.38	7.19	929.85	285.32	0.80
Headquarters	2280	100-year	7864.00	204.45	204.45	12.48	7.41	5.13	6.50	1061.67	296.80	0.83
Headquarters	2280	500-year	12150.00	205.46	205.46	14.36	8.83	6.76	7.67	1375.37	314.14	0.89
Headquarters	2197	2-year	1871.00	201.55	201.35	7.05	5.27	3.39	1.97	355.31	249.92	0.58
Headquarters	2197	10-year	3842.00	202.61		7.70	5.64	5.31	2.47	681.77	329.13	0.57
Headquarters	2197	25-year	4937.00	203.06		7.81	5.94	5.99	3.00	830.53	330.90	0.56
Headquarters	2197	50-year	6344.00	203.57		8.00	6.36	6.69	3.51	997.70	332.64	0.55
Headquarters	2197	100-year	7864.00	204.06		8.19	6.76	7.31	3.95	1163.57	334.27	0.54
Headquarters	2197	500-year	12150.00	205.21		8.88	7.85	8.80	4.96	1546.81	337.55	0.55
Headquarters	2048	2-year	1871.00	200.67	200.37	7.76	4.59	2.37	2.34	407.67	250.13	0.64
Headquarters	2048	10-year	3842.00	201.96		8.22	4.99	3.44	4.13	769.83	299.93	0.60
Headquarters	2048	25-year	4937.00	202.43		8.64	5.40	3.98	4.68	913.65	312.58	0.61
Headquarters	2048	50-year	6344.00	202.97		9.04	5.83	4.56	5.20	1087.86	329.36	0.61
Headquarters	2048	100-year	7864.00	203.53		9.26	6.18	5.02	5.67	1272.51	331.57	0.60
Headquarters	2048	500-year	12150.00	204.73		10.23	7.27	6.21	6.92	1671.23	334.95	0.61
Headquarters	1935	2-year	1871.00	200.34		6.35	4.11	1.92	2.77	455.05	226.41	0.50
Headquarters	1935	10-year	3842.00	201.49		7.88	4.99	2.41	4.08	769.66	302.25	0.56
Headquarters	1935	25-year	4937.00	201.96		8.24	5.39	2.71	4.71	915.78	314.79	0.57
Headquarters	1935	50-year	6344.00	202.52		8.52	5.79	3.18	5.30	1096.03	325.94	0.56
Headquarters	1935	100-year	7864.00	203.12		8.66	6.08	3.81	5.69	1293.79	335.35	0.55
Headquarters	1935	500-year	12150.00	204.34		9.37	7.11	5.34	6.86	1708.23	340.94	0.55
Headquarters	1849	2-year	1871.00	200.11		6.12	3.82	2.01	2.88	490.22	254.74	0.49
Headquarters	1849	10-year	3842.00	201.27		7.17	4.70	2.30	4.07	817.42	307.88	0.52
Headquarters	1849	25-year	4937.00	201.73		7.52	5.12	2.12	4.62	963.75	319.03	0.52
Headquarters	1849	50-year	6344.00	202.31		7.73	5.49	2.66	5.12	1156.40	342.05	0.51
Headquarters	1849	100-year	7864.00	202.94		7.70	5.73	3.75	5.44	1373.01	345.83	0.49
Headquarters	1849	500-year	12150.00	204.17		8.36	6.74	6.09	6.49	1802.67	350.89	0.49
Headquarters	1753	2-year	1871.00	199.31	199.31	6.94	5.14	11.79	2.71	364.31	237.42	0.59
Headquarters	1753	10-year	3842.00	200.31	200.25	8.36	6.18	14.32	4.42	621.58	268.75	0.64
Headquarters	1753	25-year	4937.00	200.86	200.66	8.47	6.37	14.54	4.90	774.77	304.77	0.62
Headquarters	1753	50-year	6344.00	201.47		8.76	6.54	14.84	5.20	970.27	323.07	0.61
Headquarters	1753	100-year	7864.00	202.57		7.51	5.91	10.73	5.12	1331.22	339.13	0.48
Headquarters	1753	500-year	12150.00	203.66		8.48	7.12	13.54	6.35	1706.64	343.94	0.51
Headquarters	1633	2-year	1871.00	198.17	197.49	8.11	6.64	2.74	1.92	281.97	128.87	0.70
Headquarters	1633	10-year	3842.00	200.09		7.12	4.89	2.58	3.54	786.17	293.79	0.51
Headquarters	1633	25-year	4937.00	200.66		7.37	5.16	2.69	4.08	957.40	315.59	0.50
Headquarters	1633	50-year	6344.00	201.28		7.76	5.44	2.85	4.51	1165.71	339.34	0.50
Headquarters	1633	100-year	7864.00	202.42		6.80	5.05	2.51	4.54	1558.01	350.25	0.41
Headquarters	1633	500-year	12150.00	203.55		7.94	6.21	2.93	5.85	1957.91	355.78	0.45
Headquarters	1553	2-year	1871.00	198.03		6.29	4.70	1.82	1.53	398.42	235.50	0.53
Headquarters	1553	10-year	3842.00	200.05		5.51	3.75	2.00	2.85	1023.61	342.15	0.38
Headquarters	1553	25-year	4937.00	200.62		5.79	4.05	2.17	3.32	1219.87	348.55	0.39
Headquarters	1553	50-year	6344.00	201.24		6.16	4.41	2.36	3.82	1438.89	357.33	0.39
Headquarters	1553	100-year	7864.00	202.38		5.77	4.22	2.28	3.84	1863.84	387.73	0.34
Headquarters	1553	500-year	12150.00	203.52		6.93	5.25	2.78	4.97	2313.00	401.27	0.39
Headquarters	1474	2-year	1871.00	197.78		5.93	4.48	1.66	1.51	417.43	227.77	0.49
Headquarters	1474	10-year	3842.00	199.94		5.20	3.55	1.90	2.68	1083.03	345.50	0.36
Headquarters	1474	25-year	4937.00	200.50		5.57	3.85	2.09	3.11	1281.58	360.02	0.37
Headquarters	1474	50-year	6344.00	201.12		5.97	4.20	2.30	3.58	1509.17	374.48	0.38
Headquarters	1474	100-year	7864.00	202.31		5.48	4.01	2.19	3.65	1962.78	394.30	0.32
Headquarters	1474	500-year	12150.00	203.42		6.68	5.04	2.72	4.76	2411.20	410.60	0.37
Headquarters	1450	2-year	1871.00	197.65	195.89	5.93	5.57	3.09	2.66	336.06	136.48	0.48
Headquarters	1450	10-year	3842.00	199.48	198.64	6.98	5.04	3.73	2.70	762.52	315.60	0.48
Headquarters	1450	25-year	4937.00	200.01	199.14	7.53	5.34	4.04	3.28	924.07	328.36	0.50
Headquarters	1450	50-year	6344.00	200.64	199.84	7.90	5.64	4.26	3.91	1124.52	343.05	0.50
Headquarters	1450	100-year	7864.00	202.08	200.27	6.59	4.88	3.58	3.93	1611.30	368.58	0.38
Headquarters	1450	500-year	12150.00	203.07	201.26	8.18	6.18	4.47	5.22	1967.50	399.07	0.45
Headquarters	1421		Bridge									
Headquarters	1391	2-year	1871.00	196.41	195.67	7.65	7.36	3.47	1.69	254.05	84.52	0.70
Headquarters	1391	10-year	3842.00	198.31	198.31	8.02	5.76	3.93	3.03	666.82	381.32	0.60
Headquarters	1391	25-year	4937.00	198.61	198.61	8.91	6.35	4.40	3.86	777.26	388.26	0.65

HEC-RAS Plan: Ex-DRN River: TinicumCreek Reach: Headquarters (Continued)

Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	Vel Chnl	Vel Total	Vel Left	Vel Right	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(sq ft)	(ft)	
Headquarters	1391	50-year	6344.00	198.99	198.99	9.67	6.92	4.82	4.72	916.54	397.43	0.68
Headquarters	1391	100-year	7864.00	199.33	199.33	10.43	7.54	5.23	5.53	1043.11	405.30	0.72
Headquarters	1391	500-year	12150.00	200.16	200.16	11.96	8.92	6.07	7.28	1361.83	423.06	0.77
Headquarters	1343	2-year	1871.00	195.90	195.83	8.20	6.99	3.17	2.22	267.78	171.61	0.77
Headquarters	1343	10-year	3842.00	197.17	197.17	8.77	5.81	3.95	3.48	661.51	364.50	0.71
Headquarters	1343	25-year	4937.00	197.55	197.55	9.30	6.09	4.31	4.08	810.12	408.87	0.72
Headquarters	1343	50-year	6344.00	197.90	197.90	10.17	6.65	4.80	4.78	953.88	415.16	0.77
Headquarters	1343	100-year	7864.00	198.23	198.23	10.97	7.21	5.27	5.45	1090.69	420.56	0.80
Headquarters	1343	500-year	12150.00	199.02	199.02	12.69	8.50	6.27	6.95	1429.14	433.10	0.87
Headquarters	1285	2-year	1871.00	196.07		5.15	3.82	3.64	2.74	489.79	356.17	0.48
Headquarters	1285	10-year	3842.00	196.90		6.11	4.59	4.40	3.87	836.75	455.04	0.51
Headquarters	1285	25-year	4937.00	197.22		6.59	5.02	4.75	4.38	983.45	469.04	0.53
Headquarters	1285	50-year	6344.00	197.60		6.96	5.44	5.02	4.91	1165.39	478.87	0.54
Headquarters	1285	100-year	7864.00	198.02		7.16	5.76	5.15	5.33	1365.88	480.95	0.54
Headquarters	1285	500-year	12150.00	199.10		7.57	6.44	5.36	6.18	1887.48	488.25	0.52
Headquarters	1219	2-year	1871.00	195.51	195.46	6.60	4.94	1.63	3.26	378.94	318.04	0.65
Headquarters	1219	10-year	3842.00	196.46		7.17	5.07	2.04	4.11	758.18	485.38	0.62
Headquarters	1219	25-year	4937.00	196.88		7.10	5.12	2.17	4.40	964.90	498.12	0.58
Headquarters	1219	50-year	6344.00	197.34		7.11	5.32	2.29	4.80	1192.18	500.96	0.56
Headquarters	1219	100-year	7864.00	197.79		7.12	5.53	2.37	5.15	1420.85	502.62	0.53
Headquarters	1219	500-year	12150.00	198.93		7.29	6.09	2.56	5.91	1994.88	506.61	0.50
Headquarters	1130	2-year	1871.00	195.11		5.56	4.09	2.12	3.21	457.41	360.00	0.55
Headquarters	1130	10-year	3842.00	196.22		5.38	4.00	1.86	3.62	961.08	484.40	0.46
Headquarters	1130	25-year	4937.00	196.67		5.40	4.17	1.75	3.92	1183.33	501.51	0.44
Headquarters	1130	50-year	6344.00	197.13		5.55	4.47	1.84	4.32	1419.24	504.65	0.43
Headquarters	1130	100-year	7864.00	197.61		5.70	4.74	1.92	4.66	1657.62	507.65	0.42
Headquarters	1130	500-year	12150.00	198.77		6.09	5.39	2.11	5.44	2253.61	515.09	0.41
Headquarters	1045	2-year	1871.00	194.91		4.48	3.31	1.79	2.54	565.71	349.70	0.40
Headquarters	1045	10-year	3842.00	196.01		5.04	3.87	1.05	3.55	991.74	435.75	0.40
Headquarters	1045	25-year	4937.00	196.45		5.35	4.15	1.14	3.93	1189.89	473.33	0.41
Headquarters	1045	50-year	6344.00	196.91		5.69	4.48	1.21	4.41	1415.40	528.37	0.41
Headquarters	1045	100-year	7864.00	197.37		5.95	4.69	1.11	4.83	1676.72	600.77	0.42
Headquarters	1045	500-year	12150.00	198.58		6.35	4.97	1.44	5.58	2442.42	652.12	0.41
Headquarters	940	2-year	1871.00	194.28		6.11	4.82	1.69	3.20	388.25	264.12	0.57
Headquarters	940	10-year	3842.00	195.62		6.05	4.31	0.91	3.59	891.94	446.68	0.48
Headquarters	940	25-year	4937.00	196.11		6.07	4.44	1.17	3.99	1112.39	454.31	0.46
Headquarters	940	50-year	6344.00	196.57		6.42	4.81	1.41	4.53	1320.21	461.25	0.47
Headquarters	940	100-year	7864.00	197.04		6.67	5.11	1.62	4.98	1538.93	468.02	0.47
Headquarters	940	500-year	12150.00	198.22		7.21	5.78	2.07	5.93	2102.61	479.34	0.46
Headquarters	868	2-year	1871.00	194.05		5.45	3.97	0.11	2.44	471.62	329.10	0.49
Headquarters	868	10-year	3842.00	195.54		4.81	3.58	0.68	3.13	1074.51	441.61	0.37
Headquarters	868	25-year	4937.00	196.03		5.00	3.82	0.88	3.54	1292.96	454.46	0.37
Headquarters	868	50-year	6344.00	196.47		5.42	4.24	1.11	4.06	1496.63	461.14	0.38
Headquarters	868	100-year	7864.00	196.94		5.75	4.59	1.31	4.52	1713.92	468.14	0.39
Headquarters	868	500-year	12150.00	198.13		6.41	5.33	1.73	5.50	2280.86	483.96	0.40
Headquarters	772	2-year	1871.00	193.70		5.46	4.08	1.72	2.29	458.48	241.83	0.46
Headquarters	772	10-year	3842.00	195.25		5.69	3.81	1.38	3.09	1008.32	421.53	0.41
Headquarters	772	25-year	4937.00	195.75		5.87	4.03	1.58	3.55	1223.65	426.72	0.41
Headquarters	772	50-year	6344.00	196.16		6.45	4.53	1.85	4.18	1399.46	430.00	0.44
Headquarters	772	100-year	7864.00	196.62		6.85	4.93	2.06	4.71	1596.49	433.75	0.45
Headquarters	772	500-year	12150.00	197.79		7.63	5.76	2.51	5.84	2108.58	442.87	0.46
Headquarters	700	2-year	1871.00	193.28		6.25	5.18	1.80	3.64	361.26	159.96	0.53
Headquarters	700	10-year	3842.00	194.39	193.53	8.73	5.84	2.06	4.04	657.56	369.25	0.66
Headquarters	700	25-year	4937.00	194.92	194.92	9.15	5.67	2.13	4.21	870.62	421.90	0.66
Headquarters	700	50-year	6344.00	195.49		9.04	5.69	2.37	4.88	1114.77	428.85	0.63
Headquarters	700	100-year	7864.00	196.04		9.04	5.81	2.56	5.41	1352.97	435.55	0.60
Headquarters	700	500-year	12150.00	197.31		9.38	6.35	3.02	6.55	1913.39	446.91	0.57
Headquarters	617	2-year	1871.00	193.15		5.07	3.65	1.49	2.56	512.36	302.49	0.44
Headquarters	617	10-year	3842.00	194.44		5.98	3.85	1.72	3.34	997.66	444.32	0.45
Headquarters	617	25-year	4937.00	194.91		6.40	4.08	1.70	3.91	1210.64	457.60	0.46
Headquarters	617	50-year	6344.00	195.45		6.70	4.34	1.94	4.44	1462.64	466.43	0.47
Headquarters	617	100-year	7864.00	195.97		7.00	4.60	2.16	4.91	1709.17	473.68	0.47
Headquarters	617	500-year	12150.00	197.23		7.73	5.26	2.67	5.97	2309.81	484.70	0.48
Headquarters	516	2-year	1871.00	192.77		5.43	3.78	1.57	3.35	495.47	341.83	0.50

HEC-RAS Plan: Ex-DRN River: TinicumCreek Reach: Headquarters (Continued)

Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	Vel Chnl	Vel Total	Vel Left	Vel Right	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(sq ft)	(ft)	
Headquarters	516	10-year	3842.00	194.19		5.78	3.26	1.69	3.30	1179.30	522.91	0.45
Headquarters	516	25-year	4937.00	194.69		5.98	3.42	1.91	3.71	1441.54	527.80	0.45
Headquarters	516	50-year	6344.00	195.25		6.24	3.64	2.14	4.14	1740.98	533.17	0.45
Headquarters	516	100-year	7864.00	195.79		6.52	3.88	2.36	4.55	2028.87	538.45	0.45
Headquarters	516	500-year	12150.00	197.07		7.24	4.46	2.86	5.48	2723.83	547.49	0.45
Headquarters	434	2-year	1871.00	192.62		4.41	2.68	1.41	3.02	697.02	464.80	0.40
Headquarters	434	10-year	3842.00	194.06		5.02	2.67	1.66	3.23	1436.27	533.79	0.39
Headquarters	434	25-year	4937.00	194.55		5.43	2.91	1.91	3.51	1698.50	538.62	0.40
Headquarters	434	50-year	6344.00	195.10		5.89	3.17	2.19	3.84	2000.26	544.21	0.41
Headquarters	434	100-year	7864.00	195.64		6.33	3.43	2.44	4.15	2291.44	550.07	0.43
Headquarters	434	500-year	12150.00	196.91		7.34	4.05	3.04	4.89	2997.23	558.61	0.45
Headquarters	325	2-year	1871.00	192.02		6.00	3.90	1.36		479.73	313.36	0.48
Headquarters	325	10-year	3842.00	193.38		7.39	3.55	1.82		1082.70	504.14	0.52
Headquarters	325	25-year	4937.00	193.90		7.73	3.67	2.17		1345.27	511.00	0.53
Headquarters	325	50-year	6344.00	194.48		8.10	3.85	2.51		1646.42	519.03	0.53
Headquarters	325	100-year	7864.00	195.03		8.48	4.07	2.83		1930.87	526.55	0.54
Headquarters	325	500-year	12150.00	196.32		9.33	4.63	3.53	0.10	2622.25	539.14	0.55
Headquarters	202	2-year	1871.00	191.75		5.41	3.34	1.36	1.95	560.00	367.93	0.43
Headquarters	202	10-year	3842.00	192.98		7.19	3.40	1.76	2.57	1128.59	495.38	0.51
Headquarters	202	25-year	4937.00	193.46		7.73	3.61	2.10	2.75	1368.00	502.57	0.53
Headquarters	202	50-year	6344.00	193.98		8.35	3.88	2.46	2.95	1634.32	510.41	0.55
Headquarters	202	100-year	7864.00	194.46		8.99	4.18	2.80	3.14	1882.16	519.30	0.57
Headquarters	202	500-year	12150.00	195.66		10.30	4.81	3.52	3.55	2525.05	545.59	0.61
Headquarters	83	2-year	1871.00	190.59	190.32	8.38	5.92	1.57	2.49	316.05	241.46	0.72
Headquarters	83	10-year	3842.00	192.03	192.01	9.31	4.45	2.22	2.77	863.70	453.28	0.69
Headquarters	83	25-year	4937.00	192.50	192.39	9.88	4.56	2.58	2.93	1082.24	474.12	0.71
Headquarters	83	50-year	6344.00	193.05		10.41	4.72	2.95	3.08	1344.90	489.15	0.71
Headquarters	83	100-year	7864.00	193.58		10.82	4.89	3.28	3.20	1608.30	502.74	0.71
Headquarters	83	500-year	12150.00	194.84		11.81	5.37	3.97	3.55	2264.32	535.92	0.72
Headquarters	9	2-year	1871.00	190.35	189.39	7.25	4.62	1.76	2.66	405.01	282.72	0.60
Headquarters	9	10-year	3842.00	191.72	191.55	8.67	3.98	2.10	3.05	965.43	468.16	0.63
Headquarters	9	25-year	4937.00	192.21	191.92	9.14	4.13	2.47	3.18	1194.25	477.78	0.64
Headquarters	9	50-year	6344.00	192.75	192.33	9.65	4.36	2.85	3.31	1454.90	485.75	0.65
Headquarters	9	100-year	7864.00	193.27	192.70	10.13	4.60	3.20	3.44	1709.72	493.32	0.66
Headquarters	9	500-year	12150.00	194.51	193.59	11.25	5.20	3.95	3.73	2335.80	509.58	0.67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Elevation (ft)
Station (ft)
Legend
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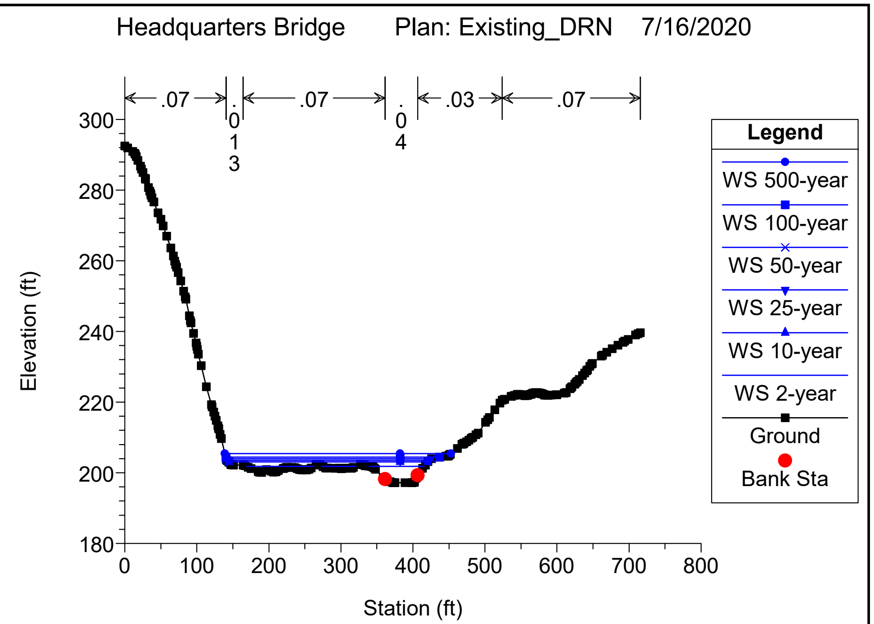
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Ineff
Bank Sta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Elevation (ft)
Station (ft)
Legend
WS 500-year
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WS 10-year
WS 2-year
Ground
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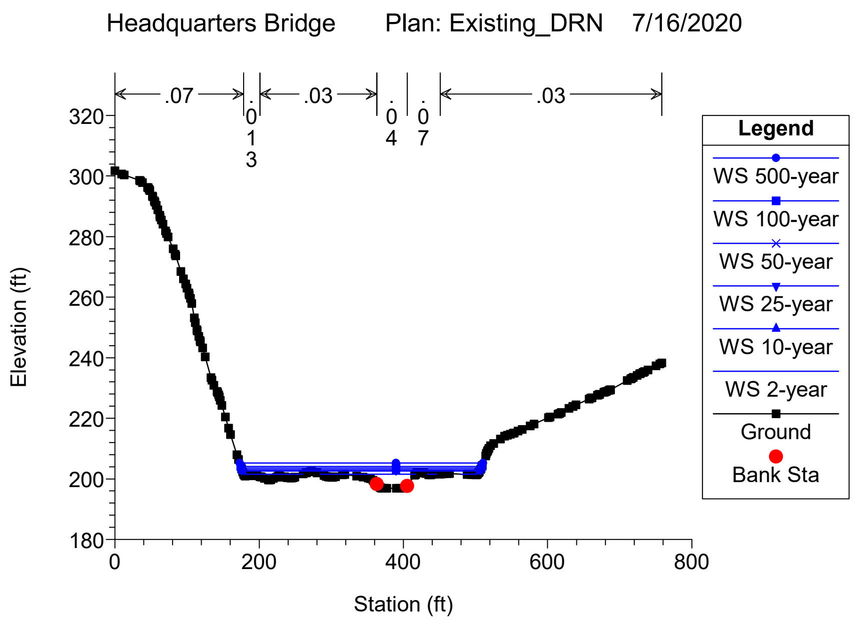
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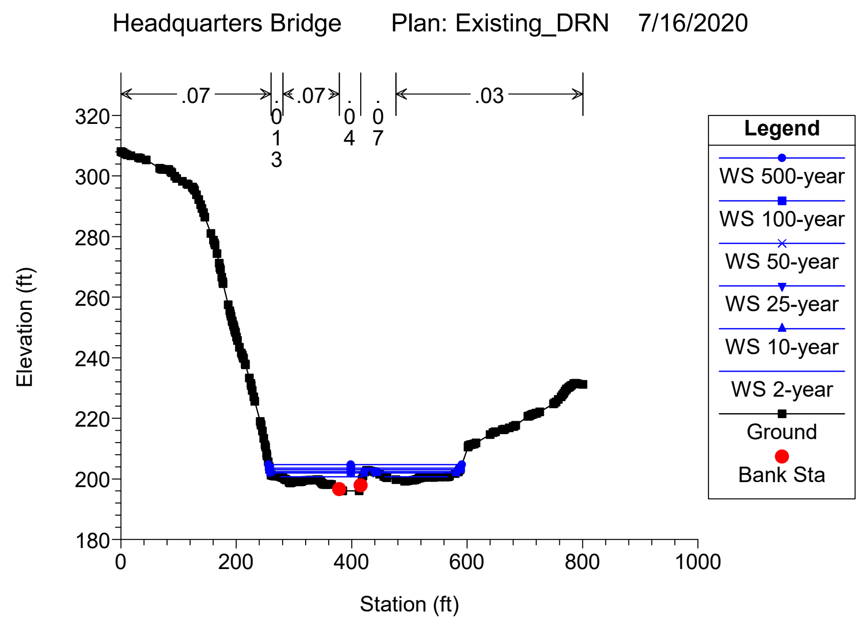
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
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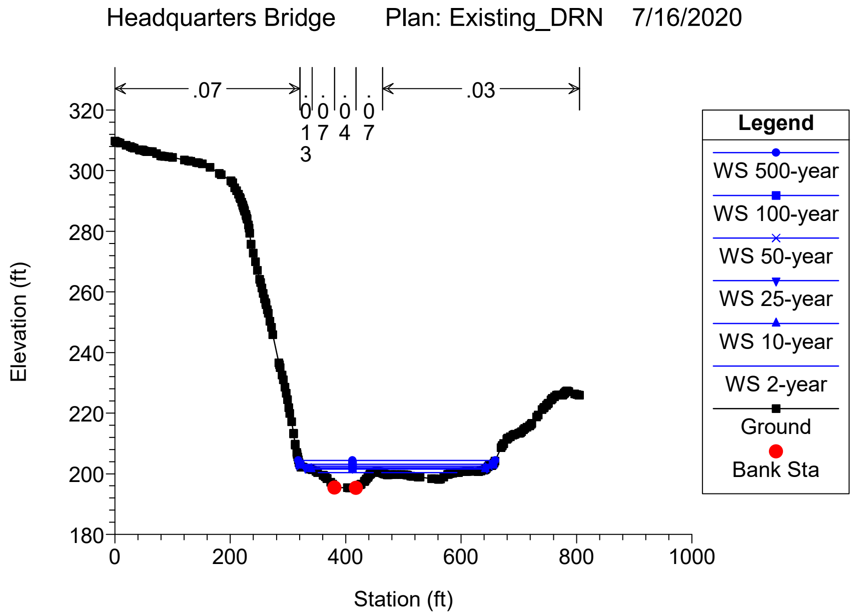
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta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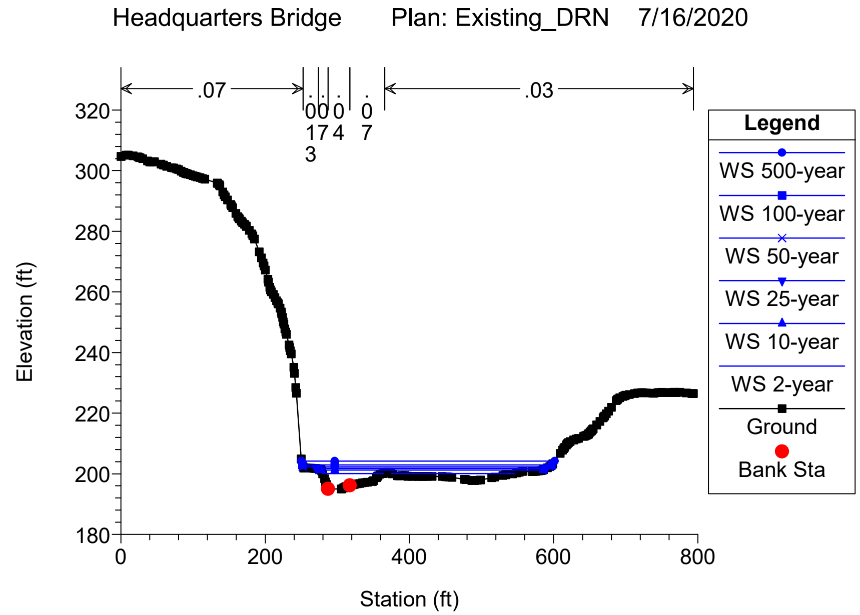
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta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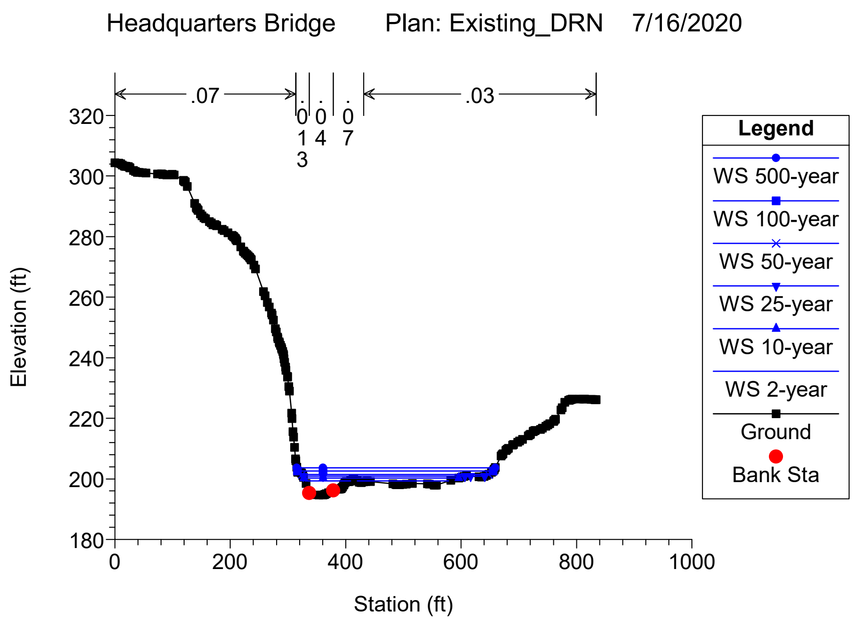
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
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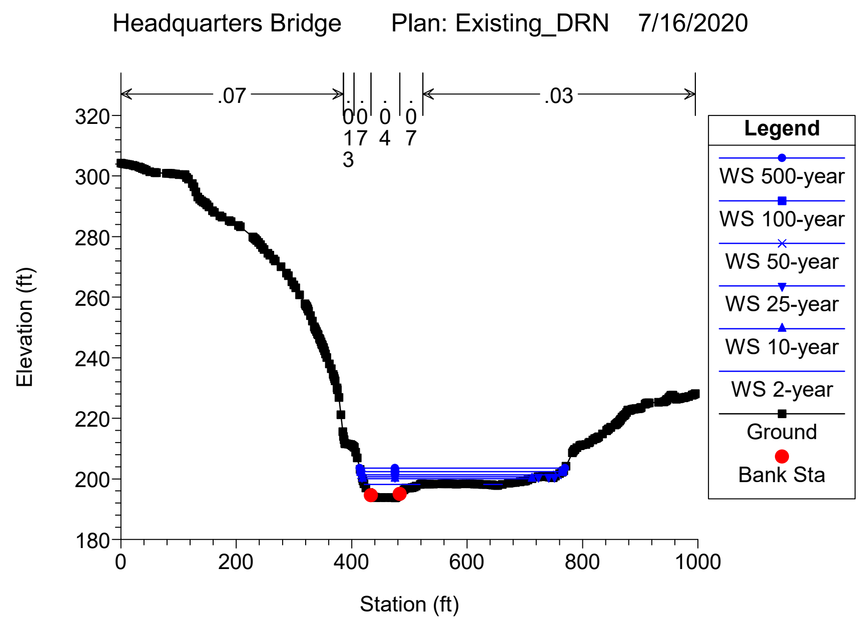
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
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WS 100-year
WS 50-year
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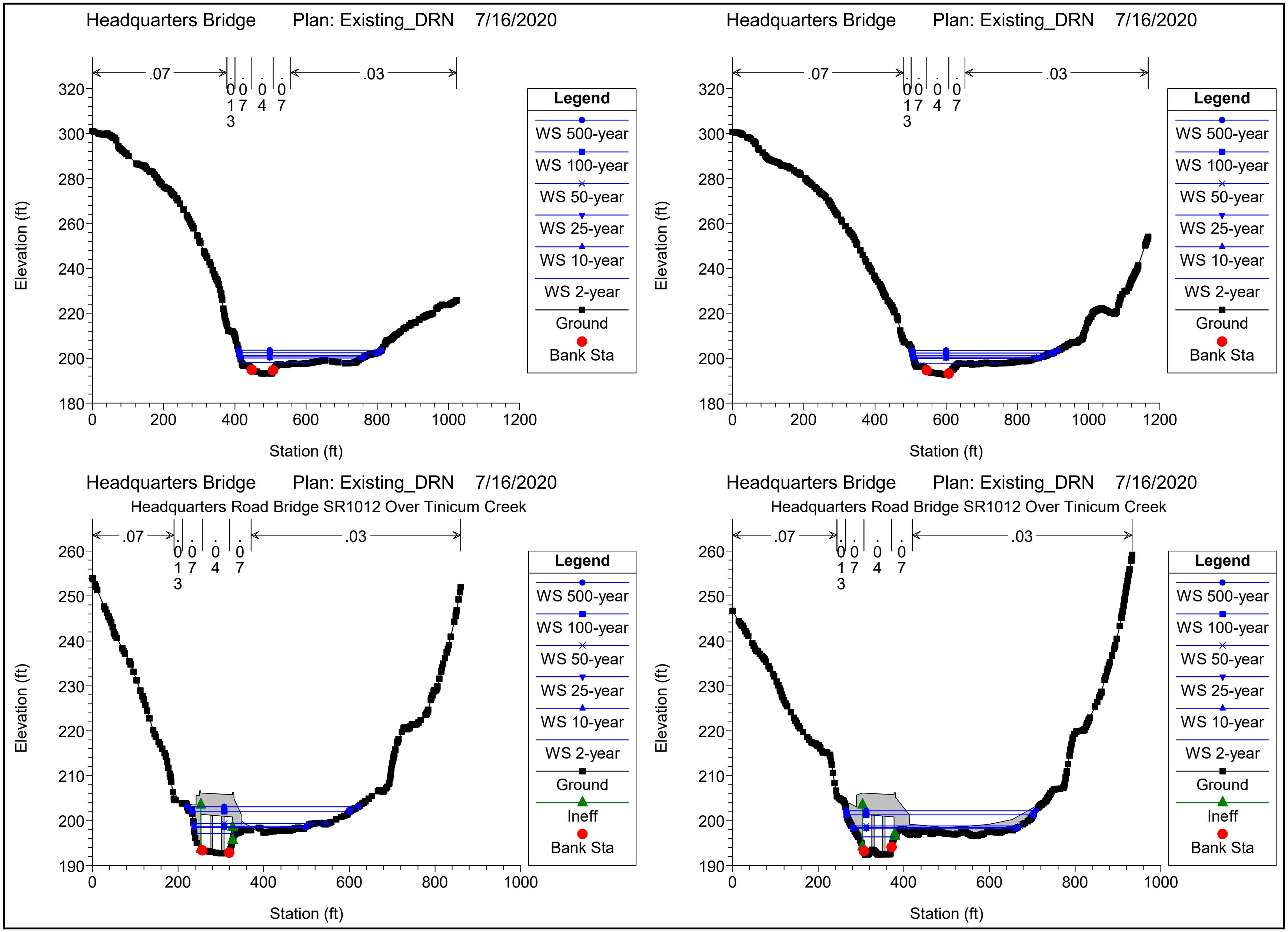
WS 10-year
WS 2-year
Ground
Bank Sta



Headquarters Bridge Plan: Existing_DRN 7/16/2020
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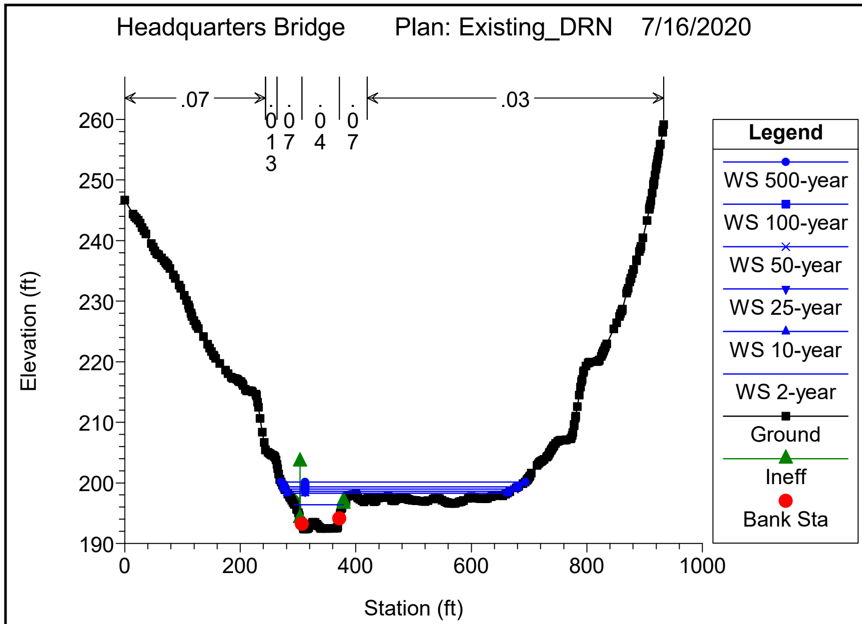
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
Headquarters Road Bridge SR1012 Over Tinicum Creek
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Ineff
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
Headquarters Road Bridge SR1012 Over Tinicum Creek
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Ineff
Bank Sta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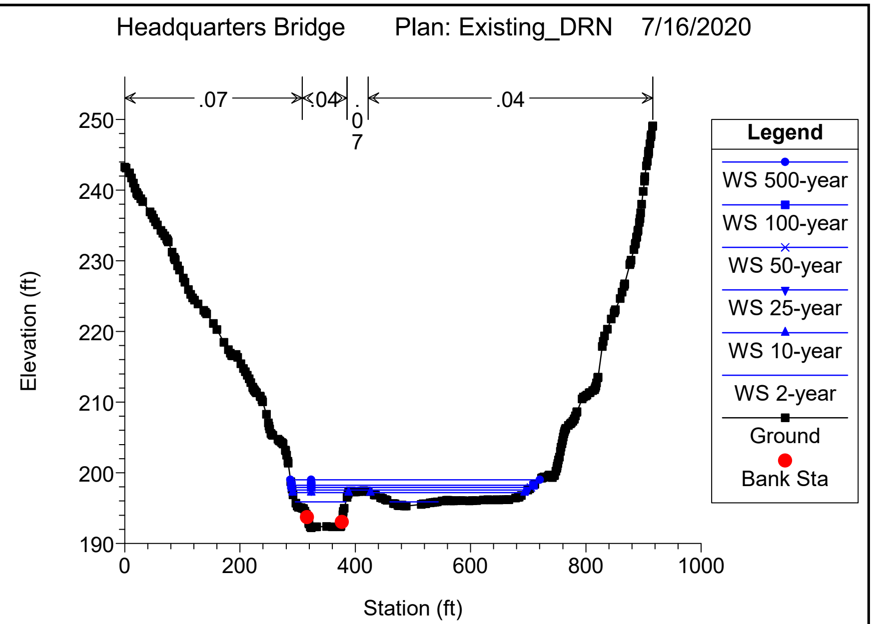
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Ineff
Bank Sta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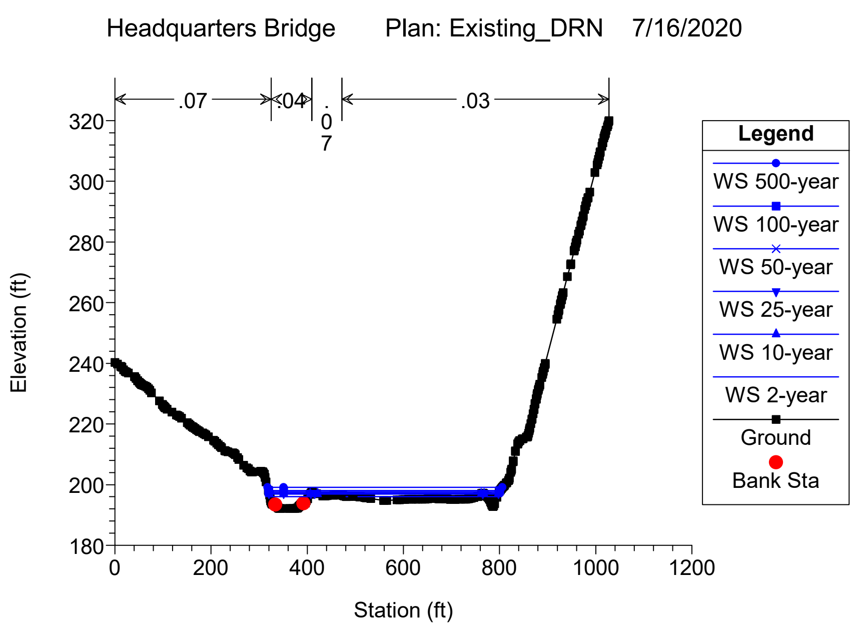
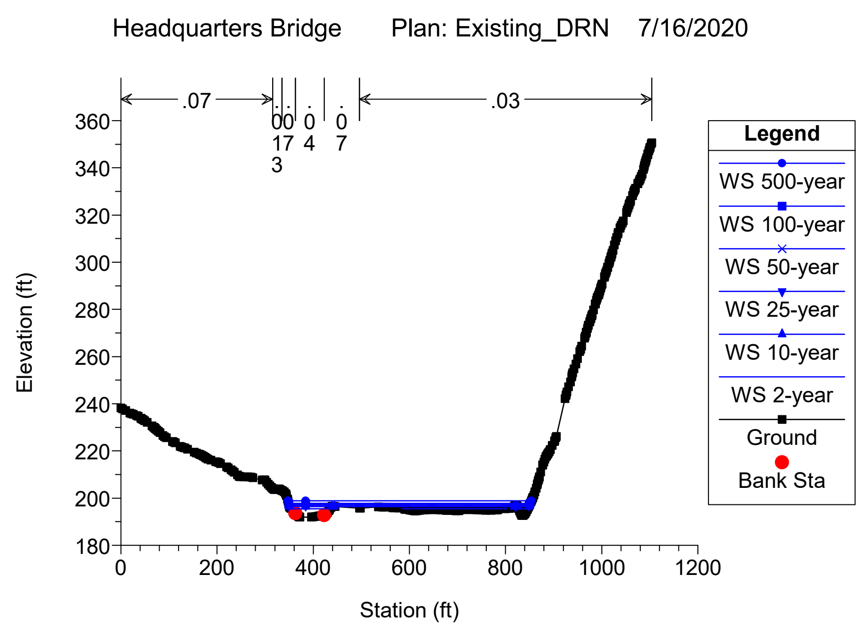
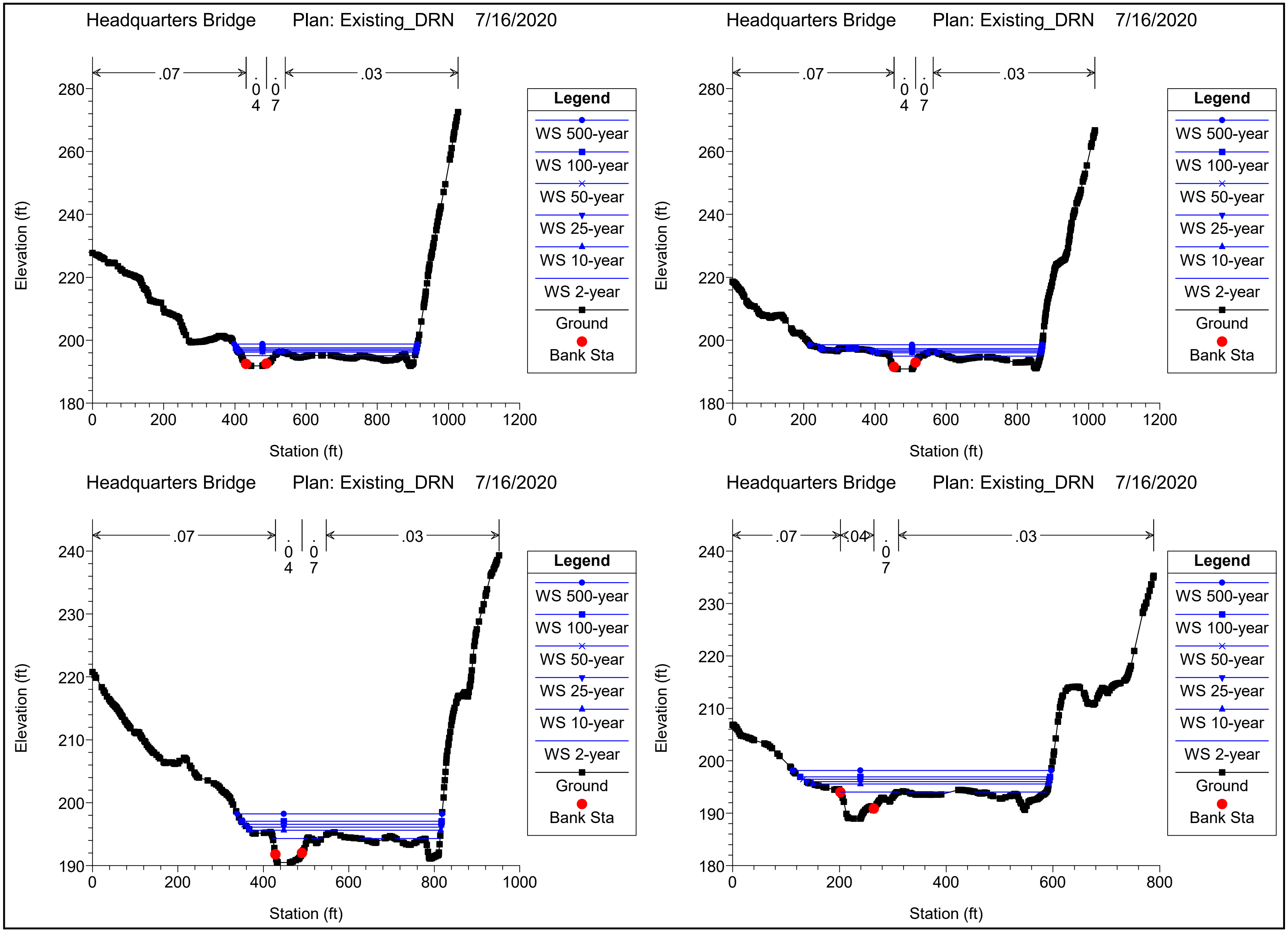
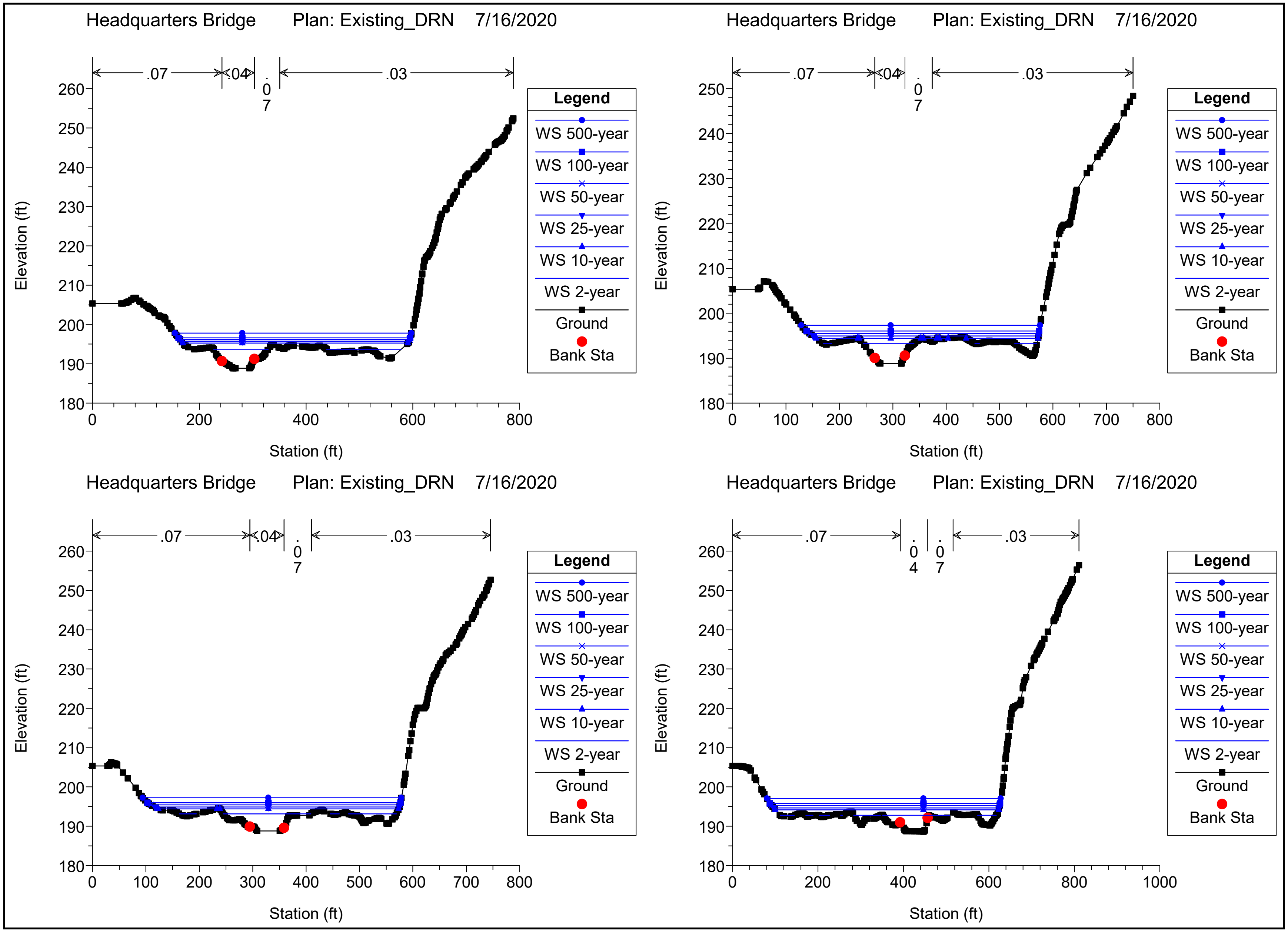
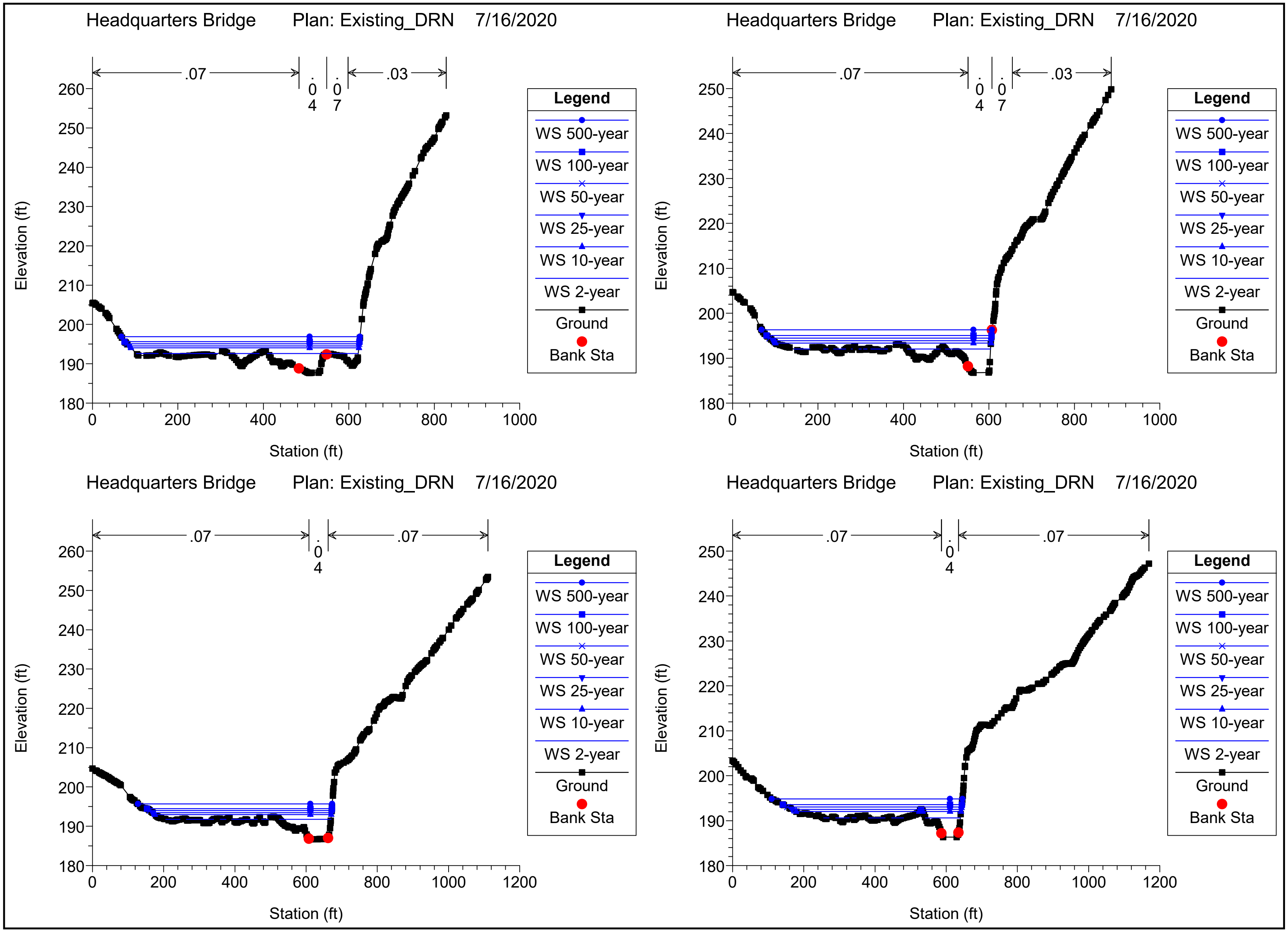
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta


Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta


Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta

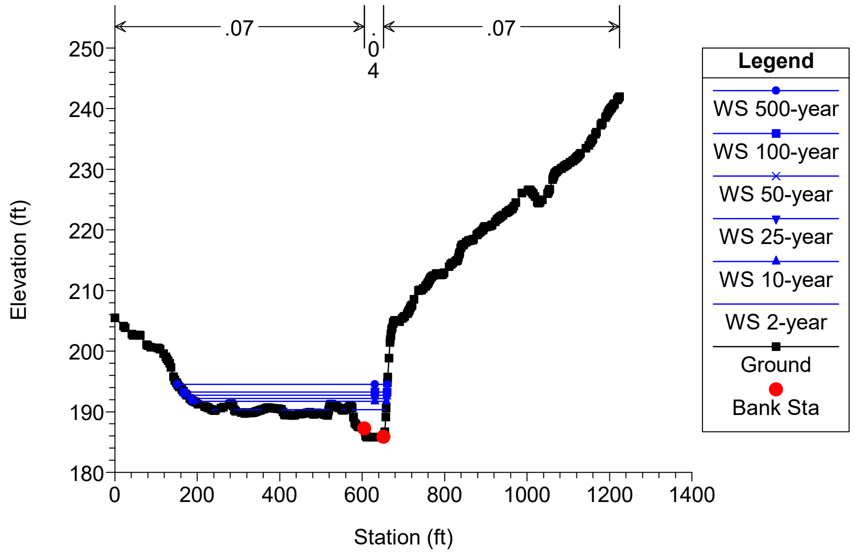

Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta


Headquarters Bridge Plan: Existing_DRN 7/16/2020
Elevation (ft)
Station (ft)
.07
.04
0
7
.03
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
Headquarters Bridge Plan: Existing_DRN 7/16/2020
Headquarters Bridge Plan: Existing_DRN 7/16/2020



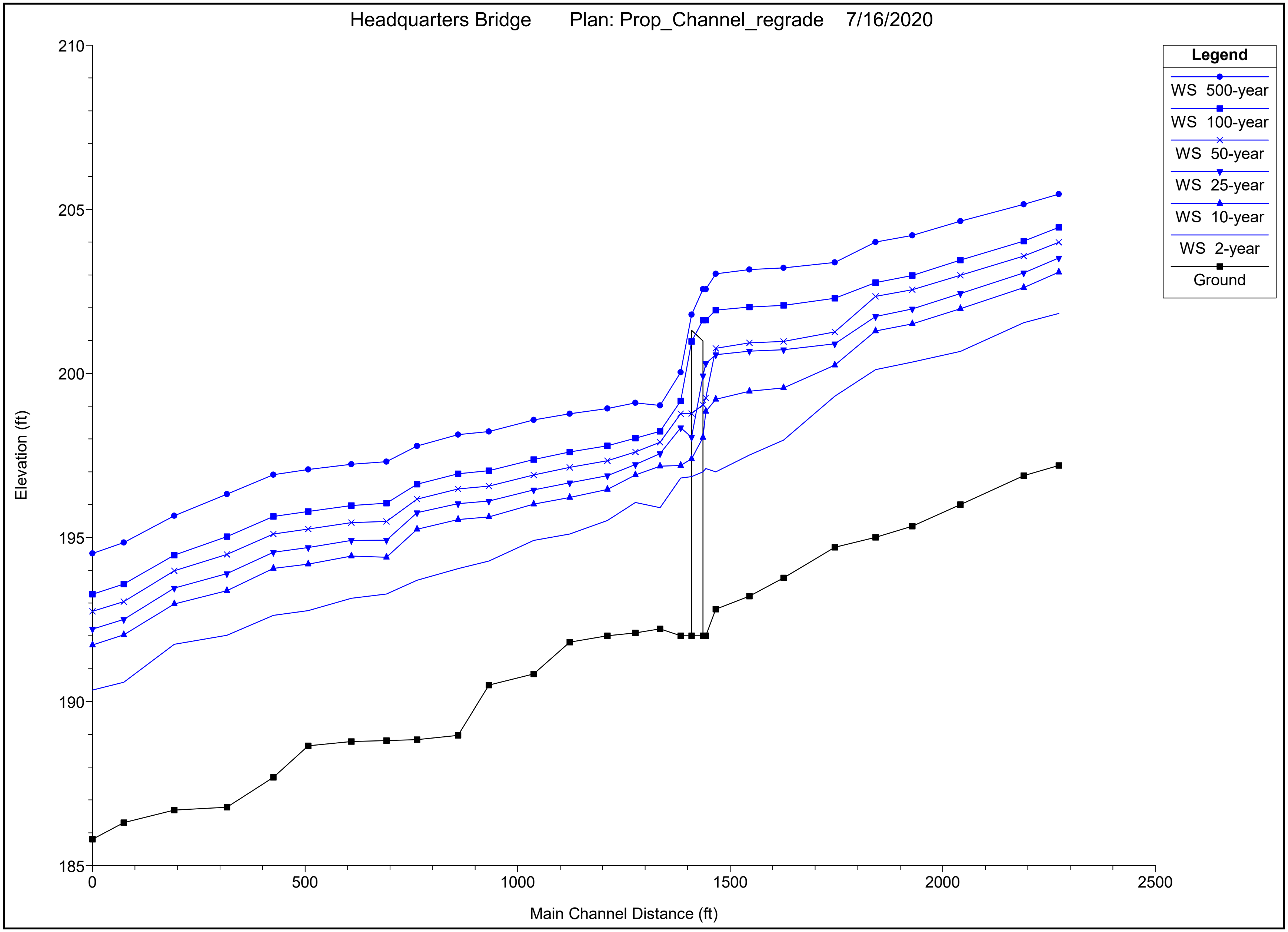
Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.07
.03
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.07
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta
Headquarters Bridge Plan: Existing_DRN 7/16/2020
.07
.04
.07
Elevation (ft)
Station (ft)
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Bank Sta

Headquarters Bridge   Plan: Existing_DRN   7/16/2020



Attachment D

HEC-RAS Proposed Conditions Analysis


Headquarters Bridge Plan: Prop_Channel_regrade 7/16/2020
Legend
WS 500-year
WS 100-year
WS 50-year
WS 25-year
WS 10-year
WS 2-year
Ground
Elevation (ft)
Main Channel Distance (ft)
210
205
200
195
190
185
0
500
1000
1500
2000
2500

HEC-RAS Plan: Prop_final River: TinicumCreek Reach: Headquarters

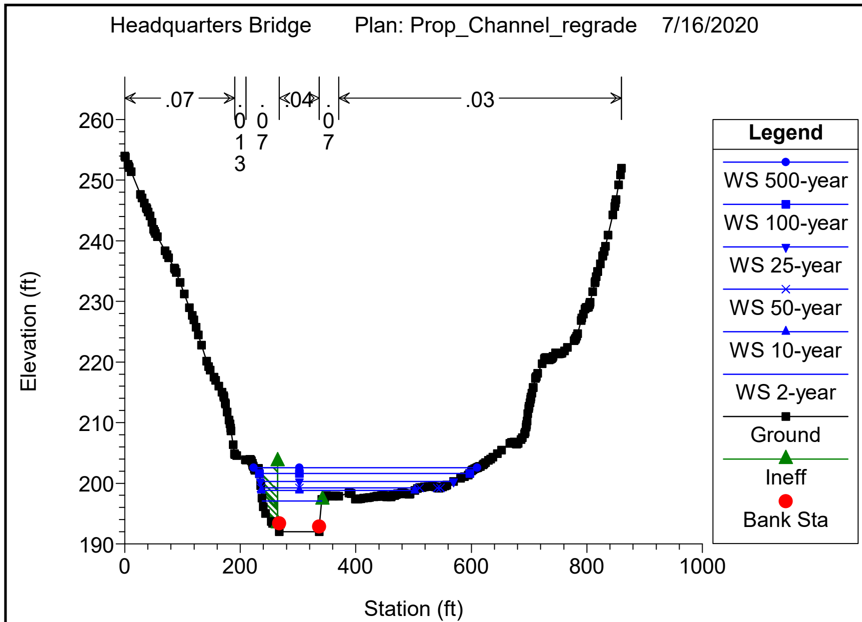
Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	Vel Chnl	Vel Total	Vel Left	Vel Right	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(sq ft)	(ft)	
Headquarters	2280	2-year	1871.00	201.83	201.36	7.98	5.36	1.63	4.49	348.75	216.09	0.67
Headquarters	2280	10-year	3842.00	203.08	203.08	9.85	5.71	2.95	6.13	673.26	276.30	0.73
Headquarters	2280	25-year	4937.00	203.52	203.52	10.71	6.21	3.63	6.66	794.38	281.24	0.76
Headquarters	2280	50-year	6344.00	204.00	204.00	11.60	6.82	4.38	7.19	929.85	285.32	0.80
Headquarters	2280	100-year	7864.00	204.45	204.45	12.48	7.41	5.13	6.50	1061.67	296.80	0.83
Headquarters	2280	500-year	12150.00	205.46	205.46	14.36	8.83	6.76	7.67	1375.37	314.14	0.89
Headquarters	2197	2-year	1871.00	201.55	201.35	7.05	5.27	3.39	1.97	355.32	249.93	0.58
Headquarters	2197	10-year	3842.00	202.61		7.69	5.63	5.31	2.47	682.13	329.13	0.57
Headquarters	2197	25-year	4937.00	203.06		7.81	5.94	5.99	3.00	830.48	330.90	0.56
Headquarters	2197	50-year	6344.00	203.57		7.98	6.35	6.68	3.51	999.60	332.66	0.55
Headquarters	2197	100-year	7864.00	204.03		8.30	6.83	7.37	3.98	1151.72	334.15	0.55
Headquarters	2197	500-year	12150.00	205.15		9.02	7.95	8.90	5.01	1528.15	337.40	0.56
Headquarters	2048	2-year	1871.00	200.67	200.37	7.76	4.59	2.37	2.34	407.60	250.11	0.64
Headquarters	2048	10-year	3842.00	201.97		8.20	4.98	3.44	4.13	771.47	300.06	0.60
Headquarters	2048	25-year	4937.00	202.43		8.64	5.40	3.99	4.68	913.50	312.57	0.61
Headquarters	2048	50-year	6344.00	202.99		8.99	5.81	4.54	5.18	1092.76	329.43	0.60
Headquarters	2048	100-year	7864.00	203.46		9.49	6.31	5.10	5.77	1247.11	331.34	0.62
Headquarters	2048	500-year	12150.00	204.63		10.47	7.41	6.31	7.04	1639.78	334.69	0.63
Headquarters	1935	2-year	1871.00	200.34		6.35	4.11	1.92	2.77	454.94	226.37	0.50
Headquarters	1935	10-year	3842.00	201.51		7.83	4.96	2.40	4.07	774.48	302.60	0.56
Headquarters	1935	25-year	4937.00	201.96		8.24	5.39	2.71	4.71	915.44	314.77	0.57
Headquarters	1935	50-year	6344.00	202.55		8.43	5.74	3.17	5.26	1105.28	326.16	0.55
Headquarters	1935	100-year	7864.00	202.99		9.05	6.30	3.84	5.87	1248.75	334.29	0.58
Headquarters	1935	500-year	12150.00	204.20		9.73	7.32	5.41	7.04	1659.22	340.42	0.58
Headquarters	1849	2-year	1871.00	200.11		6.13	3.82	2.01	2.88	490.01	254.69	0.49
Headquarters	1849	10-year	3842.00	201.29		7.10	4.66	2.27	4.05	824.53	308.19	0.51
Headquarters	1849	25-year	4937.00	201.73		7.53	5.13	2.12	4.63	963.29	318.95	0.52
Headquarters	1849	50-year	6344.00	202.35		7.62	5.43	2.68	5.07	1169.20	342.40	0.50
Headquarters	1849	100-year	7864.00	202.77		8.14	5.98	3.65	5.66	1314.34	345.02	0.52
Headquarters	1849	500-year	12150.00	204.00		8.73	6.97	6.11	6.70	1743.09	350.21	0.52
Headquarters	1753	2-year	1871.00	199.31	199.31	6.94	5.14	11.79	2.71	364.31	237.42	0.59
Headquarters	1753	10-year	3842.00	200.25	200.25	8.62	6.36	14.76	4.49	604.16	267.45	0.66
Headquarters	1753	25-year	4937.00	200.90		8.34	6.27	14.31	4.84	786.88	309.23	0.61
Headquarters	1753	50-year	6344.00	201.26	201.24	9.53	7.03	16.24	5.46	902.74	320.25	0.67
Headquarters	1753	100-year	7864.00	202.29		8.24	6.36	11.36	5.46	1236.30	337.10	0.54
Headquarters	1753	500-year	12150.00	203.38		9.14	7.55	14.25	6.70	1608.55	342.86	0.56
Headquarters	1633	2-year	1871.00	197.97	197.49	8.61	7.22	2.89	2.03	259.10	104.26	0.76
Headquarters	1633	10-year	3842.00	199.55	199.52	9.00	6.09	3.22	3.82	630.68	284.49	0.67
Headquarters	1633	25-year	4937.00	200.72		7.23	5.06	2.64	4.03	975.70	319.50	0.49
Headquarters	1633	50-year	6344.00	200.97		8.68	5.99	3.18	4.78	1059.95	336.22	0.58
Headquarters	1633	100-year	7864.00	202.07		7.49	5.47	2.76	4.83	1436.92	347.14	0.46
Headquarters	1633	500-year	12150.00	203.21		8.59	6.61	3.17	6.16	1837.02	354.44	0.50
Headquarters	1553	2-year	1871.00	197.51	196.85	7.62	6.30	1.92	1.33	296.96	152.76	0.68
Headquarters	1553	10-year	3842.00	199.46		7.01	4.67	2.44	3.09	822.54	335.25	0.51
Headquarters	1553	25-year	4937.00	200.68		5.68	3.98	2.13	3.29	1240.82	349.31	0.38
Headquarters	1553	50-year	6344.00	200.93		6.75	4.78	2.56	4.05	1327.78	352.45	0.44
Headquarters	1553	100-year	7864.00	202.02		6.27	4.55	2.46	4.09	1726.59	378.56	0.38
Headquarters	1553	500-year	12150.00	203.16		7.47	5.60	2.99	5.24	2170.04	398.34	0.43
Headquarters	1474	2-year	1871.00	197.00		7.45	6.25	1.59	2.68	299.53	116.38	0.68
Headquarters	1474	10-year	3842.00	199.21		6.85	4.60	2.37	2.96	835.69	329.46	0.50
Headquarters	1474	25-year	4937.00	200.57		5.46	3.78	2.06	3.08	1305.67	361.68	0.36
Headquarters	1474	50-year	6344.00	200.76		6.62	4.61	2.52	3.82	1376.24	366.59	0.43
Headquarters	1474	100-year	7864.00	201.92		5.99	4.34	2.37	3.89	1813.51	386.57	0.36
Headquarters	1474	500-year	12150.00	203.04		7.22	5.39	2.92	5.04	2254.78	405.09	0.41
Headquarters	1450	2-year	1871.00	197.10	194.84	5.22	5.04	2.47	1.35	371.27	102.59	0.41
Headquarters	1450	10-year	3842.00	198.84	196.55	7.27	5.91	3.65	2.19	650.14	266.09	0.49
Headquarters	1450	25-year	4937.00	200.30	197.34	6.25	4.69	3.23	2.81	1052.65	334.73	0.38
Headquarters	1450	50-year	6344.00	199.25	199.25	10.70	8.46	5.43	3.90	749.73	280.02	0.70
Headquarters	1450	100-year	7864.00	201.62	200.00	7.07	5.33	3.72	3.92	1475.94	364.34	0.40
Headquarters	1450	500-year	12150.00	202.56	201.10	8.82	6.77	4.69	5.40	1793.87	386.71	0.48
Headquarters	1421		Bridge									
Headquarters	1391	2-year	1871.00	196.81	194.79	5.41	5.31	2.60	0.28	352.29	119.84	0.44
Headquarters	1391	10-year	3842.00	197.20	196.47	10.16	9.50	4.96	1.94	404.34	200.50	0.79
Headquarters	1391	25-year	4937.00	198.34	198.34	8.84	6.72	4.48	3.34	734.59	382.04	0.62

HEC-RAS Plan: Prop_final River: TinicumCreek Reach: Headquarters (Continued)

Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	Vel Chnl	Vel Total	Vel Left	Vel Right	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(sq ft)	(ft)	
Headquarters	1391	50-year	6344.00	198.77	198.77	9.56	7.16	4.90	4.31	886.48	392.17	0.65
Headquarters	1391	100-year	7864.00	199.16	199.16	10.24	7.66	5.29	5.15	1026.12	401.47	0.68
Headquarters	1391	500-year	12150.00	200.03	200.03	11.80	9.00	6.20	7.00	1349.29	420.83	0.73
Headquarters	1343	2-year	1871.00	195.90	195.83	8.20	6.99	3.17	2.22	267.78	171.61	0.77
Headquarters	1343	10-year	3842.00	197.17	197.17	8.77	5.81	3.95	3.48	661.51	364.50	0.71
Headquarters	1343	25-year	4937.00	197.55	197.55	9.30	6.09	4.31	4.08	810.12	408.87	0.72
Headquarters	1343	50-year	6344.00	197.90	197.90	10.17	6.65	4.80	4.78	953.88	415.16	0.77
Headquarters	1343	100-year	7864.00	198.23	198.23	10.97	7.21	5.27	5.45	1090.69	420.56	0.80
Headquarters	1343	500-year	12150.00	199.02	199.02	12.69	8.50	6.27	6.95	1429.14	433.10	0.87
Headquarters	1285	2-year	1871.00	196.07		5.15	3.82	3.64	2.74	489.79	356.17	0.48
Headquarters	1285	10-year	3842.00	196.90		6.11	4.59	4.40	3.87	836.75	455.04	0.51
Headquarters	1285	25-year	4937.00	197.22		6.59	5.02	4.75	4.38	983.45	469.04	0.53
Headquarters	1285	50-year	6344.00	197.60		6.96	5.44	5.02	4.91	1165.39	478.87	0.54
Headquarters	1285	100-year	7864.00	198.02		7.16	5.76	5.15	5.33	1365.88	480.95	0.54
Headquarters	1285	500-year	12150.00	199.10		7.57	6.44	5.36	6.18	1887.48	488.25	0.52
Headquarters	1219	2-year	1871.00	195.51	195.46	6.60	4.94	1.63	3.26	378.94	318.04	0.65
Headquarters	1219	10-year	3842.00	196.46		7.17	5.07	2.04	4.11	758.18	485.38	0.62
Headquarters	1219	25-year	4937.00	196.88		7.10	5.12	2.17	4.40	964.90	498.12	0.58
Headquarters	1219	50-year	6344.00	197.34		7.11	5.32	2.29	4.80	1192.18	500.96	0.56
Headquarters	1219	100-year	7864.00	197.79		7.12	5.53	2.37	5.15	1420.85	502.62	0.53
Headquarters	1219	500-year	12150.00	198.93		7.29	6.09	2.56	5.91	1994.88	506.61	0.50
Headquarters	1130	2-year	1871.00	195.11		5.56	4.09	2.12	3.21	457.41	360.00	0.55
Headquarters	1130	10-year	3842.00	196.22		5.38	4.00	1.86	3.62	961.08	484.40	0.46
Headquarters	1130	25-year	4937.00	196.67		5.40	4.17	1.75	3.92	1183.33	501.51	0.44
Headquarters	1130	50-year	6344.00	197.13		5.55	4.47	1.84	4.32	1419.24	504.65	0.43
Headquarters	1130	100-year	7864.00	197.61		5.70	4.74	1.92	4.66	1657.62	507.65	0.42
Headquarters	1130	500-year	12150.00	198.77		6.09	5.39	2.11	5.44	2253.61	515.09	0.41
Headquarters	1045	2-year	1871.00	194.91		4.48	3.31	1.79	2.54	565.71	349.70	0.40
Headquarters	1045	10-year	3842.00	196.01		5.04	3.87	1.05	3.55	991.74	435.75	0.40
Headquarters	1045	25-year	4937.00	196.45		5.35	4.15	1.14	3.93	1189.89	473.33	0.41
Headquarters	1045	50-year	6344.00	196.91		5.69	4.48	1.21	4.41	1415.40	528.37	0.41
Headquarters	1045	100-year	7864.00	197.37		5.95	4.69	1.11	4.83	1676.72	600.77	0.42
Headquarters	1045	500-year	12150.00	198.58		6.35	4.97	1.44	5.58	2442.42	652.12	0.41
Headquarters	940	2-year	1871.00	194.28		6.11	4.82	1.69	3.20	388.25	264.12	0.57
Headquarters	940	10-year	3842.00	195.62		6.05	4.31	0.91	3.59	891.94	446.68	0.48
Headquarters	940	25-year	4937.00	196.11		6.07	4.44	1.17	3.99	1112.39	454.31	0.46
Headquarters	940	50-year	6344.00	196.57		6.42	4.81	1.41	4.53	1320.21	461.25	0.47
Headquarters	940	100-year	7864.00	197.04		6.67	5.11	1.62	4.98	1538.93	468.02	0.47
Headquarters	940	500-year	12150.00	198.22		7.21	5.78	2.07	5.93	2102.61	479.34	0.46
Headquarters	868	2-year	1871.00	194.05		5.45	3.97	0.11	2.44	471.62	329.10	0.49
Headquarters	868	10-year	3842.00	195.54		4.81	3.58	0.68	3.13	1074.51	441.61	0.37
Headquarters	868	25-year	4937.00	196.03		5.00	3.82	0.88	3.54	1292.96	454.46	0.37
Headquarters	868	50-year	6344.00	196.47		5.42	4.24	1.11	4.06	1496.63	461.14	0.38
Headquarters	868	100-year	7864.00	196.94		5.75	4.59	1.31	4.52	1713.92	468.14	0.39
Headquarters	868	500-year	12150.00	198.13		6.41	5.33	1.73	5.50	2280.86	483.96	0.40
Headquarters	772	2-year	1871.00	193.70		5.46	4.08	1.72	2.29	458.48	241.83	0.46
Headquarters	772	10-year	3842.00	195.25		5.69	3.81	1.38	3.09	1008.32	421.53	0.41
Headquarters	772	25-year	4937.00	195.75		5.87	4.03	1.58	3.55	1223.65	426.72	0.41
Headquarters	772	50-year	6344.00	196.16		6.45	4.53	1.85	4.18	1399.46	430.00	0.44
Headquarters	772	100-year	7864.00	196.62		6.85	4.93	2.06	4.71	1596.49	433.75	0.45
Headquarters	772	500-year	12150.00	197.79		7.63	5.76	2.51	5.84	2108.58	442.87	0.46
Headquarters	700	2-year	1871.00	193.28		6.25	5.18	1.80	3.64	361.26	159.96	0.53
Headquarters	700	10-year	3842.00	194.39	193.53	8.73	5.84	2.06	4.04	657.56	369.25	0.66
Headquarters	700	25-year	4937.00	194.92	194.92	9.15	5.67	2.13	4.21	870.62	421.90	0.66
Headquarters	700	50-year	6344.00	195.49		9.04	5.69	2.37	4.88	1114.77	428.85	0.63
Headquarters	700	100-year	7864.00	196.04		9.04	5.81	2.56	5.41	1352.97	435.55	0.60
Headquarters	700	500-year	12150.00	197.31		9.38	6.35	3.02	6.55	1913.39	446.91	0.57
Headquarters	617	2-year	1871.00	193.15		5.07	3.65	1.49	2.56	512.36	302.49	0.44
Headquarters	617	10-year	3842.00	194.44		5.98	3.85	1.72	3.34	997.66	444.32	0.45
Headquarters	617	25-year	4937.00	194.91		6.40	4.08	1.70	3.91	1210.64	457.60	0.46
Headquarters	617	50-year	6344.00	195.45		6.70	4.34	1.94	4.44	1462.64	466.43	0.47
Headquarters	617	100-year	7864.00	195.97		7.00	4.60	2.16	4.91	1709.17	473.68	0.47
Headquarters	617	500-year	12150.00	197.23		7.73	5.26	2.67	5.97	2309.81	484.70	0.48
Headquarters	516	2-year	1871.00	192.77		5.43	3.78	1.57	3.35	495.47	341.83	0.50

HEC-RAS Plan: Prop_final   River: TinicumCreek   Reach: Headquarters (Continued)

Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	Vel Chnl	Vel Total	Vel Left	Vel Right	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)	(sq ft)	(ft)	
Headquarters	516	10-year	3842.00	194.19		5.78	3.26	1.69	3.30	1179.30	522.91	0.45
Headquarters	516	25-year	4937.00	194.69		5.98	3.42	1.91	3.71	1441.54	527.80	0.45
Headquarters	516	50-year	6344.00	195.25		6.24	3.64	2.14	4.14	1740.98	533.17	0.45
Headquarters	516	100-year	7864.00	195.79		6.52	3.88	2.36	4.55	2028.87	538.45	0.45
Headquarters	516	500-year	12150.00	197.07		7.24	4.46	2.86	5.48	2723.83	547.49	0.45
Headquarters	434	2-year	1871.00	192.62		4.41	2.68	1.41	3.02	697.02	464.80	0.40
Headquarters	434	10-year	3842.00	194.06		5.02	2.67	1.66	3.23	1436.27	533.79	0.39
Headquarters	434	25-year	4937.00	194.55		5.43	2.91	1.91	3.51	1698.50	538.62	0.40
Headquarters	434	50-year	6344.00	195.10		5.89	3.17	2.19	3.84	2000.26	544.21	0.41
Headquarters	434	100-year	7864.00	195.64		6.33	3.43	2.44	4.15	2291.44	550.07	0.43
Headquarters	434	500-year	12150.00	196.91		7.34	4.05	3.04	4.89	2997.23	558.61	0.45
Headquarters	325	2-year	1871.00	192.02		6.00	3.90	1.36		479.73	313.36	0.48
Headquarters	325	10-year	3842.00	193.38		7.39	3.55	1.82		1082.70	504.14	0.52
Headquarters	325	25-year	4937.00	193.90		7.73	3.67	2.17		1345.27	511.00	0.53
Headquarters	325	50-year	6344.00	194.48		8.10	3.85	2.51		1646.42	519.03	0.53
Headquarters	325	100-year	7864.00	195.03		8.48	4.07	2.83		1930.87	526.55	0.54
Headquarters	325	500-year	12150.00	196.32		9.33	4.63	3.53	0.10	2622.25	539.14	0.55
Headquarters	202	2-year	1871.00	191.75		5.41	3.34	1.36	1.95	560.00	367.93	0.43
Headquarters	202	10-year	3842.00	192.98		7.19	3.40	1.76	2.57	1128.59	495.38	0.51
Headquarters	202	25-year	4937.00	193.46		7.73	3.61	2.10	2.75	1368.00	502.57	0.53
Headquarters	202	50-year	6344.00	193.98		8.35	3.88	2.46	2.95	1634.32	510.41	0.55
Headquarters	202	100-year	7864.00	194.46		8.99	4.18	2.80	3.14	1882.16	519.30	0.57
Headquarters	202	500-year	12150.00	195.66		10.30	4.81	3.52	3.55	2525.05	545.59	0.61
Headquarters	83	2-year	1871.00	190.59	190.32	8.38	5.92	1.57	2.49	316.05	241.46	0.72
Headquarters	83	10-year	3842.00	192.03	192.01	9.31	4.45	2.22	2.77	863.70	453.28	0.69
Headquarters	83	25-year	4937.00	192.50	192.39	9.88	4.56	2.58	2.93	1082.24	474.12	0.71
Headquarters	83	50-year	6344.00	193.05		10.41	4.72	2.95	3.08	1344.90	489.15	0.71
Headquarters	83	100-year	7864.00	193.58		10.82	4.89	3.28	3.20	1608.30	502.74	0.71
Headquarters	83	500-year	12150.00	194.84		11.81	5.37	3.97	3.55	2264.32	535.92	0.72
Headquarters	9	2-year	1871.00	190.35	189.39	7.25	4.62	1.76	2.66	405.01	282.72	0.60
Headquarters	9	10-year	3842.00	191.72	191.55	8.67	3.98	2.10	3.05	965.43	468.16	0.63
Headquarters	9	25-year	4937.00	192.21	191.92	9.14	4.13	2.47	3.18	1194.25	477.78	0.64
Headquarters	9	50-year	6344.00	192.75	192.33	9.65	4.36	2.85	3.31	1454.90	485.75	0.65
Headquarters	9	100-year	7864.00	193.27	192.70	10.13	4.60	3.20	3.44	1709.72	493.32	0.66
Headquarters	9	500-year	12150.00	194.51	193.59	11.25	5.20	3.95	3.73	2335.80	509.58	0.67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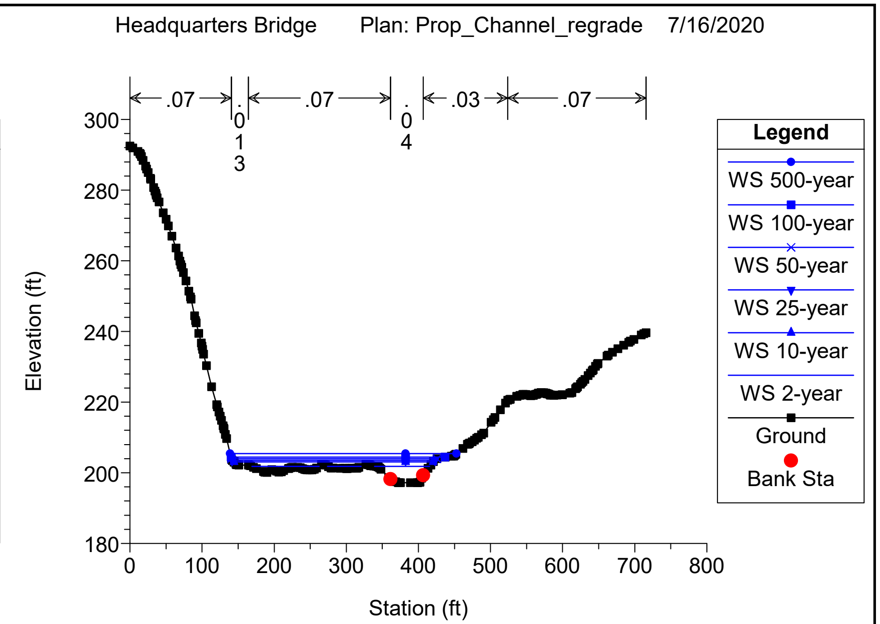
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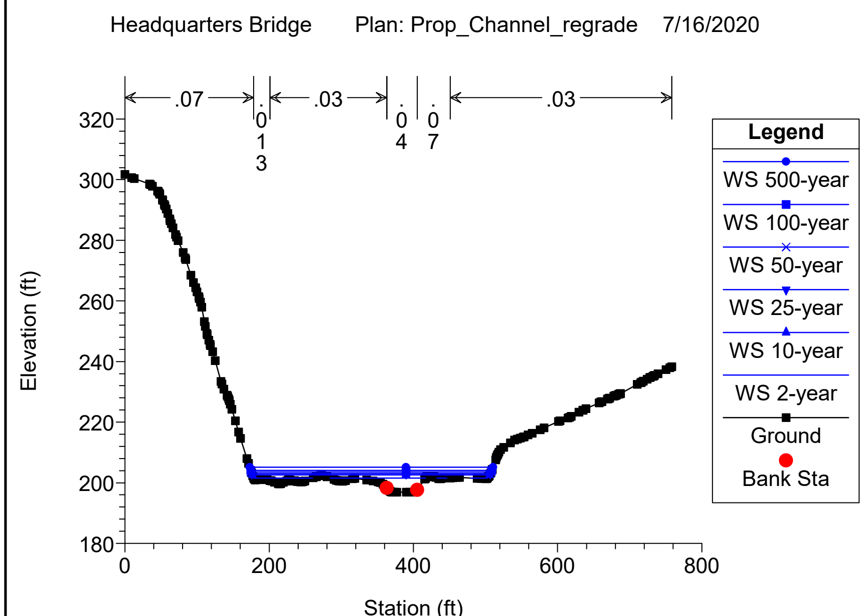
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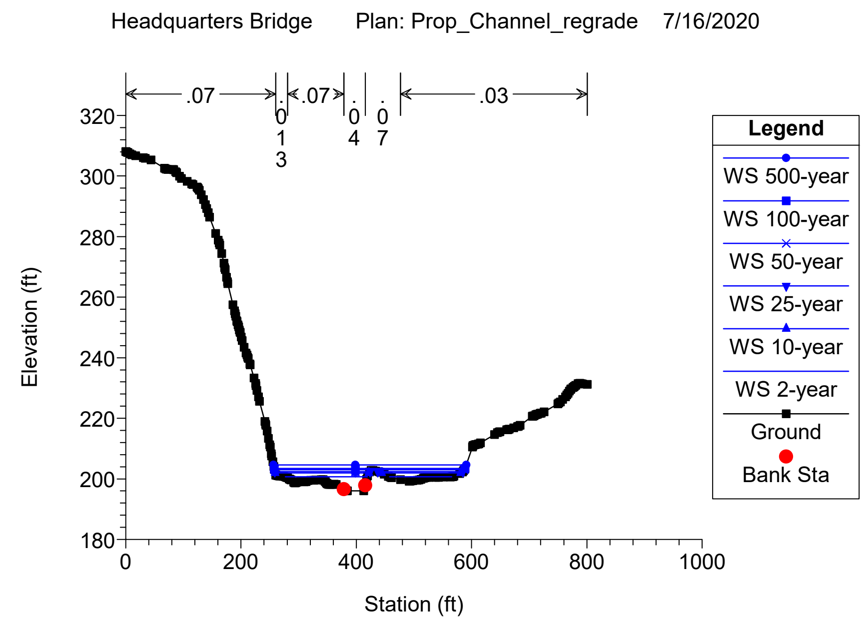
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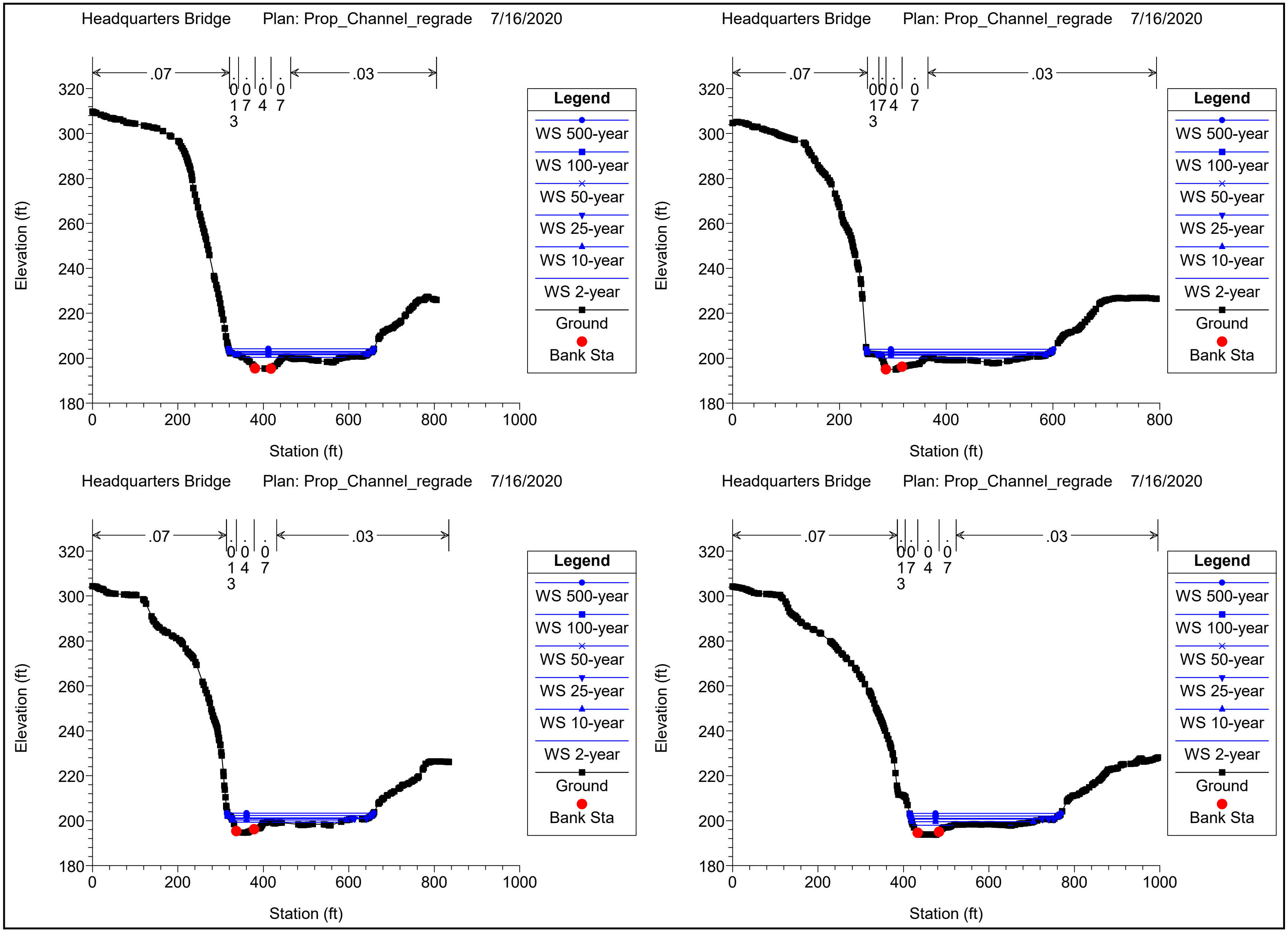
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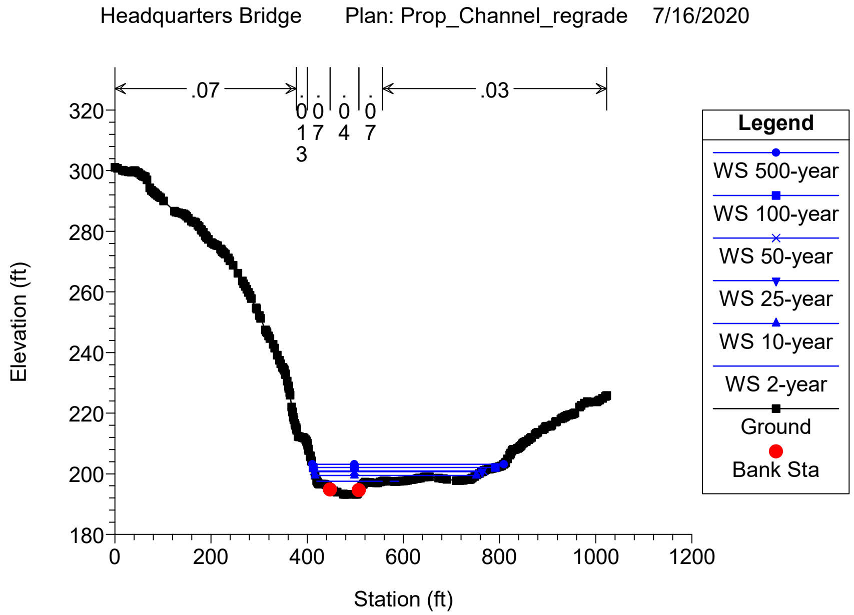
Headquarters Bridge Plan: Prop_Channel_regrade 7/16/2020
Headquarters Bridge Plan: Prop_Channel_regrade 7/16/2020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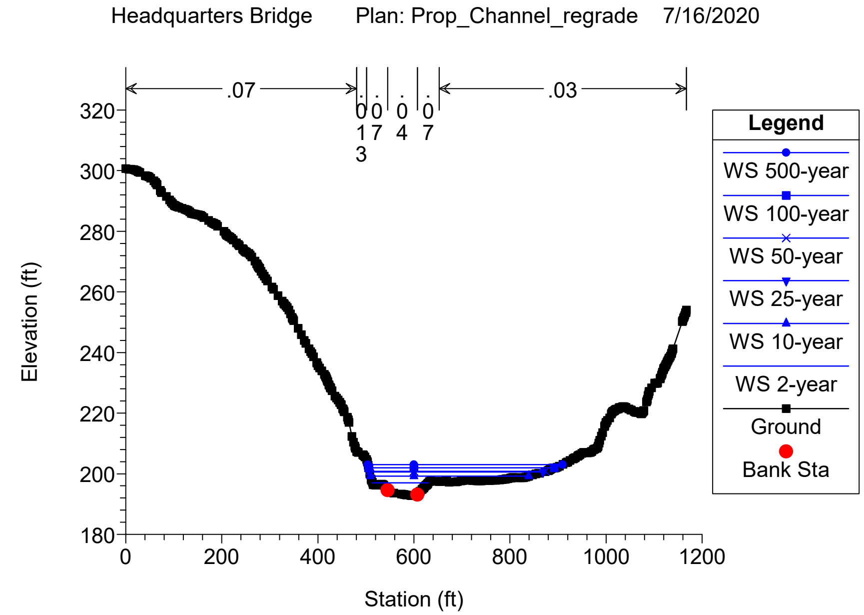
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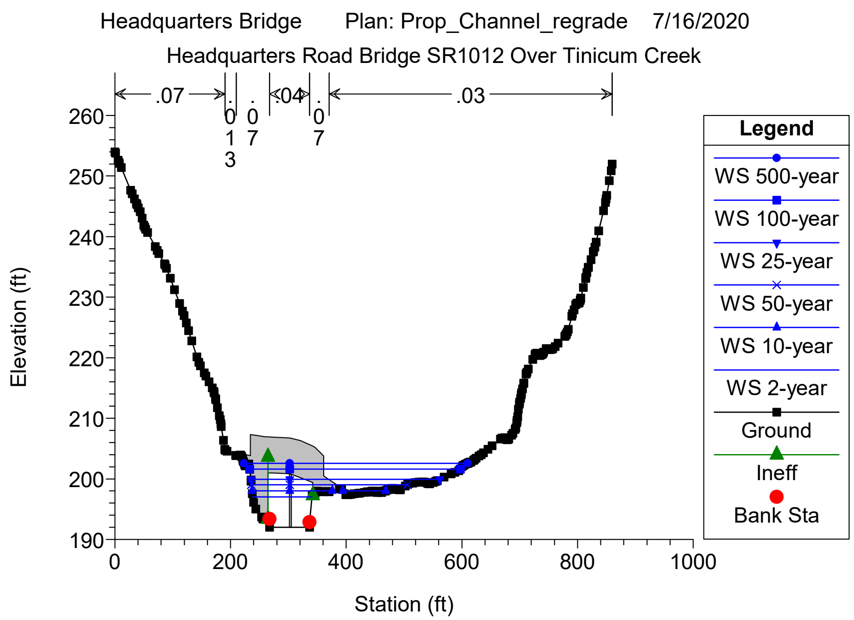
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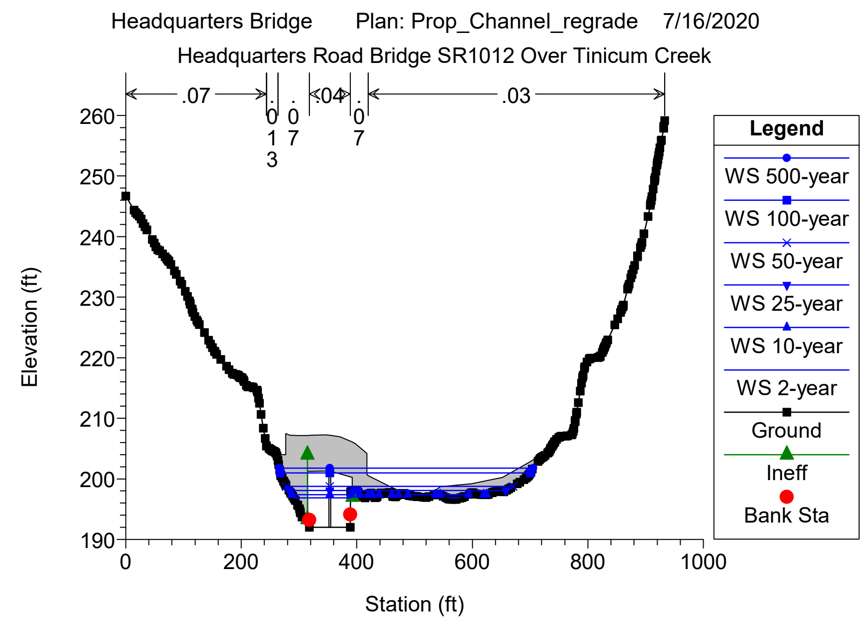
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Headquarters Road Bridge SR1012 Over Tinicum Creek
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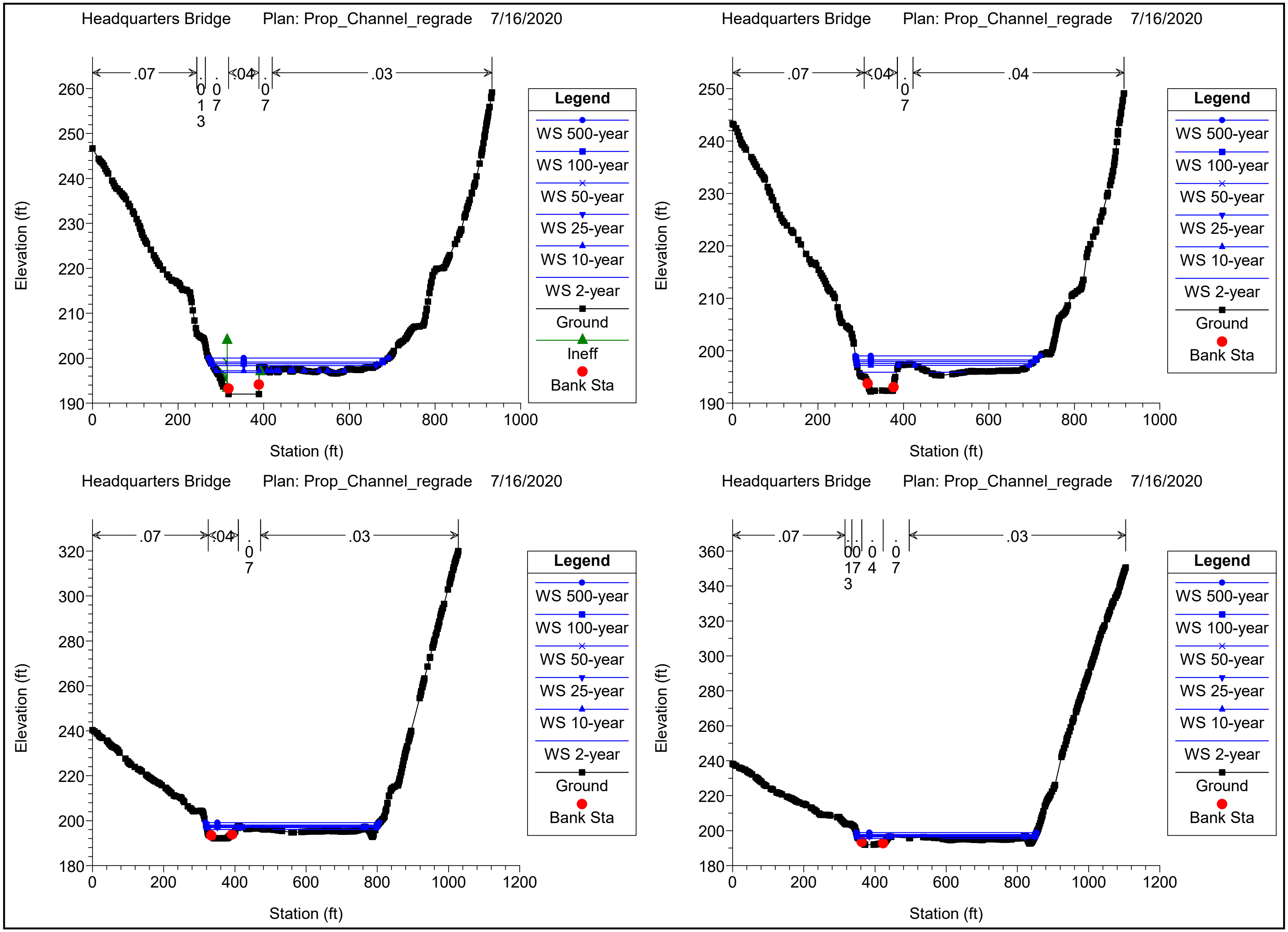
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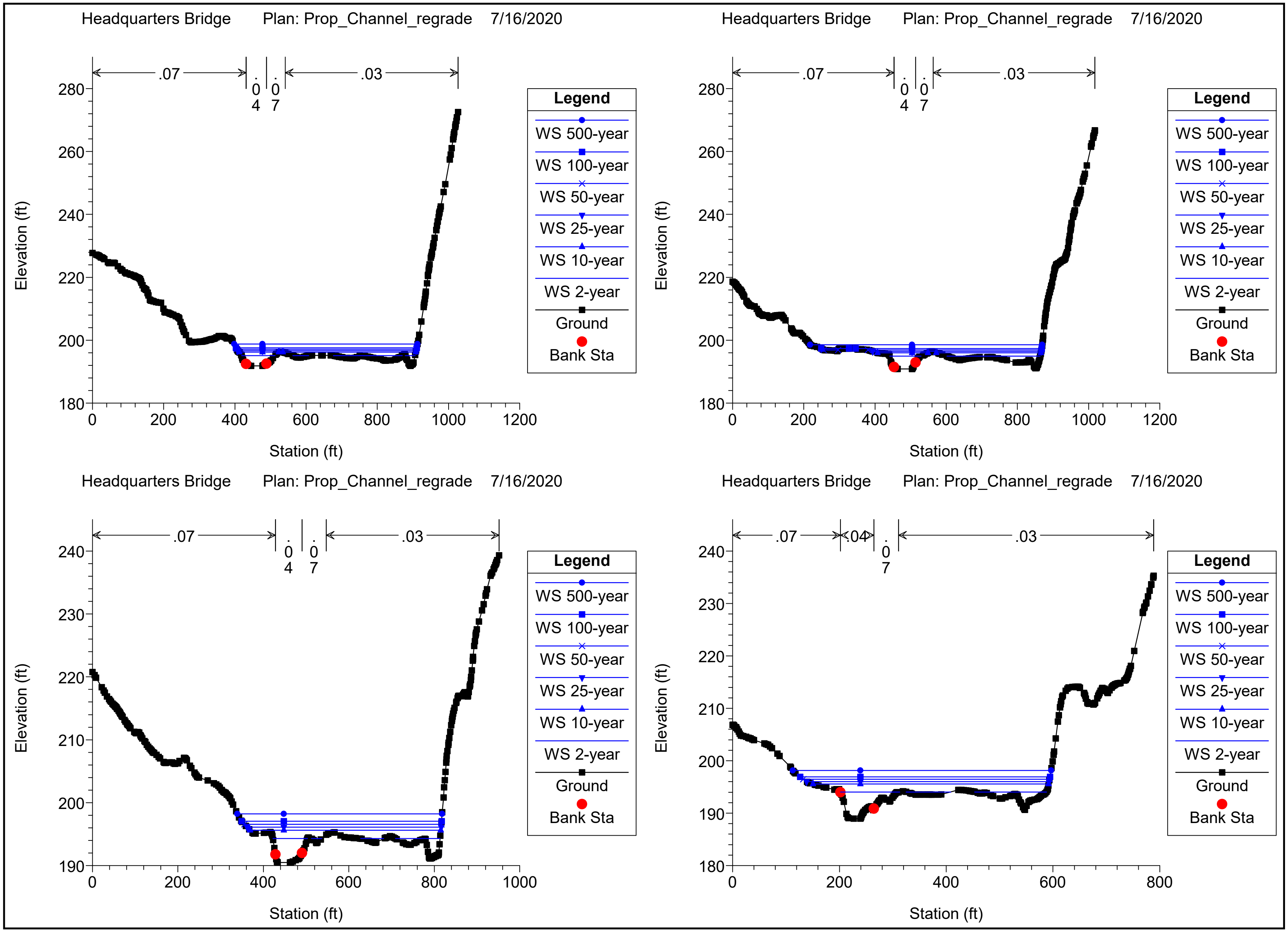
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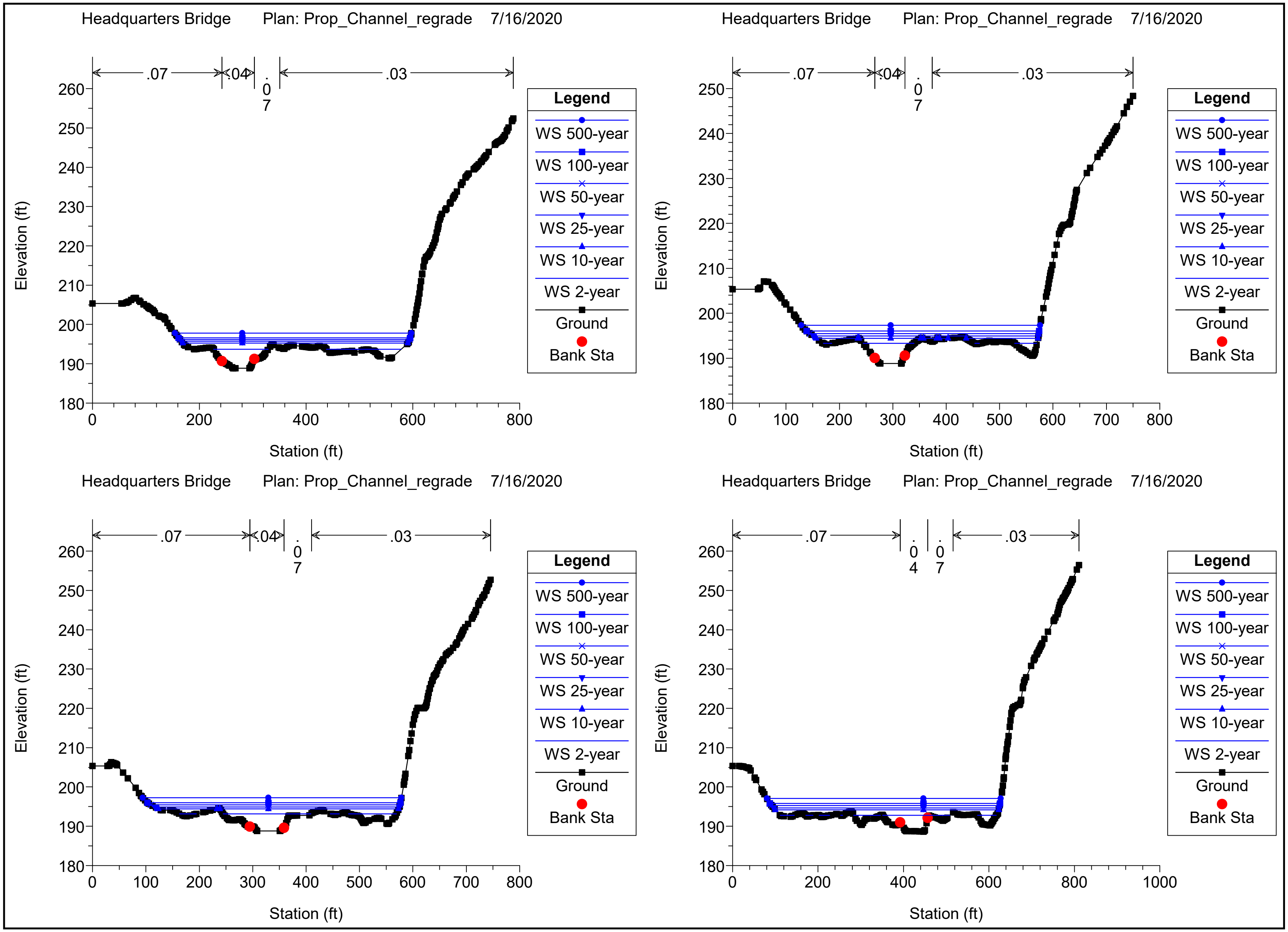
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Elevation (ft)
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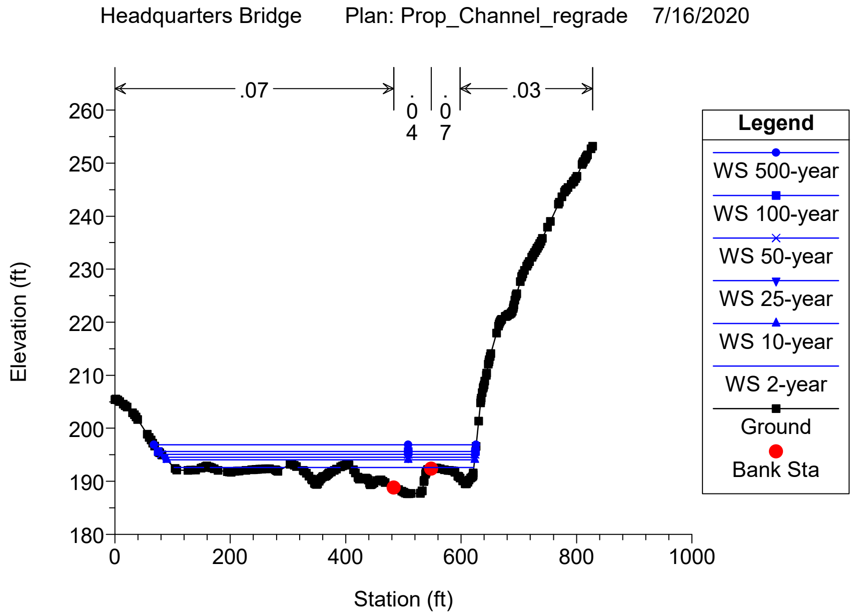
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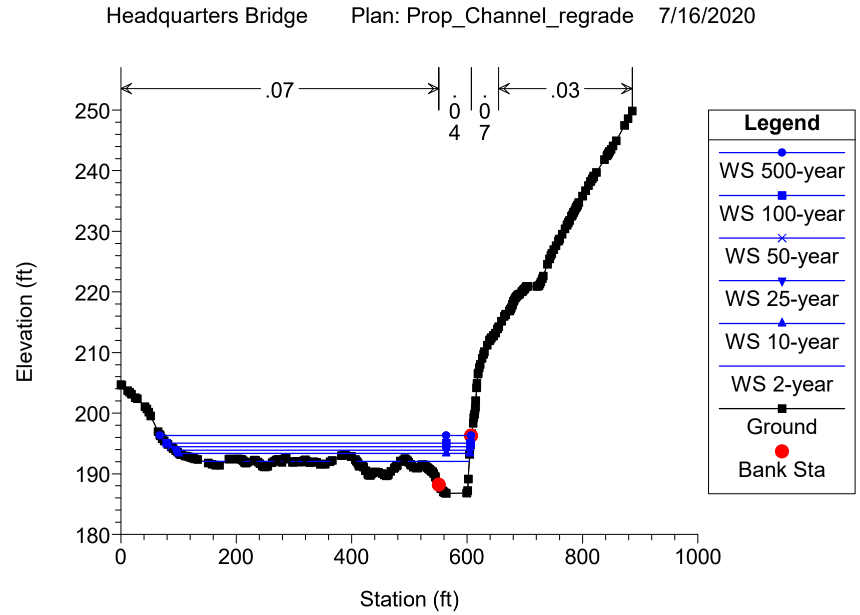
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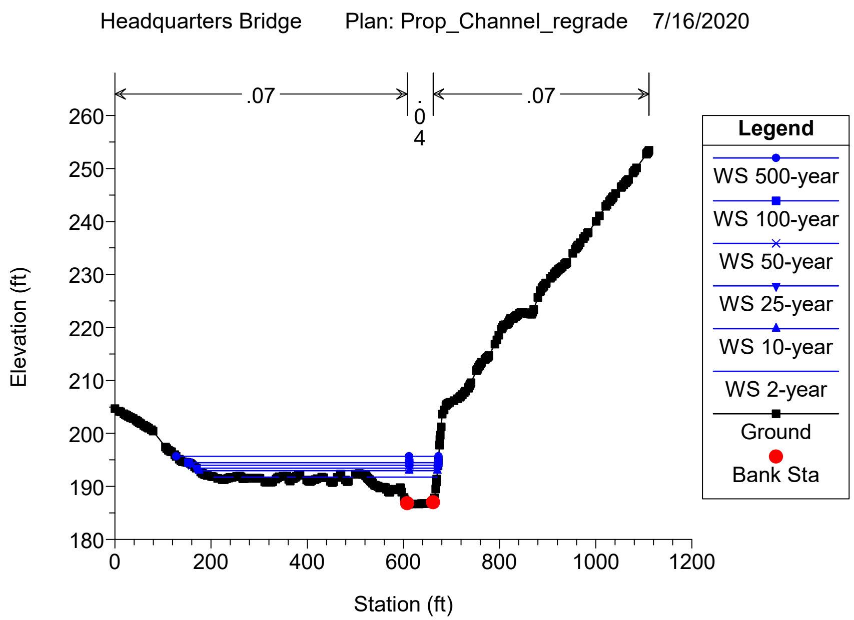
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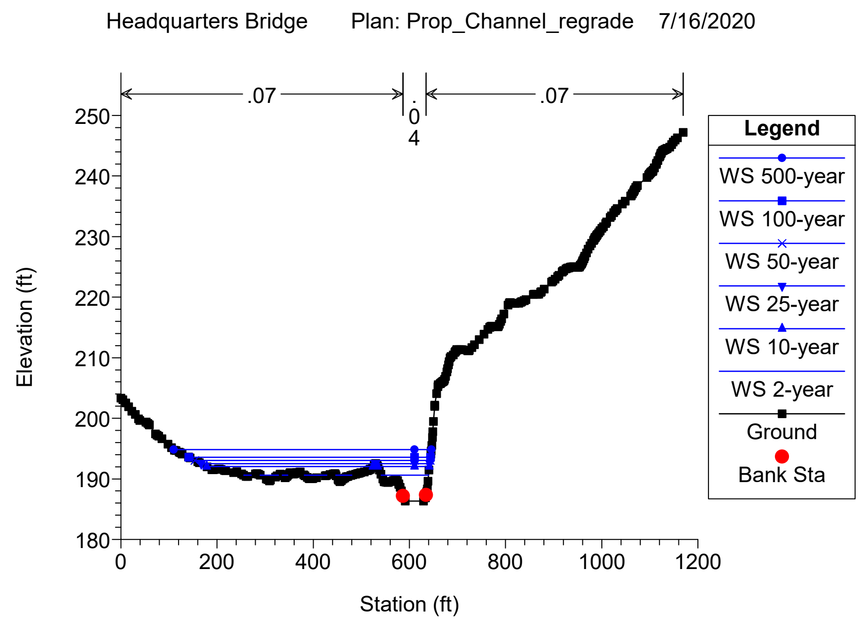
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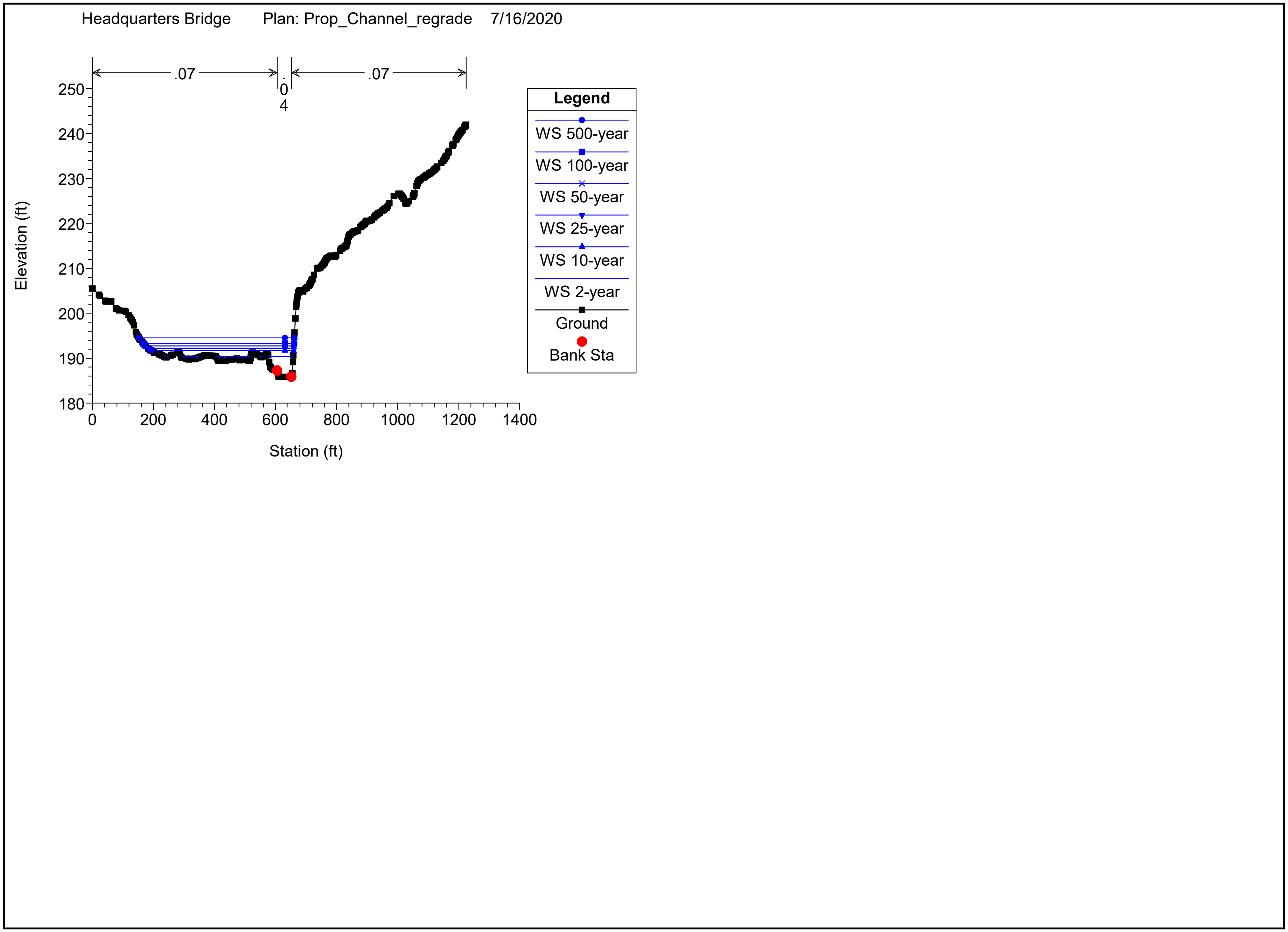
Headquarters Bridge Plan: Prop_Channel_regrade 7/16/2020
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Elevation (ft)
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Station (ft)
Legend
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Ground
Bank Sta

Attachment E

Stormwater Studio Analysis

Storm Sewer Tabulation*

Stormwater Studio 2020 v 3.0.0.18

Line ID	Length	Drng Area		Rational	C x A		Tc		Intensity	Total Q	Capacity	Velocity	Line		Invert Elev		HGL Elev		Surface Elev		Line No
		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Up	Dn	Up	Dn	Up	Dn	
	(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
WEST	31.80	1.310	1.310	0.50	0.66	0.66	10.0	10.00	0.00	3.75	11.71	3.37	14x19e	2.14	195.40	194.72	196.10	195.89	0.00	0.00	1
WESTEX	32.00	1.310	1.310	0.40	0.52	0.52	10.0	10.00	0.00	3.00	32.97	1.16	24	2.12	195.40	194.72	196.71	196.72	198.00	0.00	2
EAST-5	5.00	0.000	1.483	0.00	0.00	0.35	0.0	10.04	0.00	2.01	29.33	1.29	18	7.80	200.77	200.38	201.87	201.88	0.00	0.00	3
EAST1	23.50	1.410	1.410	0.20	0.28	0.28	10.0	10.00	0.00	1.61	29.30	2.20	18	7.79	202.60	200.77	203.09	201.90	0.00	0.00	4
Line 5	18.47	0.020	0.073	0.95	0.02	0.07	5.0	5.47	0.00	0.47	10.37	0.36	18	0.97	200.95	200.77	201.91	201.91	0.00	0.00	5
EAST2	41.45	0.030	0.030	0.95	0.03	0.03	5.0	5.00	0.00	0.20	10.50	0.25	18	1.00	201.36	200.95	201.91	201.91	0.00	0.00	6
EAST3	60.00	0.023	0.023	0.95	0.02	0.02	5.0	5.00	0.00	0.15	10.50	0.29	18	1.00	201.55	200.95	201.92	201.91	0.00	0.00	7
EASTEX1	32.50	1.400	1.400	0.20	0.28	0.28	10.0	10.00	0.00	1.60	29.33	2.08	18	7.80	202.92	200.38	203.40	201.88	0.00	0.00	8

* Results NOT current with inputs. r = rectangular e = elliptical a = arch

NOAA Atlas 14, Volume 2, Version 3
Location name: Ottsville, Pennsylvania, USA*
Latitude: 40.4708°, Longitude: -75.1369°
Elevation: 195.95 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**4.00** (3.61-4.40)	**4.76** (4.32-5.26)	**5.60** (5.08-6.18)	**6.23** (5.63-6.86)	**7.00** (6.28-7.69)	**7.55** (6.74-8.30)	**8.10** (7.20-8.92)	**8.62** (7.61-9.52)	**9.28** (8.11-10.3)	**9.79** (8.48-10.9)
10-min	**3.19** (2.89-3.52)	**3.80** (3.45-4.20)	**4.49** (4.06-4.94)	**4.98** (4.50-5.48)	**5.58** (5.00-6.13)	**6.01** (5.36-6.61)	**6.44** (5.72-7.09)	**6.83** (6.03-7.54)	**7.34** (6.41-8.12)	**7.71** (6.68-8.57)
15-min	**2.66** (2.41-2.93)	**3.19** (2.89-3.52)	**3.78** (3.42-4.17)	**4.20** (3.79-4.62)	**4.71** (4.23-5.18)	**5.08** (4.53-5.58)	**5.42** (4.82-5.97)	**5.75** (5.07-6.34)	**6.16** (5.38-6.82)	**6.45** (5.59-7.17)
30-min	**1.82** (1.65-2.01)	**2.20** (2.00-2.43)	**2.69** (2.43-2.96)	**3.04** (2.75-3.35)	**3.49** (3.13-3.84)	**3.82** (3.41-4.20)	**4.15** (3.69-4.57)	**4.47** (3.95-4.94)	**4.90** (4.28-5.42)	**5.22** (4.53-5.80)
60-min	**1.14** (1.03-1.25)	**1.38** (1.25-1.53)	**1.72** (1.56-1.90)	**1.98** (1.79-2.18)	**2.32** (2.09-2.55)	**2.59** (2.31-2.85)	**2.86** (2.54-3.15)	**3.14** (2.77-3.46)	**3.52** (3.07-3.89)	**3.81** (3.30-4.24)
2-hr	**0.684** (0.618-0.756)	**0.830** (0.751-0.918)	**1.04** (0.940-1.15)	**1.21** (1.08-1.33)	**1.43** (1.28-1.57)	**1.61** (1.44-1.77)	**1.80** (1.59-1.98)	**2.00** (1.76-2.21)	**2.28** (1.98-2.53)	**2.51** (2.15-2.79)
3-hr	**0.501** (0.452-0.557)	**0.609** (0.549-0.676)	**0.763** (0.687-0.847)	**0.883** (0.793-0.978)	**1.05** (0.936-1.16)	**1.18** (1.05-1.31)	**1.32** (1.17-1.46)	**1.47** (1.29-1.63)	**1.68** (1.45-1.87)	**1.85** (1.58-2.06)
6-hr	**0.317** (0.287-0.352)	**0.383** (0.347-0.426)	**0.477** (0.432-0.530)	**0.555** (0.500-0.614)	**0.665** (0.595-0.736)	**0.757** (0.672-0.836)	**0.856** (0.753-0.945)	**0.963** (0.837-1.06)	**1.12** (0.955-1.24)	**1.25** (1.05-1.38)
12-hr	**0.193** (0.175-0.215)	**0.233** (0.211-0.260)	**0.292** (0.265-0.325)	**0.342** (0.308-0.380)	**0.416** (0.371-0.460)	**0.479** (0.423-0.529)	**0.548** (0.479-0.605)	**0.624** (0.539-0.690)	**0.738** (0.624-0.818)	**0.834** (0.694-0.927)
24-hr	**0.113** (0.105-0.123)	**0.137** (0.126-0.149)	**0.172** (0.159-0.187)	**0.201** (0.185-0.218)	**0.244** (0.223-0.264)	**0.280** (0.255-0.302)	**0.319** (0.288-0.344)	**0.361** (0.324-0.389)	**0.423** (0.374-0.456)	**0.475** (0.415-0.512)
2-day	**0.066** (0.061-0.072)	**0.080** (0.073-0.088)	**0.100** (0.092-0.110)	**0.117** (0.107-0.128)	**0.141** (0.128-0.154)	**0.161** (0.145-0.176)	**0.182** (0.164-0.199)	**0.205** (0.183-0.223)	**0.238** (0.209-0.259)	**0.264** (0.231-0.289)
3-day	**0.046** (0.043-0.051)	**0.056** (0.052-0.061)	**0.070** (0.065-0.077)	**0.082** (0.075-0.089)	**0.098** (0.090-0.107)	**0.112** (0.102-0.122)	**0.126** (0.114-0.137)	**0.142** (0.127-0.154)	**0.164** (0.145-0.178)	**0.182** (0.160-0.198)
4-day	**0.037** (0.034-0.040)	**0.044** (0.041-0.048)	**0.055** (0.051-0.060)	**0.064** (0.059-0.070)	**0.077** (0.070-0.083)	**0.087** (0.080-0.095)	**0.098** (0.089-0.107)	**0.110** (0.099-0.119)	**0.127** (0.113-0.138)	**0.141** (0.125-0.153)
7-day	**0.025** (0.023-0.027)	**0.029** (0.027-0.032)	**0.036** (0.034-0.039)	**0.042** (0.039-0.046)	**0.050** (0.046-0.054)	**0.057** (0.052-0.062)	**0.064** (0.058-0.069)	**0.072** (0.065-0.077)	**0.082** (0.074-0.089)	**0.091** (0.081-0.099)
10-day	**0.020** (0.018-0.021)	**0.023** (0.022-0.025)	**0.029** (0.027-0.031)	**0.033** (0.030-0.035)	**0.038** (0.036-0.041)	**0.043** (0.040-0.046)	**0.048** (0.044-0.051)	**0.053** (0.048-0.057)	**0.060** (0.054-0.064)	**0.065** (0.059-0.070)
20-day	**0.013** (0.012-0.014)	**0.016** (0.015-0.017)	**0.019** (0.018-0.020)	**0.021** (0.020-0.023)	**0.024** (0.023-0.026)	**0.027** (0.025-0.029)	**0.029** (0.027-0.031)	**0.032** (0.029-0.034)	**0.035** (0.032-0.038)	**0.038** (0.035-0.041)
30-day	**0.011** (0.010-0.012)	**0.013** (0.012-0.014)	**0.015** (0.014-0.016)	**0.017** (0.016-0.018)	**0.019** (0.018-0.020)	**0.021** (0.019-0.022)	**0.022** (0.021-0.024)	**0.024** (0.022-0.025)	**0.026** (0.024-0.027)	**0.027** (0.025-0.029)
45-day	**0.009** (0.009-0.010)	**0.011** (0.010-0.012)	**0.013** (0.012-0.013)	**0.014** (0.013-0.015)	**0.015** (0.015-0.016)	**0.017** (0.016-0.017)	**0.018** (0.017-0.019)	**0.019** (0.018-0.020)	**0.020** (0.019-0.021)	**0.021** (0.020-0.022)
60-day	**0.008** (0.008-0.009)	**0.010** (0.009-0.010)	**0.011** (0.011-0.012)	**0.012** (0.012-0.013)	**0.014** (0.013-0.014)	**0.014** (0.014-0.015)	**0.015** (0.015-0.016)	**0.016** (0.015-0.017)	**0.017** (0.016-0.018)	**0.018** (0.017-0.019)

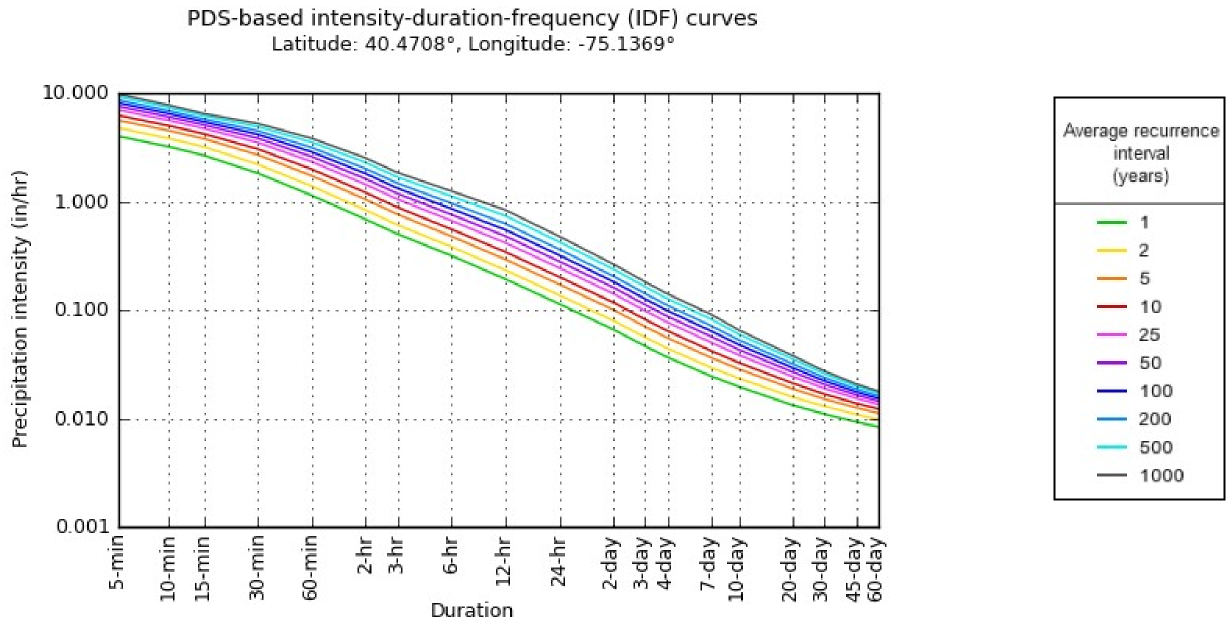
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

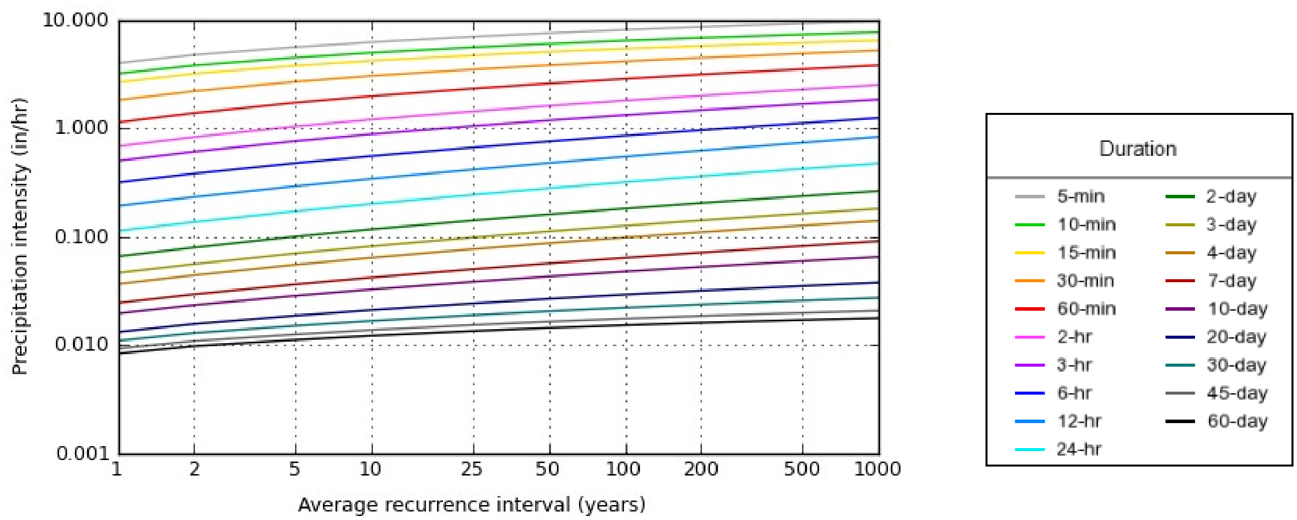
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical





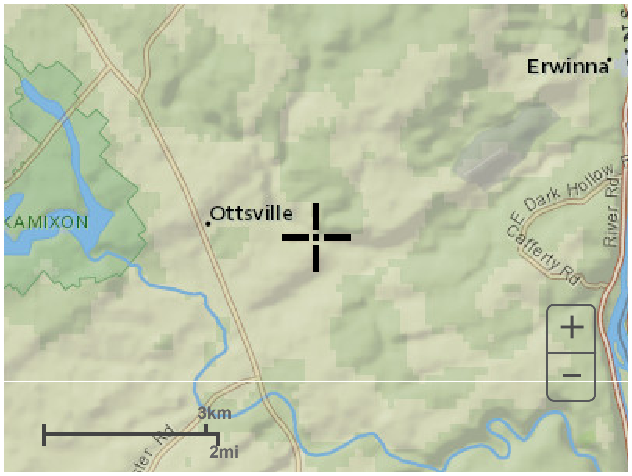
NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Thu Jul 2 01:04:17 2020

Back to Top

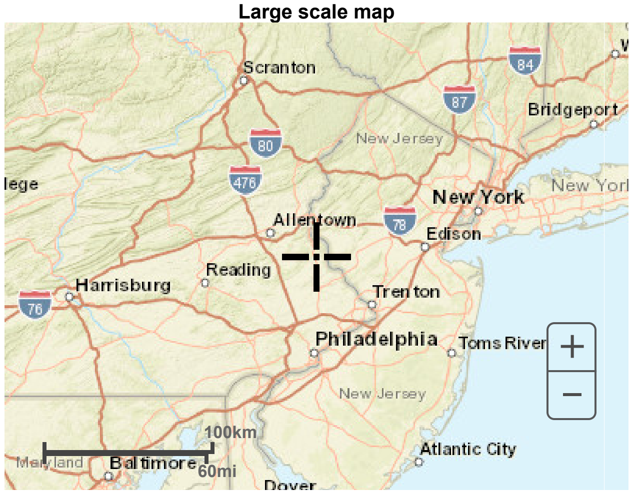
Maps & aerials

Small scale terrain

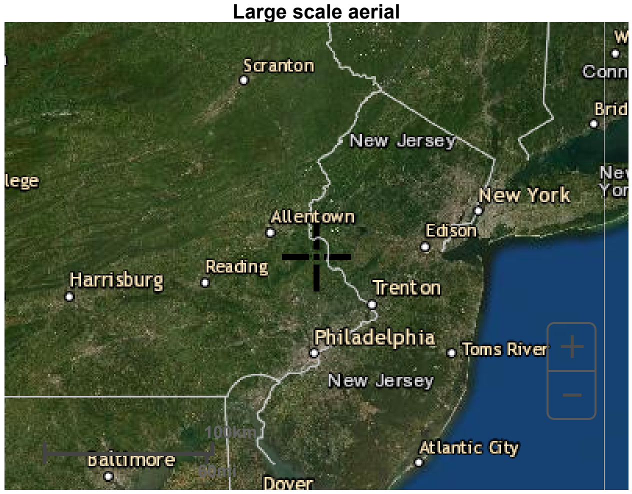


Large scale terrain

Large scale map



Large scale aerial



[Back to Top](#)

[US Department of Commerce](#)
[National Oceanic and Atmospheric Administration](#)
[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

Attachment F

Resume

Mary L. Paist-Goldman, P.E.
Principal, Owner

Rippled Waters Engineering, LLC

Education:
- B.S. 2000. Civil Engineering, University of Maryland, College Park, MD

Professional Certifications:
- Professional Engineer:
  Maryland, New Jersey, North Carolina, New York, Pennsylvania
- Rosgen Level I – Applied Fluvial Geomorphology Certification

Professional Affiliations:
- Musconetcong Watershed Association, Board Trustee
- Musconetcong River Management Council Member Alternate
- North Jersey RC&D Technical Advisory Committee member

Areas of Expertise:

- Wetland restoration and mitigation
- Stream restoration and stabilization
- Floodplain management and design
- Stormwater management design
- Teaching – continuing education courses at introductory to advanced levels
- Permitting and regulatory compliance
- Hydrologic and hydraulic modeling
- Dam removals, dam inspections and inundation/breach analyses
- Onsite wastewater disposal system design – including alternative systems
- Wastewater and watershed management planning and design

Summary of Qualifications:

Ms. Paist-Goldman has more than 20 years of experience in the fields of wetland and stream restoration, stormwater management, regulatory compliance, hydrology and hydraulics, dam safety, and wastewater management. Prior to founding Rippled Waters Engineering in 2018, Ms. Paist-Goldman served as Principal Engineer and Director of Engineering Services at Princeton Hydro. Her attention to detail and creative eye lead to out-of-the-box solutions to complex stormwater, stream, wetland, and wastewater problems.

Throughout her career, Ms. Paist-Goldman has designed dozens of projects with low impact development techniques, green infrastructure, and with a focus on water quality – particularly in regard to TMDL compliance. She has designed rain gardens, cistern systems for water re-use in the form of landscape irrigation, bioretention islands, manufactured LID devices, and constructed wetlands. She has developed projects with goals of zero discharge upon completion, groundwater recharge to address aquifer deficits, and retrofits to reduce water quality impacts on Category One waters and EV streams.

Additionally, Ms. Paist-Goldman has served as Project Manager and Lead Designer for a multitude of wetland restoration and mitigation projects. Frequently, these projects are planned for use as mitigation banks or serve as mitigation for development onsite. Working closely with wetland ecologists and landscape architects, she has designed a variety of wetlands including subtidal channels, marsh, and upland habitats for estuarine and marine systems. She also has experience in design development of living shorelines and edge treatments for coastal resiliency and climate change.

Ms. Paist-Goldman has been actively involved in regulatory compliance since the beginning of her career. She is an expert at navigating the New Jersey Department of Environmental Protection's (NJDEP) Division of Land Use Regulation's Flood Hazard Area Rules and demonstrating compliance with the Flood Hazard Area Control Act. Ms. Paist-Goldman has extensive experience in dealing with the NJDEP Bureau of Nonpoint Pollution Control and the Dam Safety programs. She served on the Hunterdon County Stormwater Ordinance Review Committee, was an active participant in the preparation of the Hunterdon County model ordinance, and has given presentations to municipalities and colleges and universities throughout the State of New Jersey on the impacts and requirements of the Stormwater Management Rules (N.J.A.C. 7:8). She prepared Stormwater Management Plans for various municipalities and Stormwater Pollution Prevention Plans for various colleges and municipalities.

Ms. Paist-Goldman's modeling experience includes hydrologic, hydraulic, and pollutant loading modeling for a variety of projects types, from developing floodplain limits, designing culvert openings for new and replacement bridge and culvert crossings, water quality impact analyses, dam inundation analyses, and stormwater facility design and analysis. She is skilled in the use of a wide range of software, including ESRI ArcMap Geographic Information Systems (GIS); United States Army Corps of Engineers' (USACE) HEC-HMS, HEC-RAS; WinSLAMM; XP-SWMM, and HydroCAD.

Ms. Paist-Goldman is experienced in dam breach analyses and dam removal design. She has also prepared inundation mapping, Emergency Action Plans, Operation and Maintenance Manuals and Dam inspection reports for both low and high hazard dams. She has completed dozens of dam safety inspections throughout New Jersey and Pennsylvania and has experience with dam owners to address deficiencies on dams from low to high hazard.

Additionally, Ms. Paist-Goldman has designed wetland mitigation projects ranging in size from less than one acre to nearly 100 acres in size. These projects are planned for use as mitigation banks or serve as mitigation for development onsite. Working closely with wetland scientists, Ms. Paist-Goldman has designed a variety of wetland habitats including creation, enhancement, restoration, and preservation. The designs have included the use of check dams and detailed grading; subtidal channels, wetland pools, intertidal marsh, and upland island habitats for both freshwater and estuarine systems.

Select Project Experience

Stream and Wetland Mitigation Bank, Charles County, MD (2015-2018) – Served as project manager and lead design engineer for design and permitting of approximately 85 acres of wetland and approximately 1,500 feet of stream restoration associated with mitigation impacts for work at a military base in the same watershed. The wetland hydrology incorporated both groundwater and surface water inputs and the design incorporated floodplain reconnection through Protocol 3 of the Chesapeake Bay Expert Panel Report.

Stream Restoration for MS4 Compliance, Prince Georges County, MD (2017-2019) – Served as project manager and lead design engineer for the preliminary design of approximately 6,900 linear feet of stream restoration in accordance with the Chesapeake Bay Expert Panel Report. Restoration activities were designed for first order, second order, and third order tributaries in a holistic approach addressing stream bed and bank erosion together with stream geomorphology using a combination of rock and large woody debris.

Dam Removal and stream restoration, Hunterdon County, NJ (2011-2017) – Project manager for the completion of a feasibility study, final design, and permitting for the removal of a run of the river dam on a river in New Jersey, which was the first blockage from the confluence with the Delaware. Removal of the dam increased the total unobstructed river miles within the Wild and Scenic designation region.

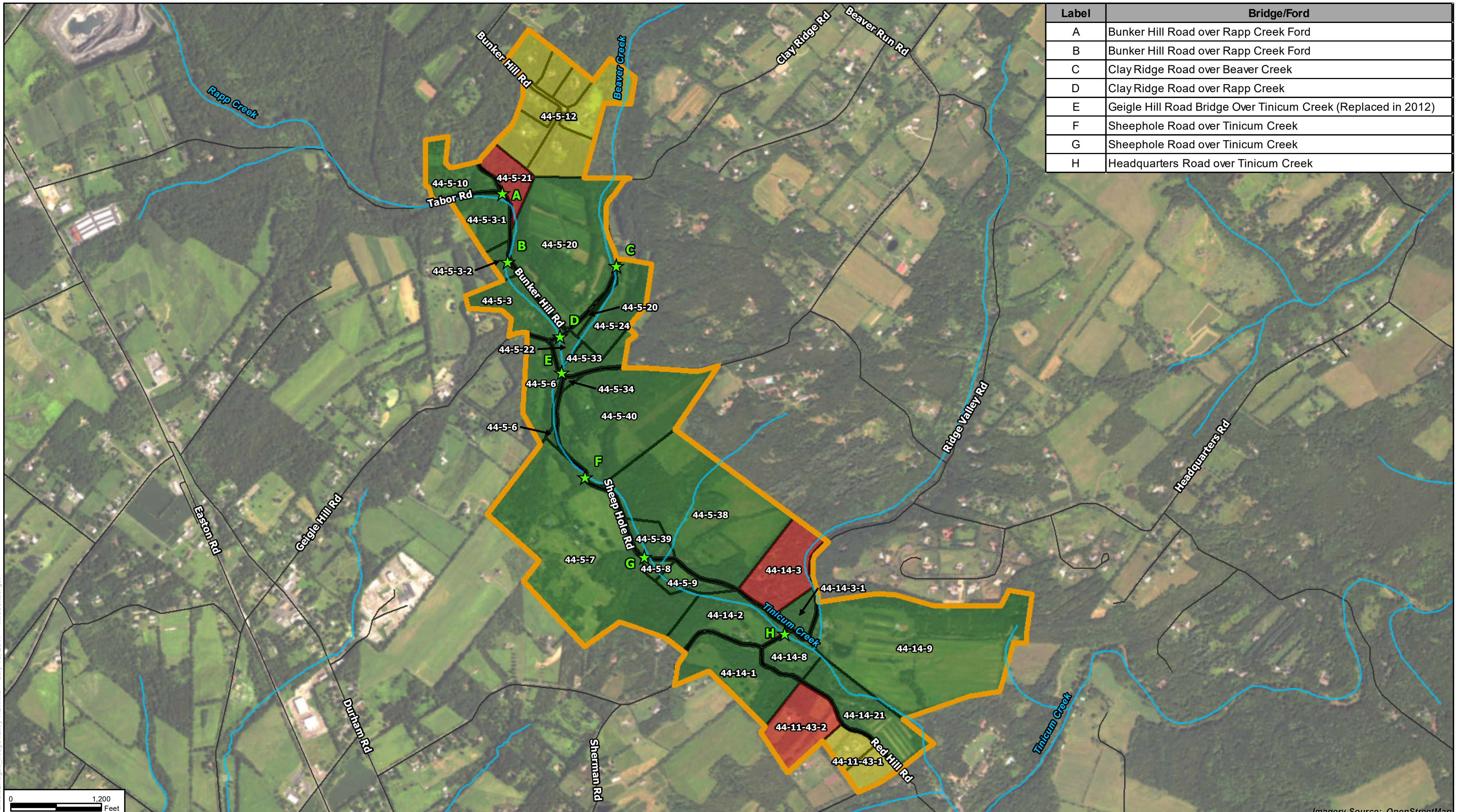
Urban stream restoration and floodplain connectivity project, Trenton, NJ (2008-2011) – Project manager for the completion of engineering design, permitting, and construction management services associated with the restoration of approximately 900 feet of urban stream including daylighting a portion of the stream that had been piped within the City of Trenton.

Publications and Presentations

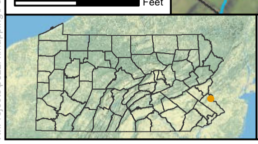
M. Paist-Goldman. Navigating the Permitting Process to Implement a Mitigation Project in New Jersey. Society for Wetland Scientists Annual Meeting. 30 May 2019, Baltimore, MD.

M. Paist-Goldman and Beth Styler-Barry. 2018. Recognizing the Power of Dam Removal to Reconnect & Restore our Ecosystem. NJ Land Conservation Rally, 2 March 2018, New Brunswick, NJ.

G. Messinger, C. Hall, L. Peterson, P.E. and M. Paist-Goldman, P.E.. 2011. "Walnut Brook Riparian Restoration Project," Land and Water Magazine, January/February 2011.



Label	Bridge/Ford
A	Bunker Hill Road over Rapp Creek Ford
B	Bunker Hill Road over Rapp Creek Ford
C	Clay Ridge Road over Beaver Creek
D	Clay Ridge Road over Rapp Creek
E	Geigle Hill Road Bridge Over Tinicum Creek (Replaced in 2012)
F	Sheephole Road over Tinicum Creek
G	Sheephole Road over Tinicum Creek
H	Headquarters Road over Tinicum Creek



Bridges/Fords

Ridge Valley Rural Historic District Boundary (National Register Listed)

Approximate Tax Parcel Boundary

Contributing

Non-Contributing

Original Parcel Contributing; Parcel has been Sub-Divided

Ridge Valley Rural Historic District
Contributing Parcels, Bridges, and Fords

Tinicum Township, Bucks County, Pennsylvania

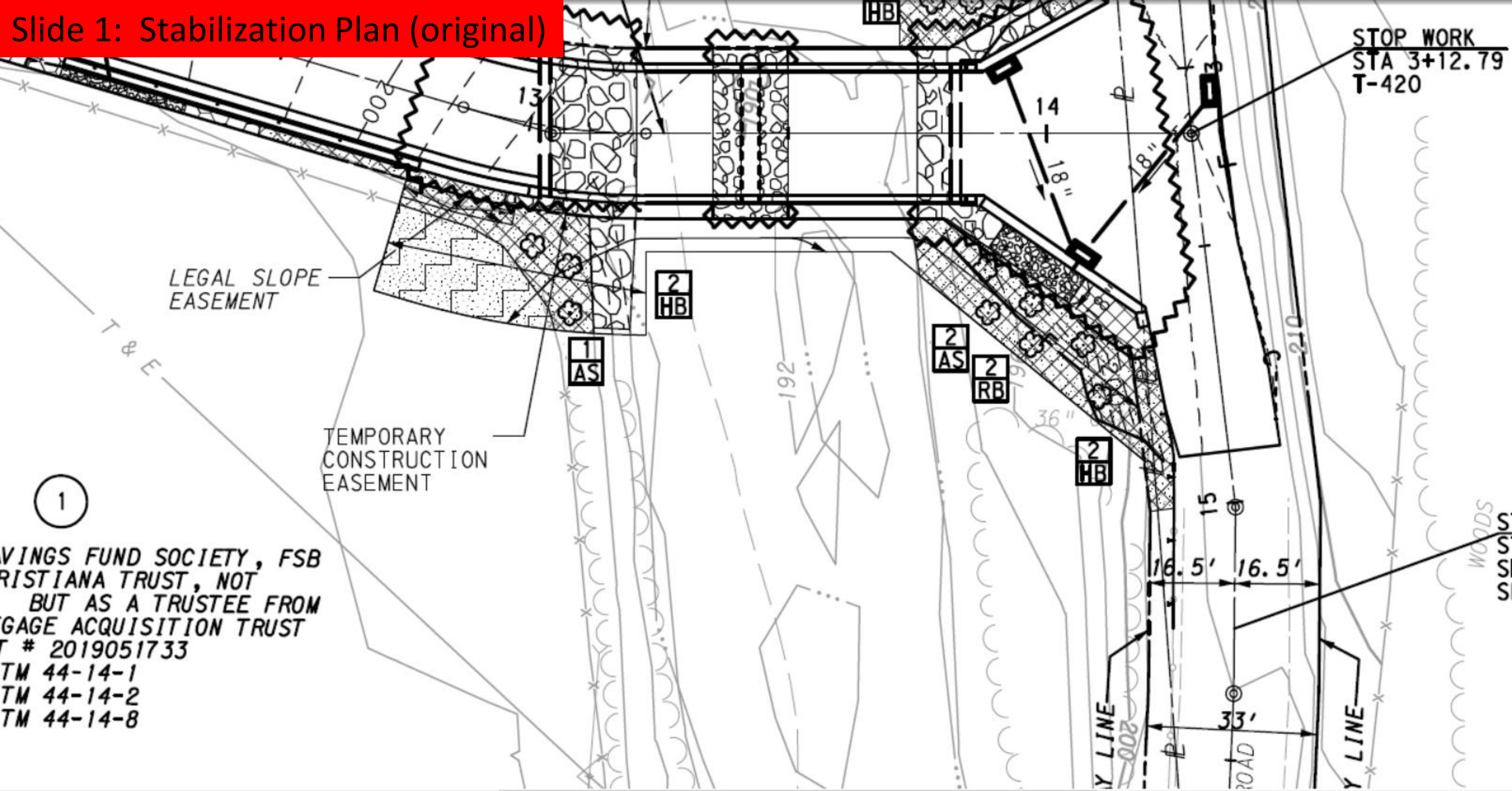
Visualizations of Riparian Corridor & Stream Channel Impacts from PennDOT Proposal for Headquarters Road Bridge

DELAWARE
RIVERKEEPER
NETWORK™

compiled by Delaware Riverkeeper Network

July 2020

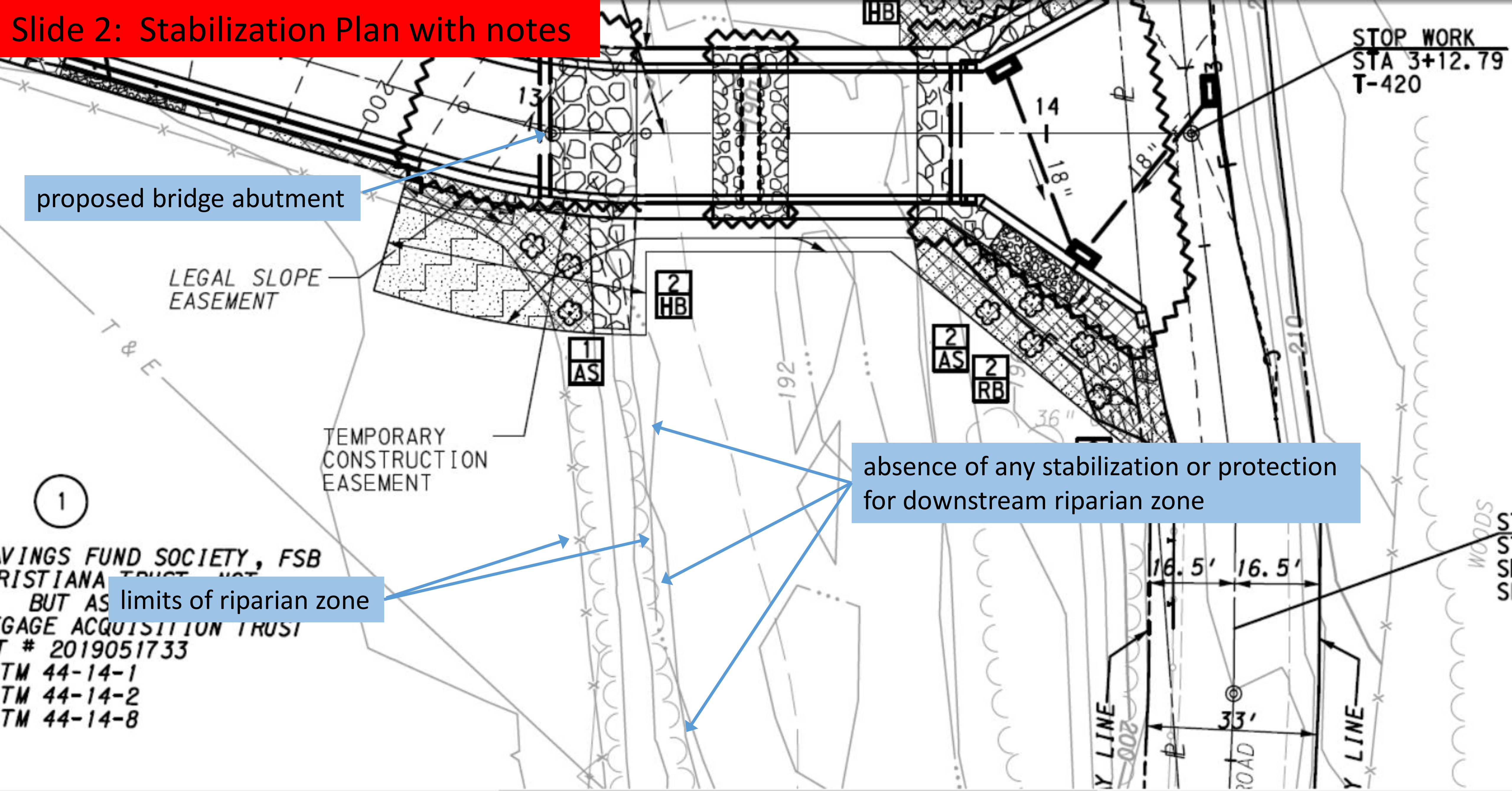
Slide 1: Stabilization Plan (original)



zoom in on “Stabilization Plan” (sheet 11 of 11)

Excerpted from “Erosion & Sediment Control Plan” by Urban Engineers, 5/04/2020 date, sealed by Gregory C. Scafonas, P.E.

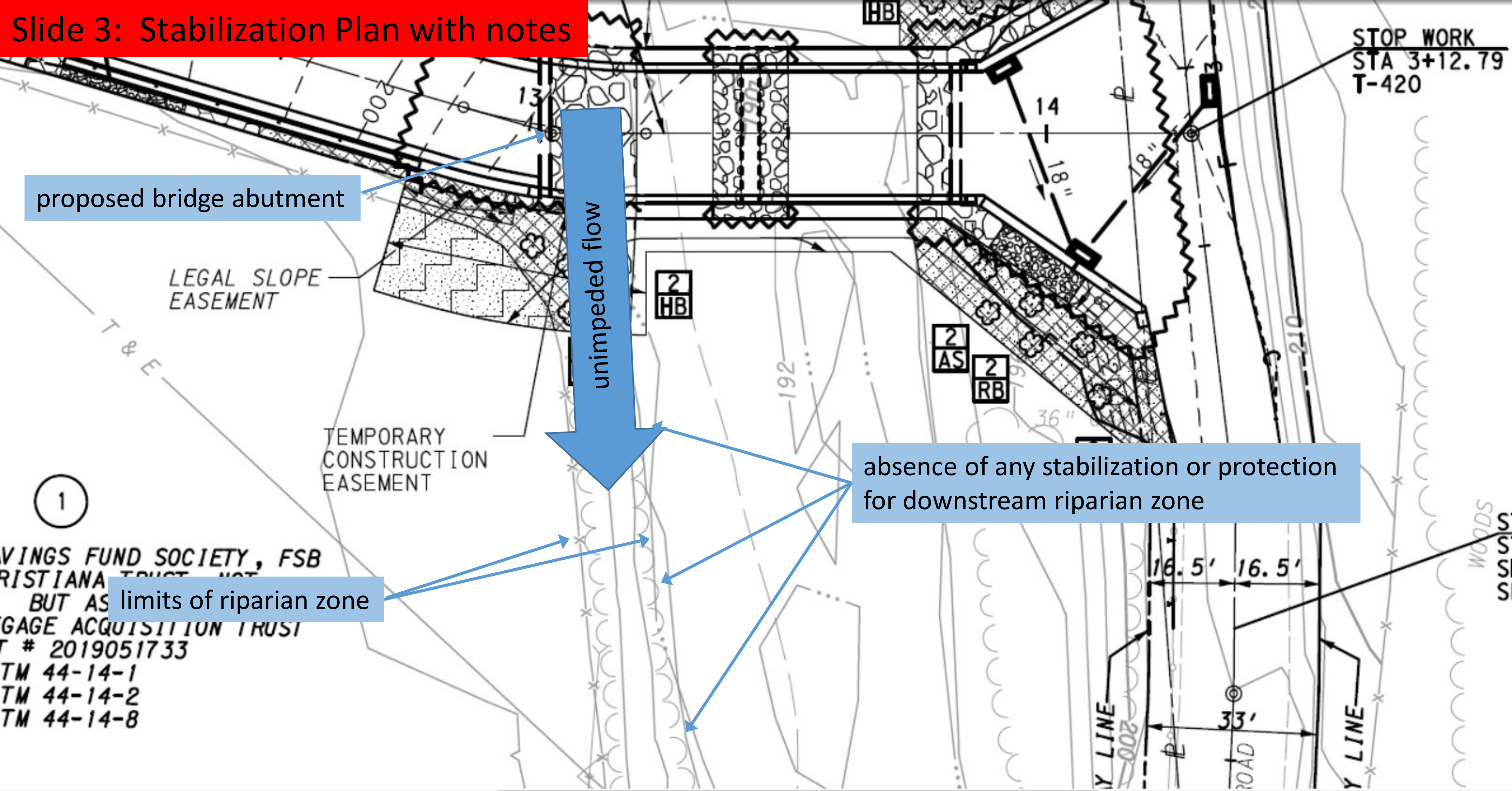
Slide 2: Stabilization Plan with notes



zoom in on “Stabilization Plan” (sheet 11 of 11)

Excerpted from “Erosion & Sediment Control Plan” by Urban Engineers, 5/04/2020 date, sealed by Gregory C. Scafonas, P.E.

Slide 3: Stabilization Plan with notes



zoom in on "Stabilization Plan" (sheet 11 of 11)

Excerpted from "Erosion & Sediment Control Plan" by Urban Engineers, 5/04/2020 date, sealed by Gregory C. Scafonas, P.E.

Current Conditions Looking Downstream (from aerial drone)

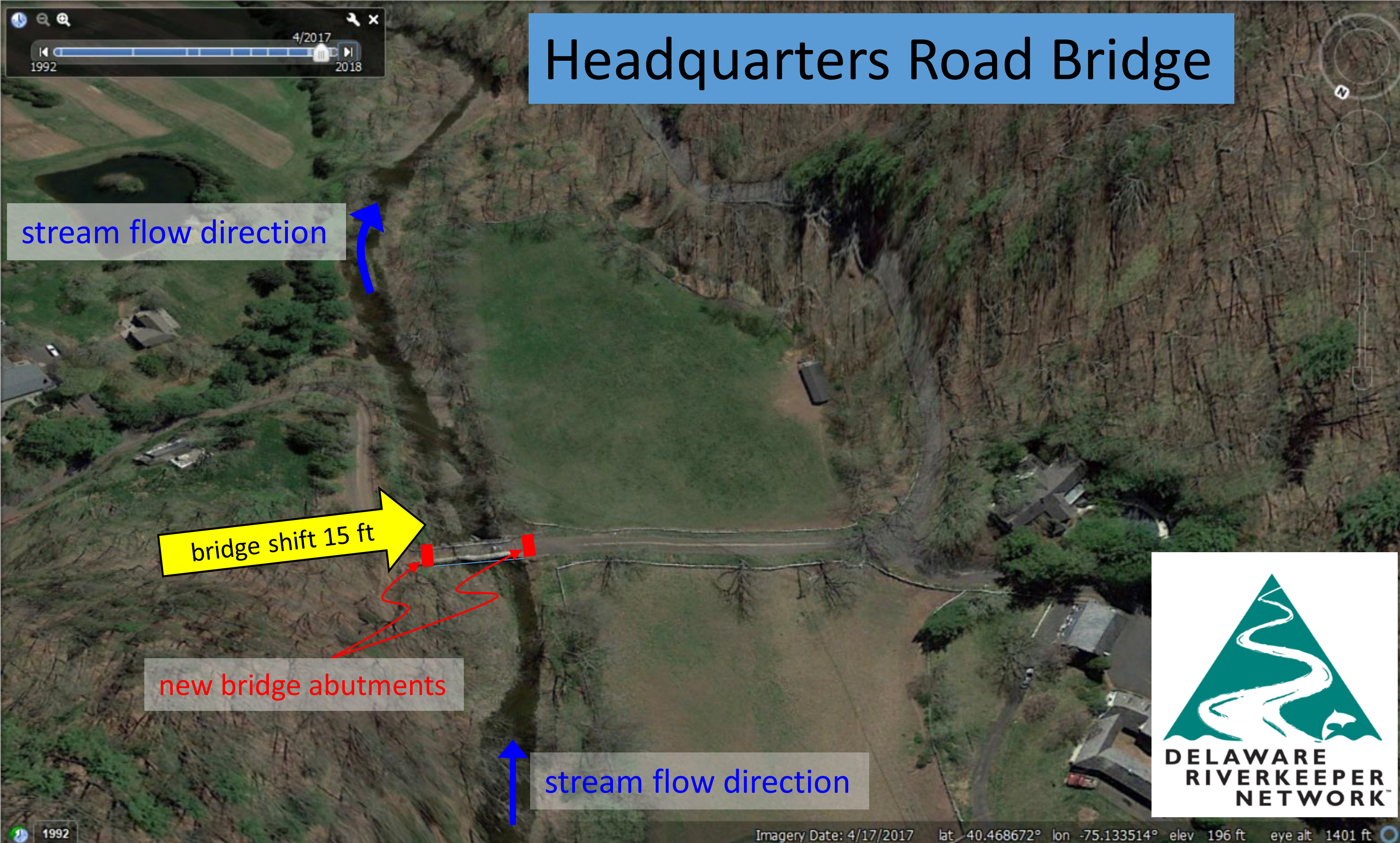
Simple Forecast / Rendering with bridge abutments shifted 15 ft westward
(Delaware Riverkeeper Network project file)

Current Conditions Looking Downstream (from PennDOT)

New Bridge Rendering Looking Downstream (from PennDOT)

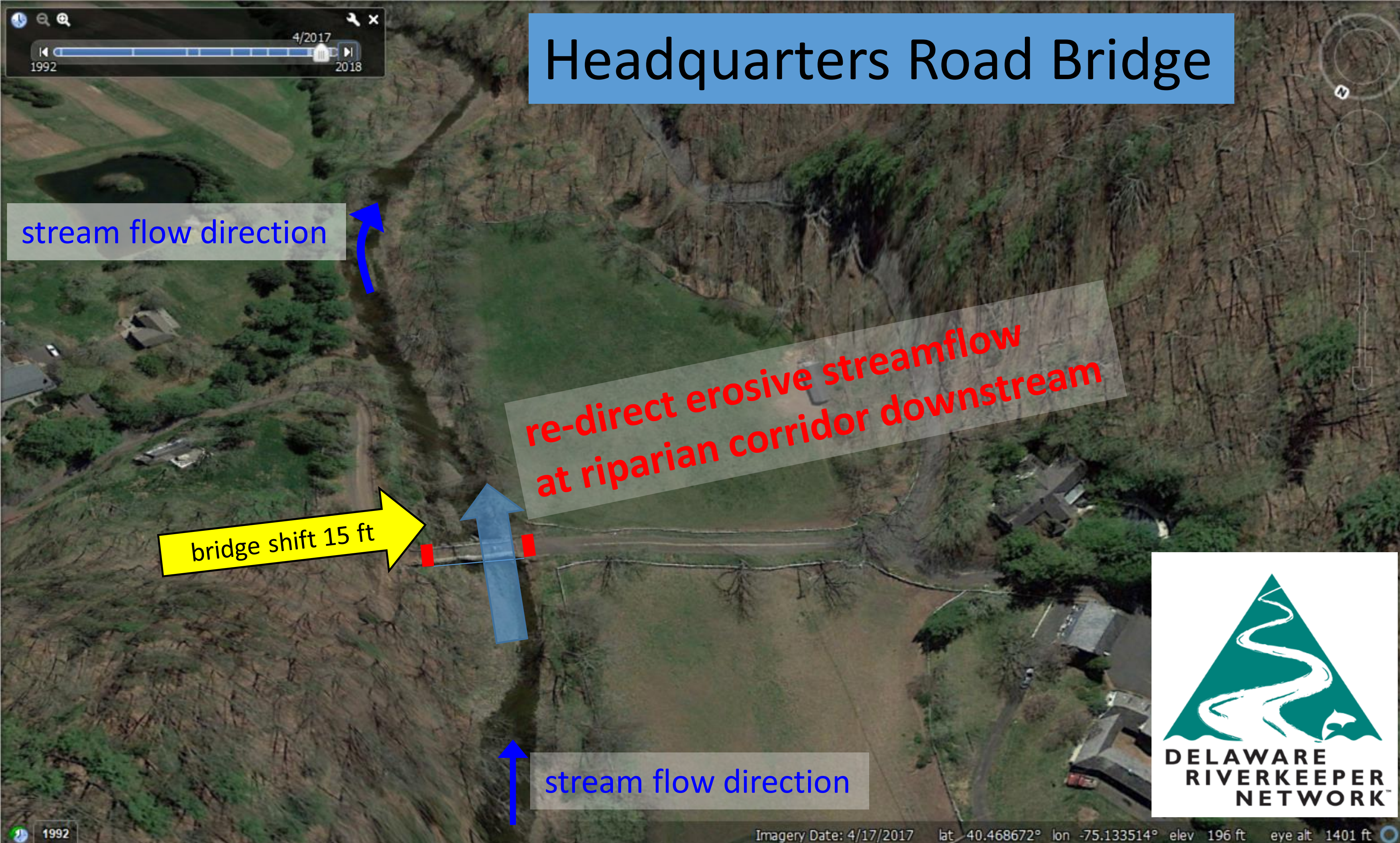
** note the exposure and impact to the downstream riparian corridor on RiverRight

Headquarters Road Bridge



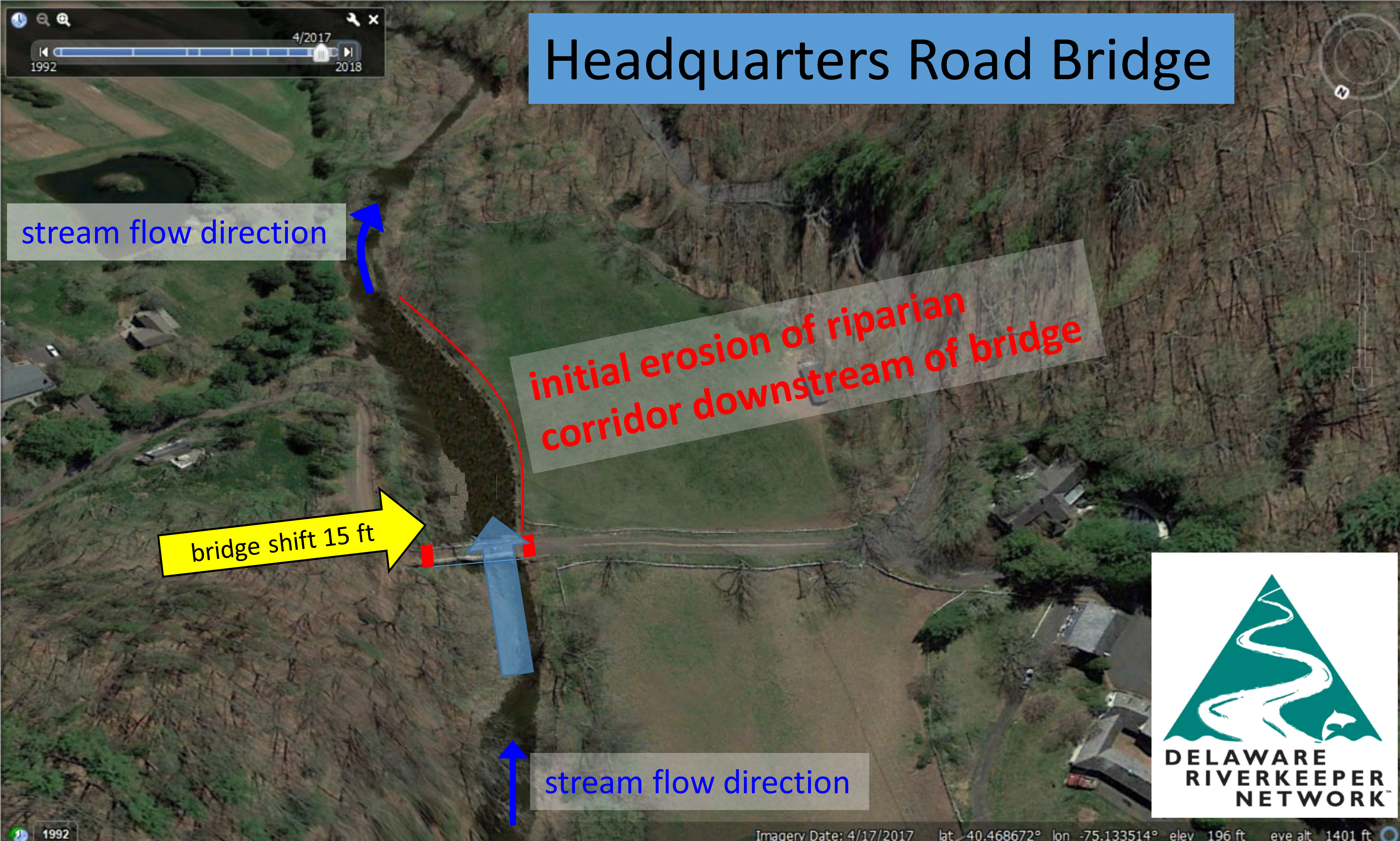
1. PennDOT proposal moves bridge abutments southwest

Headquarters Road Bridge



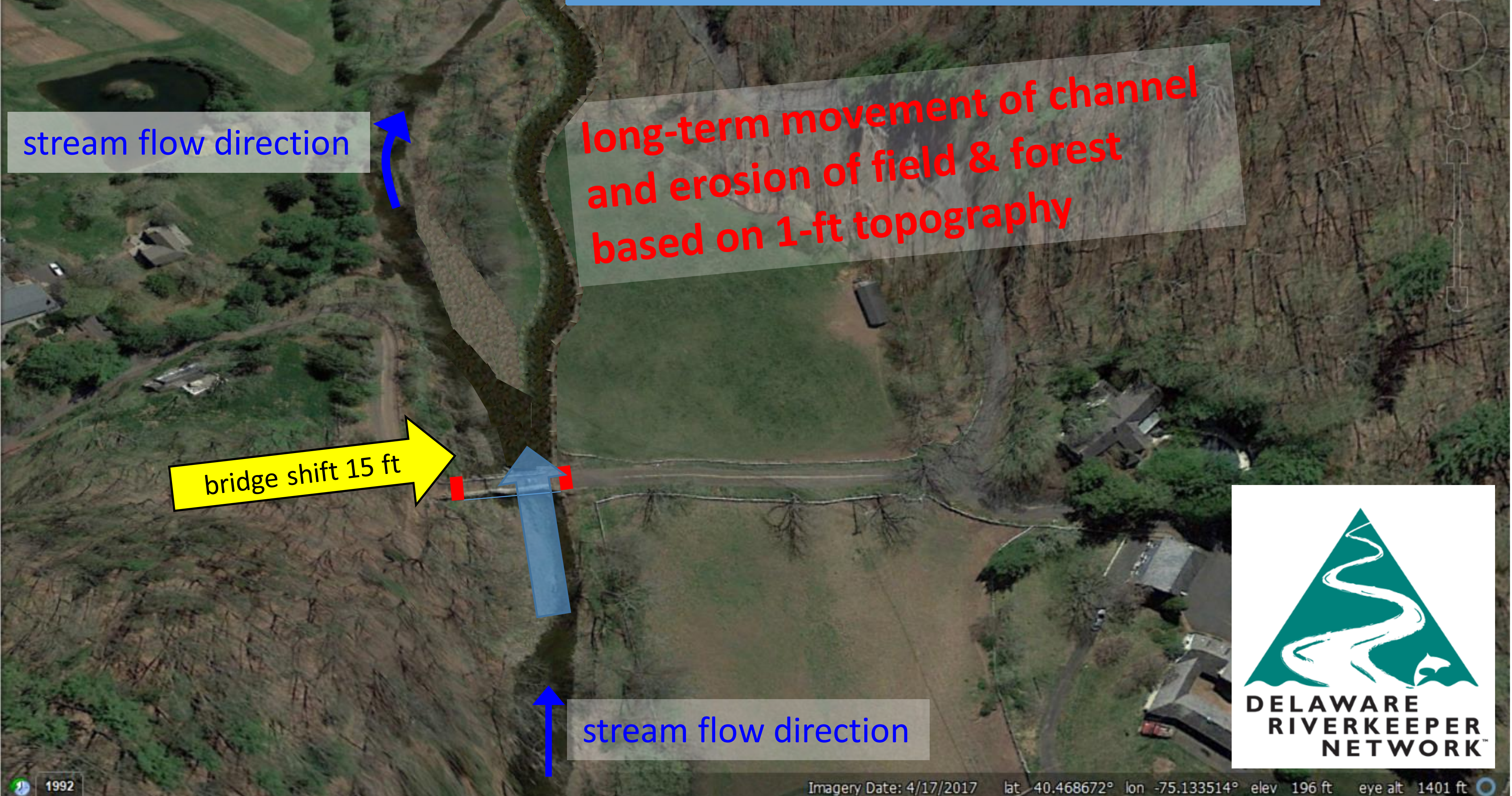
2. Bridge movement re-directs high flows directly at downstream stream banks & riparian zone

Headquarters Road Bridge



3. Stream immediately erodes downstream stream banks & tree line, and eliminates riparian corridor

Headquarters Road Bridge



4. Elimination of riparian corridor leads to new channel formation, impacts to historic pasture, and loss of additional streamside forest

ATTACHMENT C

United States Department of the Interior

NATIONAL PARK SERVICE
Philadelphia Support Office
U. S. Custom House - 3rd Floor
200 Chestnut Street
Philadelphia, PA 19106

IN REPLY REFER TO:

June 21, 2001

Mr. Robert Eppley, Jr.
Pennsylvania Department of Transportation, Region 6
Engineering District 6-O
7000 Geerdes Boulevard
King of Prussia, PA 19406-1525

Re: Tinicum Creek, Geigel Hill Road Bridge

Dear Mr. Eppley:

We have revised our opinion regarding the replacement of the Geigel Hill Bridge and believe that rehabilitation of the existing bridge is the preferred alternative. This is based on the May 21st Geigel Hill Road site visit, direction from the recently organized Lower Delaware National Wild and Scenic River Management Committee, and the fact that the 1997 Geigel Hill MOA with PHMC on historic issues is no longer in effect.

The Geigel Hill Road Bridge replacement project is located on Tinicum Creek, which was designated into the National Wild and Scenic Rivers System on November 1, 2000. Designated rivers are protected by Section 7(a) of the Wild & Scenic Rivers Act. Pursuant to Section 7(a): "no department or agency of the United States shall assist by loan, grant, license, or otherwise in the construction of any water resources project that would have a direct and adverse effect on the values for which such river was established." The Service considers water resource projects to include dams, diversion projects, bridge and roadway projects involving construction in the bed or on the banks of the river, bank stabilization projects and activities that require a section 404 permit from the Army Corps of Engineers.

The proposed bridge crossing will significantly and adversely affect values and resources for which the Tinicum Creek was designated into the Wild and Scenic Rivers System.

First, replacement of the existing steel truss bridge and natural stone retaining walls adversely affects the scenic and historic value for which the Tinicum Creek is classified as a scenic river. It removes a contributing resource from the Ridge Valley Rural Historic District. The historic district was identified as an outstandingly remarkable resource in the Lower Delaware National Wild and Scenic River Study Report and was crucial to Wild and Scenic River eligibility for the Tinicum. The historic district registration form identifies six bridges as contributing resources and states that, "as a collection, the bridges of the Ridge Valley strongly reflect two themes:

early settlement and transportation changes." Geigel Hill Road Bridge is the oldest existing bridge in the district. In addition, the Criteria of Effects Report, Geigel Hill Road Bridge Replacement Project, February 1997, states that "the removal of the contributing bridge from the historic district will have an Adverse Effect on the Ridge Valley Rural Historic District."

Second, installation of a box culvert replacement bridge will inhibit the free flowing character of the stream. A primary criterion for a National Wild and Scenic River is that it be maintained in a free flowing condition. The National Park Service generally prefers clear span bridges with abutments out of the floodplain. Proposed alterations to the west of the bridge will raise the roadway by approximately two feet and impede the floodplain. We believe these proposed impediments to stream flow and the floodplain will increase scouring above and below the bridge and increase stream bank erosion.

To maintain the free flowing, historic and scenic values of the Tinicum Creek we recommend that the existing bridge be rehabilitated as a truss bridge or reinforced with "I" beams if necessary.

Thank you for consulting with the National Park Service. Please call me at 215-597-1655 if you have any questions.

Sincerely,

William Sharp, Project Manager
Stewardship and Partnerships

cc: Lawrence M. Slavitter
Linda Wieand
Ann Safley

DELAWARE RIVER BASIN

NATIONAL PARK SERVICE | NATIONAL WILD AND SCENIC RIVERS SYSTEM | US DEPARTMENT OF THE INTERIOR

NATIONAL WILD AND SCENIC RIVER VALUES

PENNSYLVANIA • NEW YORK • NEW JERSEY

DELAWARE RIVER BASIN WILD AND SCENIC RIVER VALUES

PENNSYLVANIA, NEW YORK, AND NEW JERSEY

Dear friends of the Delaware River Basin,

What comes to mind when you think about the Delaware River and its tributaries?

Do you think of a beautiful river valley where one can experience solitude in nature and enjoy the incredible scenery of the meandering river and forested hillsides? A family friendly destination that provides great opportunities for boating, fishing, and picnicking? A rare example of a large, undammed river that allows continual natural migration of native fish from the sea to the river headwaters and back? An intact network of aquatic and riparian habitat that supports abundance and diversity of plants, fish, birds, and other animals? A waterway and valley with an incredible cultural history that relays vivid stories about past inhabitants, including native people, European settlers, and early Americans?

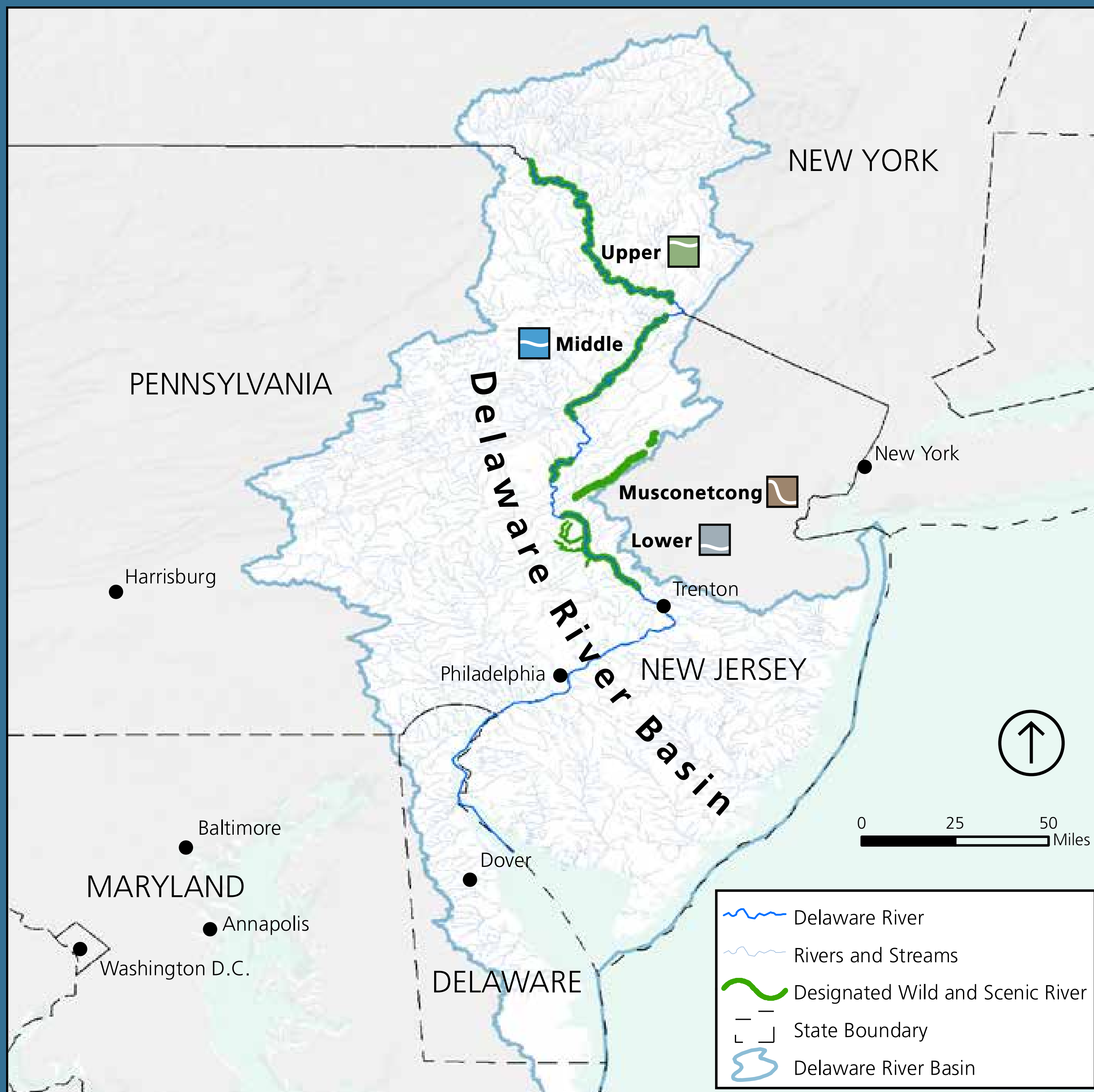
The Delaware River basin is all of this, and much more. Because of these unique values, several segments of the Delaware River and its tributaries have been designated for protection under the Wild and Scenic Rivers Act. To help us protect this river system for the benefit and enjoyment of future generations, we have contemplated these special values to determine what makes it outstandingly remarkable.

Knowledgeable people from many agencies and organizations in the region contributed important information, insight, and perspectives on these values, including representatives from the National Park Service, U.S. Fish and Wildlife Service, Delaware River Basin Commission, The Nature Conservancy, and various other river partners from New Jersey, New York, and Pennsylvania.

Based on this hard work and thoughtful input, we are pleased to present to you the outstandingly remarkable values of the designated segments of the Delaware River and its tributaries. The value statements that follow have been developed to provide a strong foundation for the future management and protection of this nationally significant river system—to help us focus our daily attention on the river's most important aspects.

We urge you to read these statements and to share your thoughts with us about what makes the designated segments of the Delaware and its tributaries outstandingly remarkable to you. Thank you for sharing your passion for the Delaware River basin by helping to shape its future!

CONTENTS



NEW YORK
PENNSYLVANIA
NEW JERSEY
MARYLAND
DELAWARE
Delaware River Basin
Upper
Middle
Musconetcong
Lower
New York
Trenton
Philadelphia
Harrisburg
Baltimore
Annapolis
Washington D.C.
Dover
0 25 50 Miles
Delaware River
Rivers and Streams
Designated Wild and Scenic River
State Boundary
Delaware River Basin

Photo: David B. Soete
UPPER
Photo: Jim Davis
MIDDLE
MUSCONETCONG
LOWER

THE WILD AND SCENIC RIVERS ACT AND THE DELAWARE RIVER BASIN

In 1968, Congress passed the Wild and Scenic Rivers Act. The act *"declared to be the policy of the United States that certain selected rivers of the Nation, which with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations."*

Photo: David B. Soete

Each designated river in the national system is to be managed in a way that protects and enhances the values that prompted its designation.

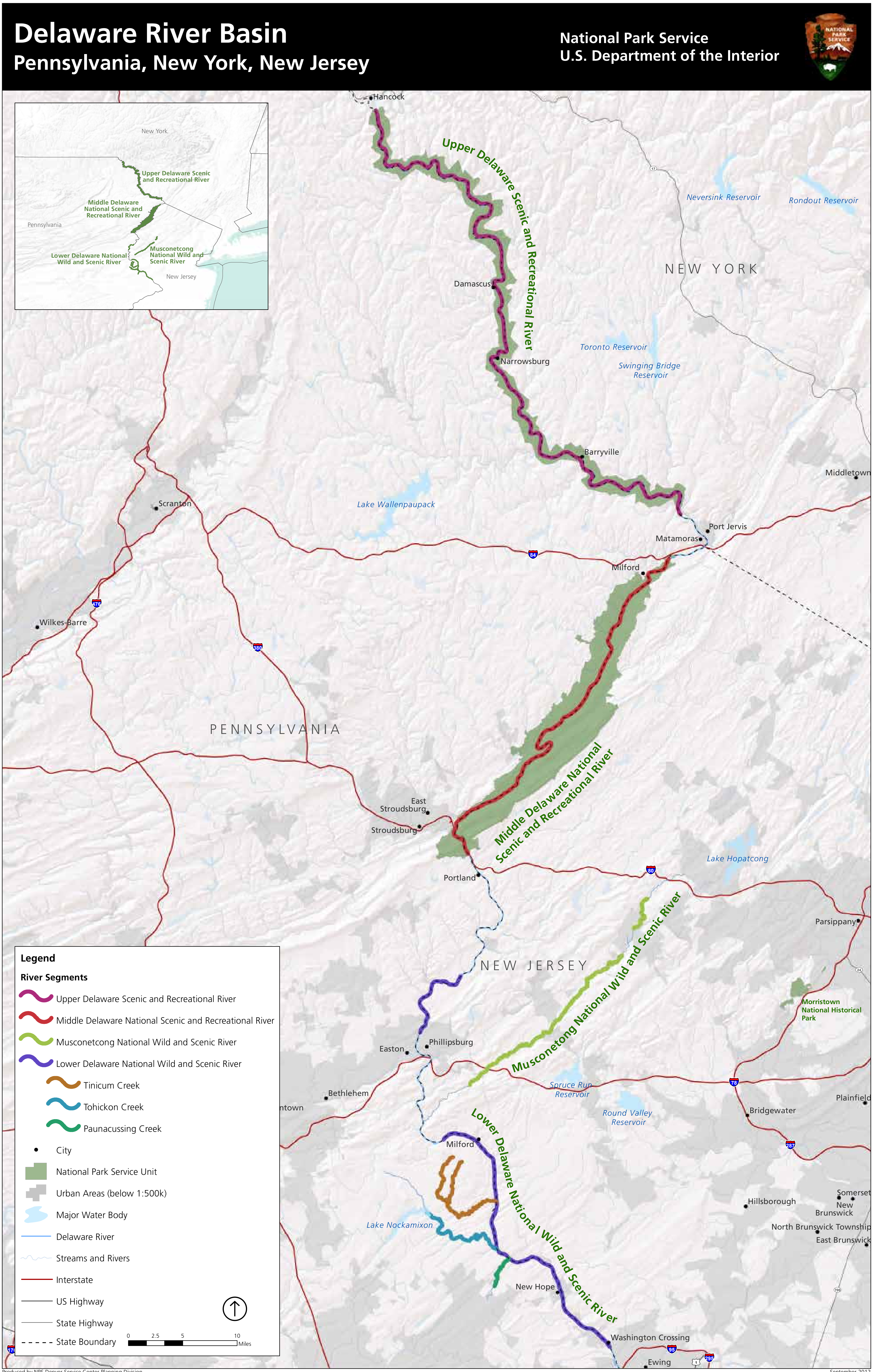
Under the Wild and Scenic Rivers Act, designated rivers are classified as wild, scenic, or recreational. The labels primarily relate to the degree of development along the river, not the proposed uses. And, regardless of the classification, each designated river in the national system is to be managed in a way that protects and enhances the values that prompted its designation. According to the act, the three classifications are defined as follows:

Photo: David B. Soete

- ***"Wild" river areas*** – Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.
- ***"Scenic" river areas*** – Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.
- ***"Recreational" river areas*** – Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some shoreline development, and that may have undergone some impoundment or diversion in the past.

Photo: David B. Soete

In 1978, Congress used the Wild and Scenic Rivers Act to designate the Middle Delaware National Scenic and Recreational River (managed by the Delaware Water Gap National Recreation Area) and Upper Delaware Scenic and Recreational River as national park system units and components of the national wild and scenic river system. Subsequently, in 2000, Congress followed up on these prior designations and acted to designate multiple sections and tributaries of the Lower Delaware National Wild and Scenic River (including Tinicum Creek, Tohickon Creek, and Paunacussing Creek) as a partnership river. Then, in 2006, the fourth river in the Delaware River basin— the Musconetcong National Wild and Scenic River, a tributary to the Delaware—was designated by Congress under the Wild and Scenic Rivers Act as a partnership river and a component of the national wild and scenic river system.


Delaware River Basin
Pennsylvania, New York, New Jersey
National Park Service
U.S. Department of the Interior
New York
Upper Delaware Scenic and Recreational River
Middle Delaware National Scenic and Recreational River
Pennsylvania
Lower Delaware National Wild and Scenic River
Musconetcong National Wild and Scenic River
New Jersey
Hancock
Upper Delaware Scenic and Recreational River
Neversink Reservoir
Rondout Reservoir
NEW YORK
Damascus
Toronto Reservoir
Swinging Bridge Reservoir
Narrowsburg
Barryville
Middletown
Scranton
Lake Wallenpaupack
Port Jervis
Matamoras
Milford
Wilkes-Barre
PENNSYLVANIA
Middle Delaware National Scenic and Recreational River
East Stroudsburg
Stroudsburg
Lake Hopatcong
Portland
Parsippany
Musconetcong National Wild and Scenic River
NEW JERSEY
Morristown National Historical Park
Easton
Phillipsburg
Bethlehem
ntown
Spruce Run Reservoir
Round Valley Reservoir
Plainfield
Bridgewater
Lower Delaware National Wild and Scenic River
Milford
Hillsborough
Somerset
New Brunswick
North Brunswick Township
East Brunswick
Lake Nockamixon
New Hope
Washington Crossing
Ewing
Legend
River Segments
Upper Delaware Scenic and Recreational River
Middle Delaware National Scenic and Recreational River
Musconetcong National Wild and Scenic River
Lower Delaware National Wild and Scenic River
Tinicum Creek
Tohickon Creek
Paunacussing Creek
City
National Park Service Unit
Urban Areas (below 1:500k)
Major Water Body
Delaware River
Streams and Rivers
Interstate
US Highway
State Highway
State Boundary
0 2.5 5 10 Miles
Produced by NPS Denver Service Center Planning Division
September 2012

WILD AND SCENIC RIVER VALUES OF THE DELAWARE RIVER BASIN

OUTSTANDINGLY REMARKABLE VALUES

Outstandingly remarkable values (ORVs) are defined by the Wild and Scenic Rivers Act as the characteristics that make a river worthy of special protection. Thus, the foundation for wild and scenic river management is a clearly defined set of ORVs. The Interagency Wild and Scenic Rivers Coordinating Council has issued criteria for identifying and defining these values. The criteria guidance states that:

- An ORV must be river related or dependent. This means that a value must
  - be in the river or on its immediate shorelands (generally within 0.25 mile on either side of the river),
  - contribute substantially to the functioning of the river ecosystem, and
  - owe its location or existence to the presence of the river.
- An ORV must be rare, unique, or exemplary at a comparative regional or national scale. Such a value would be one that is a conspicuous example from among a number of similar values that are themselves uncommon or extraordinary.

Based on these criteria and a careful analysis of the designated reaches of the Delaware River and its tributaries, the National Park Service has determined that several ORVs are present. The analysis concluded that the designated segments of the Delaware River basin contain the following ORVs: cultural, ecological, geological, recreational, and scenic. A set of broad statements has been developed that articulates each ORV for the collection of all designated segments of the Delaware basin. These narratives capture the overall, combined values of the river system, as protected under the Wild and Scenic Rivers Act.

An evaluation process for each ORV was then used to determine which river segments contain the different ORVs. The results of this evaluation were used to develop segment-specific ORV statements providing further evidence and support for the broad ORV statements. These segment-specific narratives provide a higher level of detail for the ORVs that are present in each designated segment. The following matrix summarizes the evaluation results and provides organization to the ORV statements and segment-specific descriptions that follow. It indicates which segments of the Delaware River basin possess the above-mentioned ORVs.

In addition to ORVs, the free-flowing condition and water quality of the Delaware and its tributaries are also integral to its designated status. Because free-flowing condition and water quality support the integrity of the ORVs and are key components of future management, they are included as part of this ORV statement.

For the purpose of ORV analysis, the designated rivers of the Delaware River basin were divided into the following seven segments. The location map identifies these seven analysis segments. The segments are defined as follows:

Photo: Scott Rando

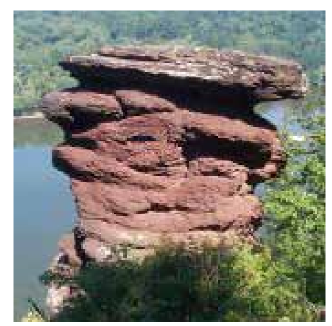


Photo: Dan Mohr

Upper Delaware Scenic and Recreational River: From the confluence of the east and west branches (below Hancock, New York) to the existing railroad bridge immediately downstream of Cherry Island in the vicinity of Sparrowbush, New York (73.4 miles)

Middle Delaware National Scenic and Recreational River: Northern boundary of Delaware Water Gap National Recreation Area to the southern boundary (approximately 40 miles)

Musconetcong National Wild and Scenic River: The 3.5-mile stretch from Saxton Falls to the Route 46 bridge and the 20.7-mile stretch from King's Highway bridge to the railroad tunnels at Musconetcong Gorge (24.2 miles)

Lower Delaware National Wild and Scenic River: From river mile 193.8 to the northern border of the city of Easton, Pennsylvania; from just south of the Gilbert Generating Station to just north of the Point Pleasant Pumping Station; from just south of the Point Pleasant Pumping Station to a point 1,000 feet north of the Route 202 bridge; from 1,750 feet south of the Route 202 bridge to the town of Washington Crossing, Pennsylvania (totaling 38.9 miles)

Tinicum Creek: Headwaters of its two upper branches to the Lower Delaware River confluence south of Erwinna and north of Point Pleasant (14.7 miles)

Tohickon Creek: From the Lake Nockamixon dam to the Lower Delaware River confluence near Point Pleasant (10.7 miles)

Paunacussing Creek: Portions passing through Solebury Township to the Lower Delaware River (approximately 3 miles)

RIVER SEGMENT	ORV CATEGORY				
	Cultural	Ecological	Geological	Recreational	Scenic
Upper Delaware River	●	●	●	●	●
Middle Delaware River	●	●	●	●	●
Musconetcong River	●	●	●	●	●
Lower Delaware River	●	●	●	●	●
Tinicum Creek	●		●		●
Tohickon Creek	●	●	●	●	●
Paunacussing Creek	●				●

CULTURAL VALUES

The Delaware River basin is rich and varied in significant historic and cultural sites, from early American Indian history to sites associated with present recreational use such as the Delaware and Hudson Canal Transportation Heritage Corridor hiking/biking trails. Unique among large northeastern rivers, many of these sites are largely intact due to the absence of large-scale industrial and agricultural land use in these river segments of the Delaware River basin.

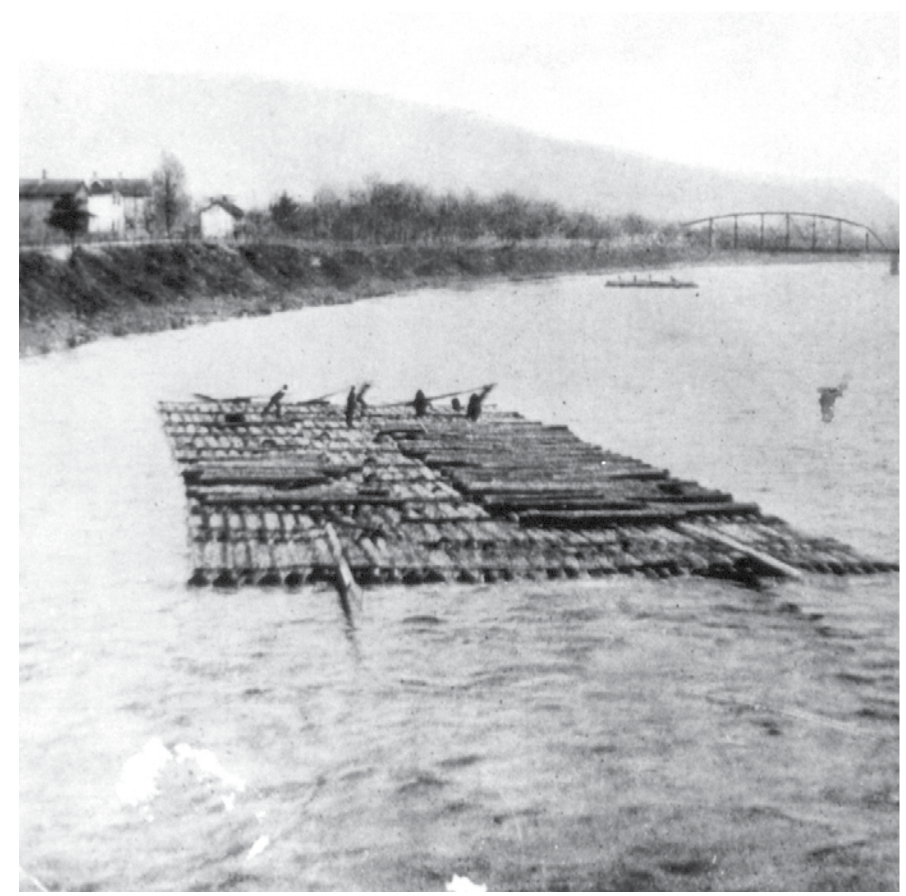
The Delaware River basin provides evidence of over 12,000 years of American Indian use and occupation, culminating in the Munsee occupation. Minisink was a major center of the regional Indian social network and was the single most important Lenape-Munsee-Delaware community in the Upper Delaware River Valley during historic contact times.

Situated between more accessible areas to the east and south along the Hudson River Valley and Atlantic Coast, and the concentrated British presence associated with the Six Nations to the north, the Delaware Valley provided space for American Revolutionary War patriots to operate. Washington's Crossing, the Minisink Battlefield, Van Campen's Inn, and Military Road are examples of sites along the Delaware River important to the Revolutionary War.

The river valley also provided an extensive transportation network for the extraction of natural resources, including coal, timber, and bluestone, for transfer to the emerging urban centers in the northeastern United States. This history provides a vignette of river-related transportation infrastructure supporting small resource extractive industries that supplied larger-scale industrial development elsewhere. Due to topography, the region's initial transportation system paralleled the river corridor along trails and the river itself, and was succeeded by wagon roads and turnpikes. Later, canals and then railroads also followed the river corridor, allowing farming and dairying to become commercialized. European settlement followed this pattern of river-related transportation, with towns springing up approximately a day's journey apart along the river and at river crossings, fords, ferries, bridges, and aqueducts. Many of the main streets and structures within these towns and hamlets retain their historic integrity and charm, drawing tourists from across the region. The Delaware River Valley also contains numerous national historic landmark (NHL)-listed water transportation-related sites and structures such as the Morris Canal, Delaware Canal, Delaware and Hudson Canal, and Roebling's Delaware Aqueduct, known locally as Roebling Bridge.

Tourism in the valley started in the 1850s with canal boats and expanded by the 1880s with the advent of railroads and construction of hotels serving residents of New York City and Philadelphia. More recently, large natural areas along the mainstem Delaware and its tributaries have been conserved to protect natural values and support recreation, epitomizing a major transformation in public attitudes toward rivers and their resources that started in the late 20th century.

> Previously, the Delaware River was valued solely for its water, timber, quarries, and potential for hydropower production. While water supply remains an important function today, conservation of the river's natural and cultural values has supported the development of a heritage tourism industry significant to the Delaware River Valley's continued economic wellbeing.



ECOLOGICAL VALUES

The ecological integrity of the Delaware River system is exceptional among the large river systems of the mid-Atlantic and Northeastern United States.

> As the longest undammed river in the eastern U.S., the Delaware River provides unparalleled access to the full range of habitats for nearly all migratory (diadromous) fish species of the Atlantic Coast.

A combination of exceptionally high water quality, fully functioning floodplains, excellent aquatic and riparian habitats, and the absence of dams on the mainstem contributes to a diverse array of species and a productive, complex food web.

Migratory fish such as the American shad, blueback herring, alewife (federally listed species of concern), sea lamprey, American eel, and shortnose sturgeon (a federally endangered species) maintain their access to key spawning and rearing grounds throughout the Delaware River watershed, from tributary streams in the Catskill Mountains downstream through the mainstem river and tidal estuaries leading to the Atlantic Ocean. Furthermore, the Delaware River occupies a central, core position within the geographic ranges of most of these migratory fish. This core position, combined with the unrivaled connectedness of habitats, underscores the vital role that the Delaware River and its tributaries serve in the long-term persistence of this extraordinary suite of Atlantic migratory fish, most of which are in perilous or declining status.

The migratory fish serve as but one of the key ecological components in a thriving and largely intact array of native species and communities that depend on the connected habitats and quality of the Delaware River and its tributaries. These ecological communities begin with important and globally rare plants and plant communities such as the aquatic indicator species, "threadfoot riverweed" *(Podostemum ceratophyllum),* the globally imperiled calcareous riverside seep and outcrop communities, and the bitternut hickory lowland forest. The ecological integrity of the aquatic invertebrate and freshwater mussel communities is likewise noteworthy, with high abundance and diversity as well as important populations of imperiled species such as the dwarf wedgemussel *(Alasmidonta heterodon)*. The extraordinary complement of migratory fish bolsters a broad guild of native fish, including increasingly rare fish such as the native brook trout and imperiled fish such as the bridle shiner. This diversity and abundance of aquatic species further enhances the riparian and river corridor ecosystem, providing exceptional habitat for species like river otters, mink, black bears, common mergansers, green and blue herons, scarlet tanagers, cerulean warblers, bald eagles, and ospreys. These river corridors and their connection to the Delaware River and tributaries also serve as vital components in the migratory bird flyway of the eastern United States. Together, these interrelated components of aquatic and terrestrial ecosystems complement and enhance the value and function of one another, strengthening their resilience and enhancing their regional importance.

Beyond the habitats and species themselves, interactions among these habitats and species yield ecosystem functions and services unmatched by other large rivers in the region. The lateral connectivity between the river and its extensive undeveloped floodplains moderate flows and reduce peak floods. The high water quality and habitat conditions support an extraordinary abundance of freshwater mussels, which creates a positive feedback loop wherein the mussels maintain and improve water quality through their filter-feeding activity. The combination of both anadromous fish (born in freshwater, migrate to the ocean) and catadromous fish (born in the ocean, migrate to freshwater) provides vital pulses of biomass (energy and nutrients) from the sea to the rivers and in turn provides pulses of biomass from the rivers back to the sea. These ecological processes also provide services essential to our society such as purifying the drinking water for millions in the region, generating fish populations for recreational and commercial fisheries, and reducing the risk of flooding and flood damage.

Photo: David B. Soete

GEOLOGICAL VALUES

The Delaware River traverses the Glaciated Appalachian Plateau Region, the Valley and Ridge Physiographic Province, and the Piedmont Physiographic Province of the Mid-Atlantic Region.

> The designated wild and scenic portions of the river system contain a high degree of diverse geological formations that are easily accessible to the public. These features provide evidence of earth's evolution over an approximately billion-year timespan and the influence of many major events in the geologic history of eastern North America. These events include folding and faulting during Appalachian mountain building and the assembly of the supercontinent Pangaea, separation of Pangaea to form the Atlantic Ocean, erosional and depositional forces, volcanic activity, and the extent of ice age glaciers in the region.

The terminal moraine (maximum extent) of the Wisconsinan Glacier (the most recent ice age glacier) began its retreat northward 20,000 years ago. The terminal moraine is a significant feature that crosses the river system.

The Upper Delaware River is the only large river that crosses the small lakes section of the glaciated Appalachian Plateau. Along this upper reach, the river is characterized by glacial and erosional processes displaying a narrow, deep valley with high relief and dramatic rock escarpments. Farther downstream, the Middle Delaware River follows the boundary between the Appalachian Plateau and the Ridge and Valley Physiographic Province before dramatically cutting across the Appalachian Ridge at Delaware Water Gap, a signature geologic feature along Delaware River. Below the gap, the river cuts through a series of transverse geologic formations, including shale and limestone belts and the Little Water Gap at South Mountain.

The northern end of the Lower Delaware River and its tributaries cuts through the Ridge and Valley Physiographic Province, specifically the Great Valley section, reflecting the folding and faulting geology and the rise of the Appalachian Mountains hundreds of millions of years ago. As the Delaware passes the mouth of the Lehigh River at Easton, Pennsylvania, it enters the rocky landscape of the Reading Prong of the New England Province, with its ancient Precambrian and Cambrian formations visible at Riegelsville, Pennsylvania. South of Riegelsville, the river enters the rolling hills of the Piedmont Province (specifically the Gettysburg-Newark Lowland section), which includes most of Bucks County and much of Hunterdon County on the New Jersey side. This Triassic Lowlands geology primarily reflects the sediments that were deposited in basins as the modern continents of Europe, Africa, and North America began to separate from Pangaea to form the Atlantic Ocean. Diverse types of fossils are prevalent at numerous places along the river.

The Musconetcong River, a designated wild and scenic tributary, is a microcosm of the Delaware River, containing many similar geologic features on a smaller scale. In addition, the Musconetcong River contains limestone bedrock formations known as karst. The dissolving solution of limestone causes sinkholes, depressions, caves, solution channels, and irregular bedrock surfaces that add to the dramatic geology of the Delaware River Valley.

The Delaware River system is characterized by a stable yet highly diverse mix of channel types and resulting habitat types. Ancient geologic processes have produced spectacular pools as deep as 113 feet and rapids that provide recreational enjoyment and scenic values. In other places along the river, the recent Holocene glacial deposition and riverine down-cutting and erosion have created island complexes, riffle/pool structures, and floodplain communities. In addition, many of the tributary valleys have narrow, deep gorges with waterfalls tumbling to the river valley below.

Overall, the geologic processes and features of the Delaware River Valley support stable, mature, and complex biological communities. This resilient, healthy river ecosystem includes a variety of micro-climates and habitats that support regionally rare plant and animal communities and optimal riverine macroinvertebrate and fish habitat. The outstandingly remarkable geologic value of the Delaware River is further exemplified by its scientific importance. The river's complex geologic processes and formations provide geologists with a nearly complete record of fluvial deposition through the Holocene. However, debates remain among scientists about how the geology of the river has changed over time, furthering the need for ongoing investigations.

Photo: David B. Soete

RECREATIONAL VALUES

Providing easy recreational access to millions of people in America's most densely populated region, the Delaware River basin provides high quality, natural recreational experiences, which include boating, hunting, fishing, hiking, biking, wildlife viewing, birding, and scenic touring. The Delaware River also provides the opportunity to recreate on the longest undammed river in the eastern United States.

> The solitude and picturesque scenery in the Delaware River basin stands in dramatic contrast to the regional metropolitan areas. It provides opportunities for people from diverse backgrounds to enjoy the inspiration of nature, and to rejuvenate and restore themselves.

Traveling through the river basin by foot, bicycle, boat, vehicle, and even excursion trains to view sweeping vistas is a popular source of year-round recreation. Windshield touring allows the visitor to view the tapestry of the Delaware River Valley woven from the geologic and cultural landscape that covers thousands of years of natural and human history. Bicycling routes parallel the entire designated length of the Delaware River offering road cyclists similar experiences while using alternative transportation. The rivers and tributaries provide opportunities for a variety of river trips, ranging from hours to days, for boaters of all abilities. The turns and bends in the river create a sense of remoteness unmatched in the region.

The clear, pristine waters found in the basin draw anglers from across the nation in pursuit of both cold-water and warm-water fish species. Additionally, hunters from across the northeast travel to the area in pursuit of the many big and small game species that can be found in the diverse habitats of the river basin.

Opportunities to experience wildlife along the river are unmatched—visitors travel here to observe black bears that range throughout the river basin. As a critical piece of the Atlantic flyway, the Delaware basin draws birders from across the nation to experience everything from songbirds to waterfowl, to the basin's many raptor species, especially bald eagles.

SCENIC VALUES

> The Delaware River and its tributaries flow through narrow valleys framed by steep, densely forested ridges reaching down to the water's edge. This landscape presents an attractive pastoral scene, more tranquil and serene than dramatic or sensational.

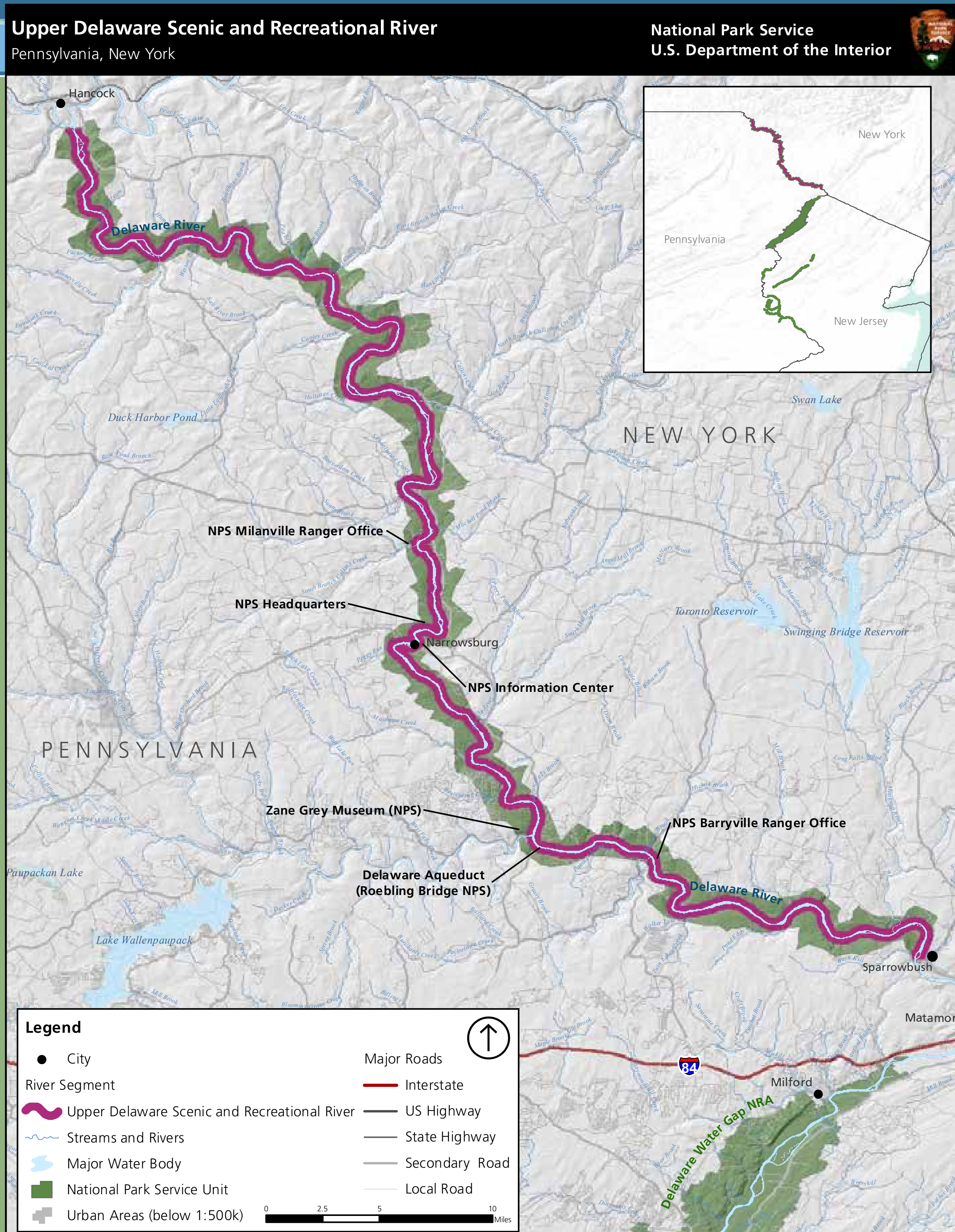
Numerous vantage points provide a variety of enclosed and panoramic views. Islands and floodplains, hamlets and farmland, rapids and riffle pools create visual interest and intrigue. The surrounding mixed forests complement the scenery by providing a fall foliage display. The nuances of the changing seasons from spring wildflowers to fall foliage, and the winter fog and ice provide an ever-changing backdrop. The morning mist and evening sunsets add a subtle charm. These scenes have inspired generations of residents, visitors, and artists.

The Delaware River basin exemplifies a mid-Atlantic watershed, crossing many geologic provinces, with scenic values largely preserved from development. The mainstem corridor and designated tributaries provide continuous views of a landscape shaped by geology and historic settlement patterns. The diversity of historic bridges—suspension, stone arch, truss (several are included in the National Register of Historic Places)—is particularly notable. There are many other unique scenic features, including iconic views of the Delaware Water Gap. In addition to the foregoing elements that contribute to the Delaware River's extraordinary scenic values, the area also provides a rare opportunity in the tri-state region / Delaware Valley region to view the Milky Way because of the dark night skies.

Photo: David B. Soete

UPPER

DELAWARE SCENIC AND RECREATIONAL RIVER



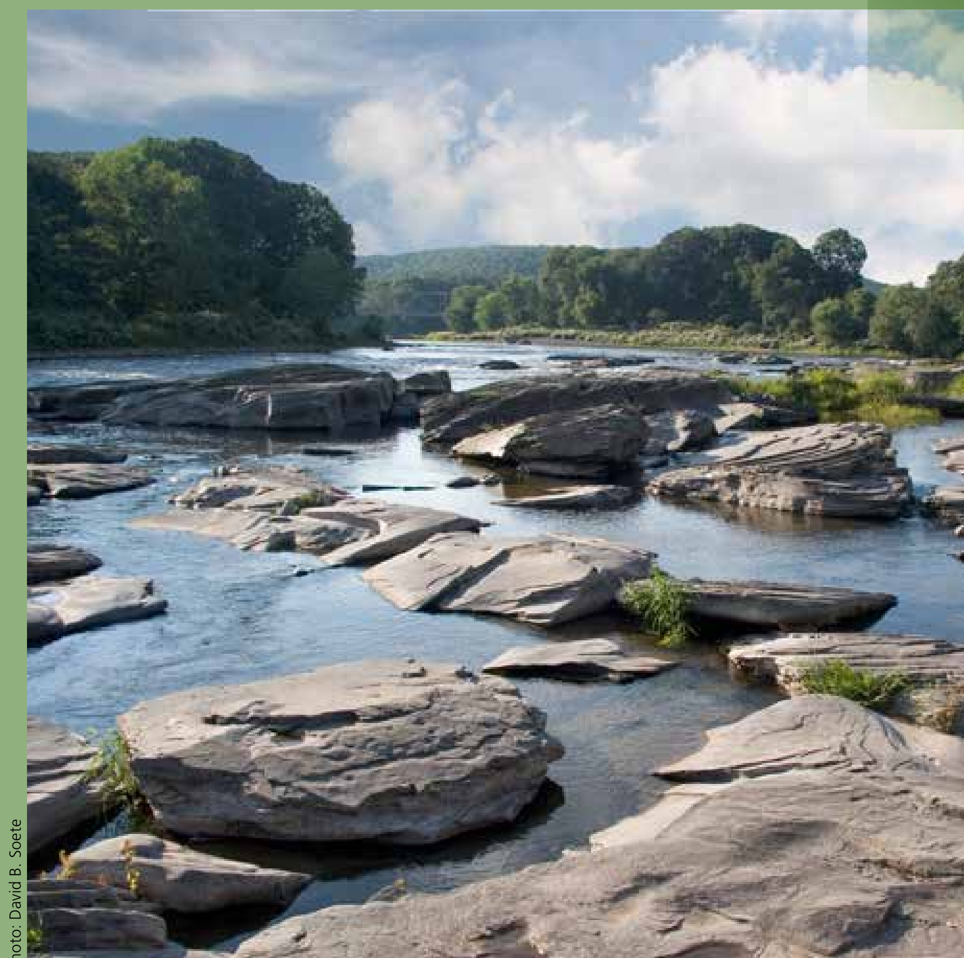


Photo: David B. Soete

UPPER DELAWARE SCENIC AND RECREATIONAL RIVER

The outstandingly remarkable values that make the Upper Delaware Scenic and Recreational River worthy of protection under the Wild and Scenic Rivers Act are described on the following pages.

CULTURAL

> "Although it lies just to the west and northwest of the Boston-to-Washington urban corridor, the Upper Delaware River appears relatively untouched by the frenetic pace of the mid-20th century. The Upper Delaware and its riverside communities have managed to retain those qualities and values of earlier times which elsewhere have passed into memory, perishing in the onslaught of industrialization, modernization, urban sprawl, and other similar forces of contemporary life. The counties which form the …region have remained essentially rural… some of these qualities and values may still be seen as they appeared to earlier eyes. This special quality, this pace of daily life, is easily discernible by comparison with the large cities and suburban overflows of the Eastern Megalopolis …"[1]


Photo: Don Hamilton

Dating from the paleo through the transitional period, 437 documented pre-contact archeological sites record a rich cultural tapestry of riverine occupation of aboriginal people who used the river as a trade route. Eighteen archeological sites worthy of more detailed investigation and one site eligible for listing in the National Register of Historic Places (NRHP), taken collectively with the archeological sites on downstream segments, are exemplary of Munsee peoples and their predecessors. Several privately owned archeological sites illustrate the history of early European settlers who arrived in the mid-18th century. Remnants of the early settlements along the river help to convey the history of the early subsistence period to the mid-1700s, including small-scale rural hydro-powered industry in the northeast, while the NRHP-listed Minisink Battleground Park tells the story of a Revolutionary War battle between local residents and militia, and Indians and Tories under the command of Joseph Brant.


Photo: David B. Soete

Extractive industries dependent on water power and water-related transportation spurred an industrial economy, contributing to a pattern of hamlet settlement identifiable today. The timber rafting industry was introduced in the 1760s to transport ship's mast-length logs to Easton and Philadelphia. From the end of the Revolutionary War to the early 1900s, this industry fed the local economy, stripping the hillsides of white pine and hemlock, while contributing to the growth of colonial America.

Early 1800s technological development spurred construction of historic transportation routes dependent on the river and valley geology for defining their routes, each contributing to the cultural profile of the Upper Delaware. Timber, coal, and bluestone transported to coastal markets contributed to growth of the early American economic centers.

1 The Upper Delaware River, A Wild and Scenic River Study, U.S. Bureau of Outdoor Recreation, 1973

The first business in the United States to be capitalized for a million dollars, the Delaware and Hudson (D&H) Canal operated from 1829 to 1898. The 171-mile-long engineering feat included 16 miles of gravity railway, 108 locks over 108 miles, and four cable-suspension aqueducts to connect the coal fields of Pennsylvania with the Hudson River and New York City markets. Roebling's Delaware Aqueduct carried the canal across the Delaware between Lackawaxen, Pennsylvania, and Minisink Ford, New York. North America's oldest existing wire suspension bridge, this NPS-owned National Historic Landmark and National Historic Civil Engineering Landmark received the Presidential Design Award for its adaptive reuse restoration as a one-lane vehicular bridge known locally as Roebling Bridge. The D&H traversed the southern river corridor, paralleling the river for 25 miles between Lackawaxen, Pennsylvania, and Port Jervis, New York, before veering to the northeast. The stone remnants can easily be seen by both boaters on the river and tourists along the Upper Delaware Scenic Byway. Of particular note is Corwin Farm, eligible for listing in the National Register of Historic Places and owned by the National Park Service, a canal-era lock tender's house and barn along an intact portion of the canal.


Photo: David B. Soete

The Erie Railroad, America's first long line railway, connected New York City with the Great Lakes and west. The Port Jervis line traversed the entire river corridor, spurring thriving hamlets as it progressed north and westward, carrying immigrants to the frontier. It also provided transportation to the Upper Delaware region for city workers who found fresh air, restful landscape, and good home cooking at local farms and boarding houses, contributing to "the Catskills and the Poconos," geographic areas famous for hospitality for nearly 150 years. Two early depots, the NRHP-listed Old Cochecton Station and the Callicoon Depot, remain. One notable vacationing fisherman, author Zane Grey, stayed on to establish a home on the Delaware at Lackawaxen, Pennsylvania, where he wrote his earliest articles and books, including "*Riders of the Purple Sage*." The National Park Service owns and manages a museum at the NRHP-listed Zane Grey House.

The railroad, and later New York State Route 97 (the Upper Delaware Scenic Byway), led to construction of several notable NRHP-listed historic bridges using petite and through-truss steel construction methods as well as stone arch construction on nearby tributaries. Many of the homes and commercial buildings dating to the late 1800s and early 1900s are extant; of note are National Register of Historic Places districts in Cochecton, Damascus, Milanville, and Equinunk, in addition to a number of individual National Register of Historic Places listings. Eighty-six historic archeological sites, in addition to 73 individual structures, were identified during a NPS-funded cultural resource survey.

Four-lane highways of the 20th century divert much of today's industrial transportation around the Upper Delaware River corridor, leaving behind an unsullied testimony to a culture dependent on the bucolic Upper Delaware Scenic and Recreational River.

Photo: David B. Soete

ECOLOGICAL

The Upper Delaware River exhibits some of the highest ecological integrity found in any of the large rivers of this region. As the least-developed section of the last major river on the Atlantic Coast, undammed the entire length of its mainstem, the Upper Delaware's wild and scenic, largely ecologically intact, free-flowing character supports key components and processes that contribute to the superb natural resources found here. Exceptional water quality, resulting from a predominately forested landscape, sustains high quality fish and aquatic insect assemblages. Excellent in-channel conditions result in an abundance of riffles, runs, and pools, and a diversity of in-stream habitats. These aquatic conditions, combined with good riparian habitat that is coupled with a functioning floodplain, provides great hydrological connectivity, structure, and function.

> The unobstructed river affords access to the full complement of sea-run migratory fish into and above this segment, thus allowing historic fluxes of nutrients, energy, and biomass to and from the ocean. These features combine to provide a complex food web, a wide variety of habitats, and a healthy diversity of species.

Photo: Scott VanArsdale

Photo: David B. Soete

Photo: David B. Soete

The riparian area along the river supports rare terrestrial plant communities, such as ice scour rock outcrop, seep communities, and bitternut hickory lowland woodland. The river itself sustains diverse and healthy native aquatic plant communities, including a plentiful population of threadfoot riverweed, a relatively rare aquatic plant that is indicative of excellent water quality. A diversity and extraordinary abundance of freshwater mussels further contribute to water quality and nutrient processing. The Upper Delaware provides habitat for a sizeable population of the federally endangered dwarf wedgemussel, as well as several state threatened and endangered species including bridle shiner, and brook floater mussel.

The Upper Delaware River's ecological value extends beyond this segment of river. It provides regionally important high quality historic spawning and rearing habitat for sea-run migratory fish, helping to buttress their larger range-wide populations. In addition to native brook trout, the river and tributaries support thriving recreational fisheries for naturalized rainbow trout and brown trout. The river corridor is also regionally important inland bald eagle wintering habitat for birds from as far away as the maritime provinces of Canada, and serves as a migratory bird stopover along the Atlantic flyway. The Upper Delaware provides drinking water for millions of people, all helping to underscore the Delaware's significance beyond its own watershed.

GEOLOGICAL

The Upper Delaware Scenic and Recreational River is an exceptional example of a deep, narrow river valley cutting across the Small Lakes section of the glaciated portion of the Appalachian Plateau. The overall landscape is a fluvial or stream-cut landscape modified by stream derangements from glacial deposits burying portions of preglacial valleys. Examples of significant geologic features include sandstone cliffs, barbed tributaries, glacial deposits, glacial outwash terraces, diverse channel morphologies, exposed ancient bedrock, bedrock knobs, cutoff incised meanders, island complexes, gorges, and fossils.


Photo: David B. Soete

The area's rolling hills vary in elevation from 800 to 2,000 feet and are characterized as a series of indistinct and irregular escarpments. Relief is generally between 300 and 500 feet, although it ranges to 700 feet in a few locations. Point Mountain, defining the northernmost extent of the wild and scenic river designation, is an isolated bedrock knob formed by glacial meltwater that eroded through a ridgeline between the east and west branches of the Delaware River. Sandstone cliffs, clearly evident at places like Hawks Nest, show ancient river channel deposits that have a wide variety of bedding features, including three types of cross-bedding, ripple marks, current lineation, tool marks, mud cracks, and conglomerates. Fossilized plant and animal remains are found here, such as bony plates from the armored fish of Devonian times, brachiopods and mollusks, a few types of coral, bryozoans, cephalopods, and rare trilobites.


Photo: David B. Soete

Glacial deposits partially fill many of the tributary valleys, especially those that are oriented transverse to the direction of the most recent ice age glacier. The post-glacial Delaware River cut into the bedrock and glacial materials at least 200 feet. Many of the tributary valleys have narrow, deep gorges with a series of waterfalls. These steeper-sloped tributaries have deposited alluvial or debris flow fans on the floodplain. Barbed tributaries, including Shehawken Creek, Calkins Creek, and Callicoon Creek, are another unique geologic anomaly where the streams enter the river in an unusual upstream direction. These barbed tributaries are evidence that the drainage pattern of the river once flowed to the north and were then reversed to the south by erosional forces.


Photo: David B. Soete

The Upper Delaware River has a variety of channel patterns ranging from pool-riffle chains in straight reaches to elongated pool-riffle chains in incised meander reaches to anastomosing channel reaches with a number of islands to short bedrock gorge reaches. For example, the Narrows is a short gorge cut through the bedrock of a preglacial ridge that once occupied the site.

The Narrowsburg Pool is a plunge pool at the downstream end of the Narrows, possibly formed from a submerged waterfall. During flood flows, the river may scour down 150 feet into glacial deposits, subsequently refilling the pool with sediment transported from upstream to an approximate depth of 113 feet at normal flow levels. Skinners Falls, Shohola Rapids, and Staircase Rapids are examples of bedrock-floored rapids where the river has incised through glacial fill and cut into the bedrock of the valley side, in essence bypassing its pre-glacial channel.

The convoluted drainage pattern of the Delaware River system provides a rare combination of drainage anomalies that challenge various explanations of how Appalachian river systems evolved over geologic time. The diversity of valley orientations has produced an equal diversity of geologic hypotheses that try to explain how the pattern came to be.


Photo: David B. Soete

RECREATIONAL

The Upper Delaware River is known for its outstanding recreational activities from tubing the rapids on a hot summer day to relaxing on a hidden deck, slope side in the Pocono or Catskill mountain forests. The river's close proximity and accessibility attracts visitors from major metropolitan areas along the northeast corridor, including Boston, New York City, Philadelphia, and Washington, D.C.

> The Upper Delaware provides a relatively undeveloped and varied river setting that is ideal for families and recreationists of all levels.

The river corridor offers a wide variety of recreational activities ranging from heavily used accesses at Skinners Falls, Narrowsburg, Mongaup, and Sparrowbush, to opportunities for solitude while hiking or canoeing various other stretches of the river. River reaches from Lordville to Callicoon, and Narrowsburg to Lackawaxen provide some of the most remote and serene experiences along the Upper Delaware.

The Upper Delaware segment is surrounded primarily by privately owned property, but there are 18 well-marked and easily accessible public access points. These developed boat and canoe launches on both sides of the river are available to the public approximately every 5 river miles. Privately owned and operated access points also exist along the river. All of these facilities, easily accessible by rural roads, include river information and amenities during the periods of heaviest visitor use. Four of the public access sites are staffed by NPS personnel during peak periods, making it easy for visitors to obtain information about recreation opportunities.

River activities include canoeing, kayaking, boating, tubing, rafting, SCUBA diving, snorkeling, swimming, and hunting waterfowl. The Upper Delaware's cold water fishery between Hancock and Callicoon attracts anglers from around the world, especially those interested in fly fishing for its world renowned wild trout. This type of fishing experience is seldom found elsewhere in the region.

Photo: David B. Soete

Other recreational activities include photography, wildlife viewing, bird-watching, picnicking, hunting for both small and big game, and hiking/cross-country skiing at places such as Jensens Ledges, Tusten Mountain Trail, Game Lands 316, Buckhorn Natural Area, Damascus Forest, and Minisink Battleground Park. Sightseeing can be found at numerous scenic overlooks such as Jensens Ledges, Peggy Runway, Indian Ledges, and Hawks Nest, as well as at historic sites such as Roebling's Delaware Aqueduct (known locally as Roebling Bridge) and Zane Grey House. Auto touring and cycling along the Upper Delaware Scenic Byway (New York State Route 97) and New York State Bicycle Route 17 is also popular. Camping at both primitive and developed commercial campgrounds, fall foliage viewing, resorts, downhill skiing, geocaching, scientific research, education activities, and ranger-led activities are also popular. Eagle watching is particularly popular in the Lackawaxen area. The Eagle Institute, a project of the Delaware Highlands Conservancy, operates eagle viewing platforms and provides interpretive services in the area.

Experienced commercial outfitters provide canoe, kayak, and raft rentals, as well as transportation between access points. Guided trips are also available. Commercial fishing guides provide guided fishing trips for both warm and cold water fish species. These guides and outfitters provide opportunities for beginners as well as experienced river users to easily explore the river. The mixture of class I and II rapids (Skinners Falls, Staircase, Mongaup, and Butlers Rift) with riffles, runs, and pools offer a varied and quality recreational experience on the river. Beginners to expert boaters alike can find something on the Upper Delaware to challenge their skills and provide an outstanding boating experience.

The exceptional water quality provides the recreationist remarkably clean water for swimming, tubing, and boating in quiet eddies or swift-moving rapids. The exceptional clarity of the water provides the swimmer, tuber, boater, and SCUBA diver or snorkeler remarkable subsurface visibility. SCUBA diving and snorkeling are particularly popular activities at Narrowsburg and Skinners Falls.

Photo: David B. Soete

Photo: David B. Soete

SCENIC

The scenic quality of the Upper Delaware River is recognized as regionally significant due to its picturesque gorge, riparian vegetation, steep forested slopes and gently rolling hills. The agricultural fields and livestock pastures add variety to this tranquil scene.

> The riffles, runs, rapids, and pools of the river provide an ever-changing visual stimulus that is enhanced by the water clarity providing for amazing views of the landscape, the river bottom, and aquatic life.

Rock outcroppings, cliff faces, and exposed unusual sedimentary formations add to the stimulating visual variety of the Upper Delaware. A number of cascading waterfalls, including Peggy Runway with the largest drop of any waterfall in Pennsylvania, delight the viewer. The contrasting hardwood forest and evergreen stands provide a rich variety of colors and textures across the four seasons. Additional outstanding natural features, landforms, and topographic features include, but are not limited to: Hawks Nest, York Lake Falls, Jensens Ledges/Bouchoux Trail, and Point Mountain. Dark night skies are prevalent.

The Upper Delaware scenery is rich in structures and sites that reflect its history of agricultural and transportation-based development. The historic canal, railroad, petite truss bridges, hotels, inns, taverns, homes, a hillside seminary built with local bluestone, and other unique structures provide beautiful scenic backdrops and a feeling of nostalgia for early American ingenuity. Particularly notable are the Roebling's Delaware Aqueduct (Roebling Bridge) and the privately owned prominent, stately and historic buildings; remnants of the Delaware and Hudson Canal; and Cochecton Station. The Hawks Nest stone wall along the Upper Delaware Scenic Byway provides the best overlook of the unspoiled river valley.

Photo: David B. Soete

Photo: David B. Soete

Photo: David B. Soete

MIDDLE

DELAWARE NATIONAL SCENIC AND RECREATIONAL RIVER

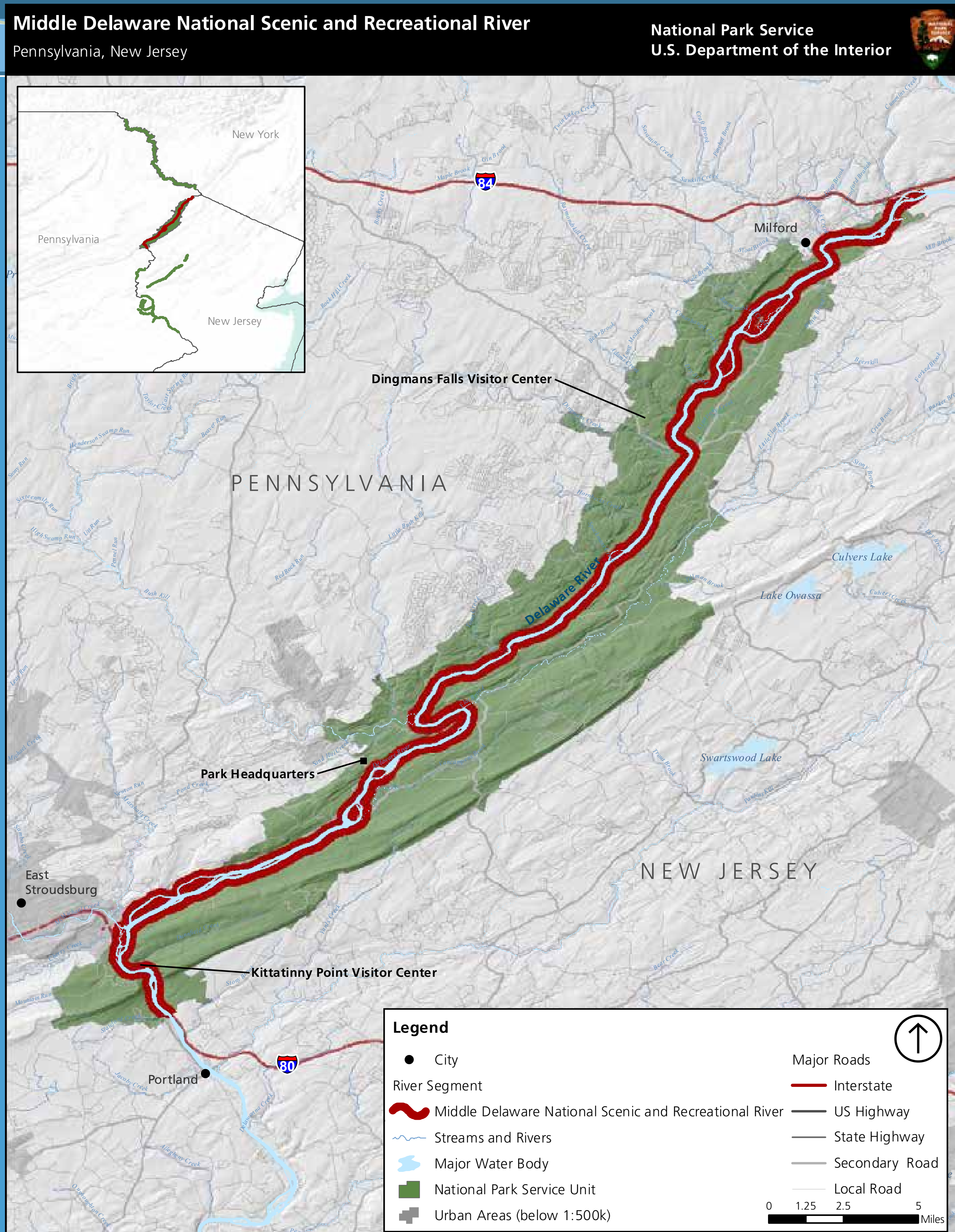


Photo: Jim Davis

MIDDLE DELAWARE NATIONAL SCENIC AND RECREATIONAL RIVER

The outstandingly remarkable values that make the Middle Delaware National Scenic and Recreational River worthy of protection under the Wild and Scenic Rivers Act are described on the following pages.

CULTURAL

The cultural significance of the Middle Delaware River Valley is typified by the continuous human presence throughout the Holocene, which is documented by a rich tapestry of river-focused living.

> The Delaware Water Gap National Recreation Area has close to 500 documented American Indian archeological sites of which over 100 are currently considered NRHP-eligible. Three-quarters of these archeological sites are found in the Middle Delaware River floodplain. This complex of American Indian sites is one of the best preserved in the northeastern United States, making it a high-value research area for archeologists and geo-archeologists.

The southern half of the Middle Delaware includes the Shawnee-Minisink site (ca. 12,900 BP), which remains one of the most spatially intact Clovis sites (Late Paleo-Indian and Early Archaic through Woodland occupations) in eastern North America. In the northern half the intact Minisink National Historic Landmark District, situated on an island and along the riverbank, was occupied by the Munsee people. The NHL district preserves this homeland area and the trails such as Minisink Path to the Atlantic, Minsi Path (or Delaware River Path), and Wyoming-Minisink Trail leading to and from the district.

Photo: Jim Davis

Expansion into the Middle Delaware Valley between 1650 and 1750 by Dutch and English settlers gave rise to construction along the river of the oldest commercial roadways in the northeast, a portion of which is preserved as the Old Mine Road Historic District. Established about 1650 and converted to a wagon road in the 1730s, the 104-mile-long Old Mine Road connected Esopus (Kingston, NY) on the Hudson River with the Pahaquarry Coppermine along the Middle Delaware River. Lying along the road, the Ennis House and Westbrook-Bell House are the oldest standing structures in Sussex County, New Jersey. Both date to the early 1700s. Several additional houses along the route (Abraham Van Campen, Alonso DePue, Smith-Roe) are nearly as old and contribute to both the cultural and historic landscape of the river valley. Landscapes of the colonial past can be seen scattered throughout the Middle Delaware River Valley. During the French and Indian War, settlers constructed approximately 20 forts at strategic crossing points along the river, as well as Military Road, which operated as a military supply route originating in Elizabeth (Elizabeth Town), New Jersey, and terminating at the Van Campen Inn, within view of the Delaware River. Military Road has been preserved as a hiking trail. In 1763, the stout walls of Van Campen Inn served as a shelter for 150 settlers against the threat of Indian attack. Military Road and Van Campen Inn continued to be important sites in the region during the

American Revolutionary War, serving as a supply route and a rest stop and quarters for travelers and officers, respectively.

European settlers initiated timber harvesting and rafting in the 1760s, which contributed to the development of Milford, Shawnee-on-Delaware, and Delaware Water Gap, Pennsylvania. Portions of all three are now protected as listed NHL districts. Ferry service occurred at various points along the Middle Delaware River to transport travelers and supplies. Dingmans Ferry operated from 1735 and was temporarily replaced by three different wooden bridges at the site from 1836 through 1860. These wooden bridges were short-lived, succumbing to floods or high wind events. The historic Dingmans Choice Bridge was built near the 1900 ferry location and is the last privately owned toll bridge extant in the region. The many streams and waterfalls that flow into the Middle Delaware provided ample hydro-electric power to supply saw mills, grist mills, woolen mills, ice plants, and electrical power generators. Remains of some of these mills can be seen today along many of the creeks, including the Metz Ice Plant on Sawkill Creek and the woolen mill ruins on Dingmans Creek within the historic George W. Childs Park site.

From the mid-19th through the early 20th centuries, the Middle Delaware region was known as a river-based resort destination. Dozens of hotels served thousands of summer visitors. The Kittatinny Hotel was constructed in 1832 and was the first of the resort hotels at Delaware Water Gap, along what is now Pennsylvania State Route 611. By the end of the Civil War, the hotel could accommodate more than 250 vacationers. The Kittatinny Hotel was destroyed by fire in 1931; however, today's visitors can explore the site ruins and enjoy the views from Resort Point Overlook in the Gap. The privately owned and operated Shawnee Inn and Golf Resort on the shores of the Middle Delaware remains an example of the popular river resorts still in operation. These early hotels led to the year-round weekend resorts in the Pocono Mountains. Camps and summer cabins were also prevalent along the river valley throughout the 20th century. Many of these camps are now public NPS-operated recreation sites such as Poxono Access, Smithfield Beach, and Bushkill Access.

Following a devastating flood in 1955, the U.S. Army Corps of Engineers proposed the Tocks Island Dam project for the Middle Delaware River beginning in 1960. The Tocks Island Dam would have created a reservoir about 40 miles long and a mile wide. The locally based environmental effort that evolved to halt dam planning and construction is an early example of the effectiveness of the emerging environmental movement. This local movement, along with geological limitations and project budget concerns, eventually caused dam construction to be postponed and eventually the project was de-authorized by Congress. In its stead, the Delaware Water National Recreation Area preserves the river valley and its rich cultural history. Congressional designation of the Middle Delaware National Scenic and Recreational River in 1978 helped to support this river's free-flowing condition. The Tocks Island Dam project was officially decommissioned in 1992.

ECOLOGICAL

The Middle Delaware National Scenic and Recreational River is a vital component of and contributes substantially to the exceptional ecological integrity of the Delaware River system among the large rivers of the mid-Atlantic and northeastern United States. Like the Upper Delaware River, this section of the Delaware flows through the Appalachian Plateau and Ridge and Valley geological provinces, but has a lower gradient and more expansive floodplain. A combination of exceptionally high water quality, fully functioning floodplains, excellent aquatic and riparian habitats, and the absence of dams on the mainstem gives rise to a diverse array of species and a productive, complex food web with strong ecological integrity.

The exceptional productivity and ecological integrity of the Middle Delaware River extends from aquatic plants, invertebrates, and fish, to aquatic and riparian mammals and birds. At least 25 native species of aquatic vascular plants inhabit this section of the river and commonly occur in large beds. Threadfoot riverweed, which is intolerant of pollution, occurs in large patches in swift moving water stretches. The diverse aquatic insect assemblage includes a high proportion of pollution-intolerant stoneflies, mayflies, and caddisflies. This section of the Delaware River also supports a high density and eight native species of mussels, including the state-endangered brook floater and state-threatened yellow lampmussel. At least 36 native species of fish also inhabit the Middle Delaware River, from the humble eastern mudminnow to the mighty striped bass. As an integral part of the entire Delaware River system, this section of the river provides a migration corridor, critical habitat, and a stronghold for native migratory (diadromous) fish species like American shad and American eel, which have been in decline in other parts of their range. In addition, the high quality water of the mainstem river provides additional beneficial habitat and a movement corridor for fish species that primarily inhabit tributaries such as native brook trout, naturalized brown and rainbow trout, and other species.

Photo: Dan Smith

The river corridor supports a variety of healthy and extraordinary plant communities and wildlife. Calcareous bedrock outcrops along the river edge support two globally imperiled plant communities. Patches of globally vulnerable Riverside Prairie Grasslands occur on islands and river shores. Floodplain terraces support globally rare plant communities such as the Bitternut Hickory Lowland Forest and Sugar Maple Floodplain Forest. Forests of sycamore and silver maple predominate along the river's edge, while mixed native hardwood, eastern hemlock, and white pine forests extend along the uplands of the river corridor.

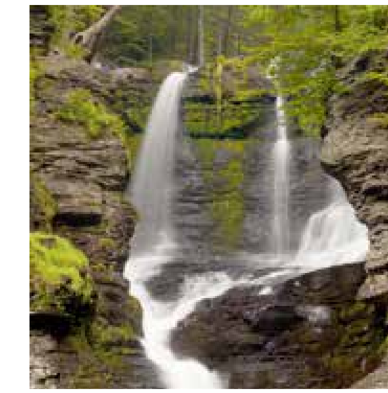
Photo: Jim Davis

> The integrity, diversity, and productivity of aquatic and riparian communities culminates in thriving populations of water-dependent mammals like river otter, beaver, and mink; and birds like common mergansers, green and blue herons, belted kingfishers, rough-winged swallows, cerulean warblers, and ospreys.

The Middle Delaware also provides high quality wintering, foraging, and nesting habitat for bald eagles and serves as a migratory bird stopover along the Atlantic flyway. Also, peregrine falcons have re-occupied historic nesting habitat on the river-formed cliffs of the Delaware Water Gap.

GEOLOGICAL

The Middle Delaware National Scenic and Recreational River follows the boundary between two physiographic regions—the Appalachian Plateau and the Ridge and Valley. The river then dramatically cuts across the Appalachian Ridge at Delaware Water Gap, a signature geologic feature along the Delaware River system. The elevation of the valley varies from 300 to 400 feet above sea level and the adjacent highlands rise an additional 600 to 1,000 feet.



In the northern two-thirds of the Middle Delaware, the river flows along the eastern edge of the Pocono Plateau, sharply defined on the west by nearly vertical cliffs composed of Mahantango shale. Waterfalls are a frequent feature as tributary streams drop onto the broad floodplain below. Raymondskill Falls is the tallest waterfall in Pennsylvania at 180 feet. Other scenic waterfalls include Hackers Falls, Adams Falls, Dingmans Falls, Indian Ladders Falls, and Tumbling Waters.

The southern one-third of the Middle Delaware River has a more complex geology. At Bushkill, Pennsylvania, the river swings away from the Poconos and flows through older, more steeply dipping Devonian Buttermilk Falls Limestone. Here the Delaware cuts across a hogback and creates a graceful S-shaped loop known as the Walpack Bend.

> A large rock formation along this section of river is known as Indian Rock, an outcrop diving into the river, where the water is up to 50 feet deep. The area also has doubly plunging folds that form complex outcrop patterns along the shoreline, such as the Five Loaves that look like multiple loaves of bread.

Many fossil localities within the park are represented within these strata. Downstream from Walpack Bend, the river cuts through a zone of weakness in the Shawangunk Formation of Kittatinny Mountain to form the dramatic Delaware Water Gap. Here, the valley is 1,000 feet wide at river level, flaring to 4,000 feet wide at mountain summits. The Delaware Water Gap was designated an Outstanding Scenic and Geologic Feature by the Pennsylvania Geological Survey.

The Middle Delaware River contains a diversity of channel types, alternating between braids to riffle/pools to deep runs and glides and backwater channels surrounding islands. Alluvial fans occur at the mouths of tributaries with the most prominent examples being at Bushkill Creek and Brodhead Creek. A number of islands in the river, ranging in size from one acre to several hundred acres, are composed of alluvial sand and gravel deposits. Named islands include Mashipacong, Minisink, Namanock, Depew, Poxono, Tocks, Depue, Shawnee, Schellenberger, and Arrow. The habitat complexity surrounding these islands supports a wide diversity of mussels, fish, and other aquatic organisms. All along the Middle Delaware River geologically formed microhabitats are found, including calcareous outcrops that support rare plant communities and exposed glacial striations.

RECREATIONAL

Close proximity to major metropolitan areas encourages first-time adventurers and life-long nature enthusiasts to enjoy the Middle Delaware and the remote natural experiences along the largely undeveloped river shoreline. The Middle Delaware is teeming with a wide variety of outstanding natural and cultural features, which make sightseeing a principal recreational pursuit. Views are framed by Kittitinny Ridge and the sheer cliffs of Pocono Plateau. While the forested mountainsides are interspersed with open grasslands and agricultural fields along the floodplain. From Mashipacong Island, south through Walpack Bend, the river visitor is immersed in striking scenery and nearly quiet solitude. Dramatic cliffs of the Delaware Water Gap can be experienced from multiple vantage points by automobile, foot, bicycle, and boat. Exemplary wildlife viewing and birding are found everywhere throughout the river corridor. Recreationists may be joined by black bears ambling along the riverbank and bald eagles soaring overhead in search of prey.

> The Middle Delaware River is surrounded almost completely by the Delaware Water Gap National Recreation Area, providing access to the corridor for a wide variety of quality year-round recreational opportunities.

Developed boat launches and swim beaches along both sides of the river, such as Milford Beach, Dingmans Ferry Access Launch, Bushkill Access Launch, Turtle Beach, and Smithfield Beach, provide amenities such as bathrooms, paved boat launches, canoe launches, and lifeguarded swim beaches along the Middle Delaware River corridor. Less developed canoe access points include Eshback, Namanock, and Poxono. Several other primitive carry-in locations are interspersed between developed launches, providing access approximately every 3 to 5 miles. Foot access can occur anywhere along the river within the recreation area. Ease of access and relatively calm waters of the Middle Delaware River provides boating opportunities for all levels—trips range from a few hours to multiple days. Approximately 65 primitive river campsites along the entire stretch of the Middle Delaware segment are free to the public on a first-come, first-served basis, providing a unique camping experience along the river. Group sites and developed campgrounds such as Dingmans Campground, Valley View Group Campground, and River Bend Group Campground provide opportunities for large groups and families to recreate along the river with some amenities such as potable water and restrooms. Easy access is enhanced by commercial canoe outfitters providing a variety of boating trips, including transportation between access points and in some cases guided overnight canoe trips. Alternative transportation buses, operated by the Monroe County Transportation Authority in partnership with the National Park Service, travel to stops along River Road and U.S. 209 on the Pennsylvania side of the river corridor on summer season weekends, making one-way biking, hiking, and boating trips feasible and trouble-free for recreationists.

Other recreational activities such as small and big game hunting, fishing, bird-watching, wildlife viewing, swimming, photography, scenic touring, hiking, biking, and cross-country skiing are popular along the river corridor. Excellent hiking and cross-country skiing experiences on the ridgetops and river valley occur along the Appalachian National Scenic Trail, the McDade Recreation Trail, Cliff Park trails, and the Red Dot Trail. Short hikes along developed boardwalks and primitive trails lead through hemlock covered ravines to the many waterfalls such as Dingmans Falls, Raymondskill Falls, and Tumbling Waters. Scenic driving is available along the river on Old Mine Road/615, River Road, and U.S. Route 209, with seasonal variations drawing visitors year-round. Old Mine Road affords road cyclists an opportunity to ride the length of the Middle Delaware National Scenic and Recreational River and is recommended by New Jersey Department of Transportation as a cycle touring route as well as being a segment of Adventure Cycling Association's Atlantic Coast Route from Maine to Florida. State Highway 611 and Interstate 80 provide unique views as visitors travel through the majestic Delaware Water Gap formation.

SCENIC

The Middle Delaware River is framed by the mountains of the Kittitinny Ridge (New Jersey) and the cliffs of Pocono Plateau (Pennsylvania). From Mashipacong Island south to Walpack Bend, the river visitor is immersed in the striking river valley scenery. The visitor sees a diversity of primarily natural landscapes interspersed with cultural resources ranging from steep forested slopes to the broader floodplain valley, with dramatic bends in the river, culminating at the iconic Delaware Water Gap. The wooded shoreline is punctuated by unique rock formations such as the Five Loaves in Walpack Bend and Godfrey Ridge through which the river bends. Other notable rock features line the banks of the Middle Delaware and include Shad Rocks, Hibachi Rocks, and the Limestone outcrops near the Dingmans Choice Bridge.

Trails traversing the surrounding cliffs and ridgelines provide panoramic vistas of the river. Ridgetop trails include Appalachian National Scenic Trail along Kittatinny Ridge and Cliff Park trails along Milford Cliffs. Mountaintop views from Mount Minsi and Mount Tammany at the climax of the geological wonder, the Delaware Water Gap, provide vivid pictures of the opposite mountain and the river far below. Scenic roadways and trails paralleling both sides of the river wind through the diverse floodplain that includes woodlands, tributary crossings, hemlock ravines, grassland, and agricultural fields. The adjoining landscape includes steep hemlock and rhododendron lined ravines. The many tributaries often include views of unique and dramatic waterfalls. Glimpses of the long human history of the river valley, including Dingmans Choice Bridge, Coppermine and Shawnee Inns, and the historic Old Mine Road, provide visual contrast to the natural backdrop. The Middle Delaware segment is the least developed of the Delaware River valley, and is within the Delaware Water Gap National Recreation Area. Dark night skies are prevalent.

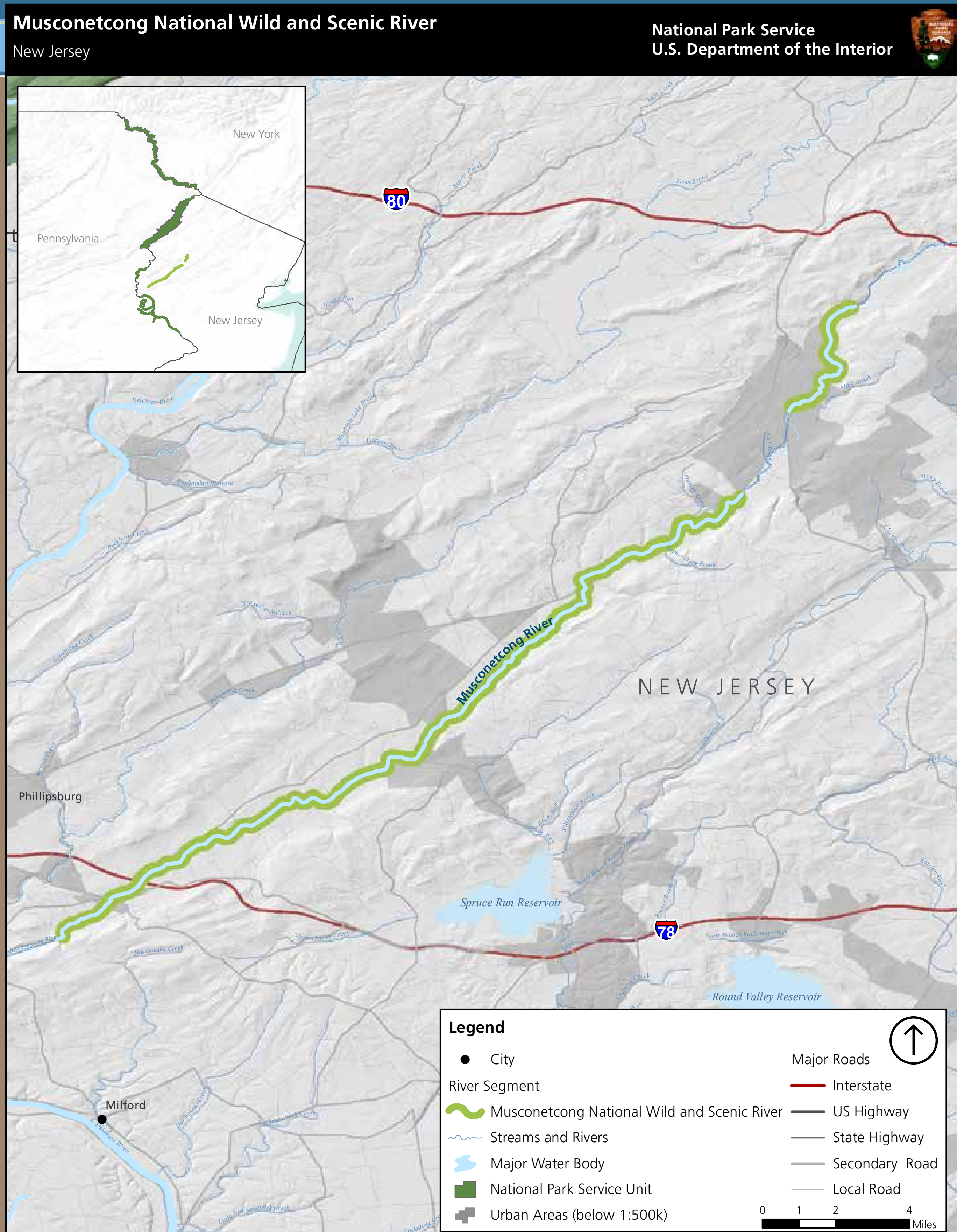
The nuances of the changing seasons such as spring wildflowers, summer greenery, fall foliage, and winter fog and ice provide a striking backdrop for river corridor visitors.

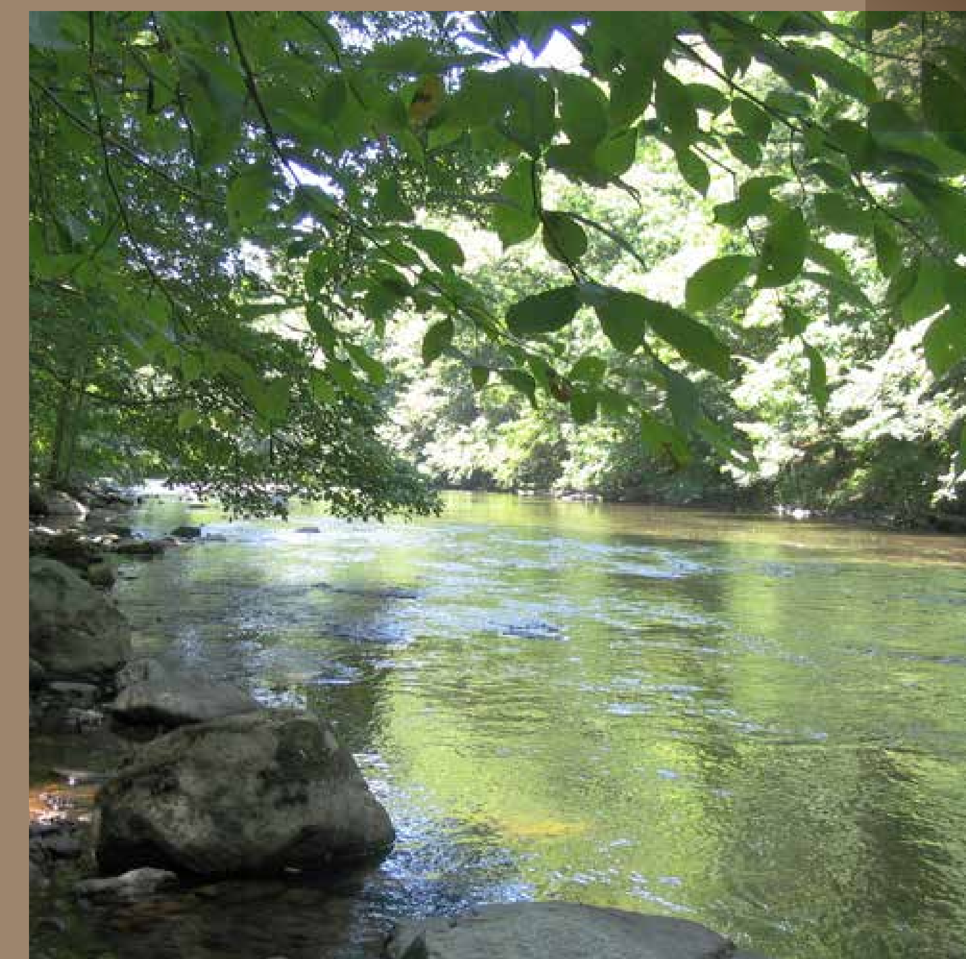
> The river channel variations of riffles, eddies, pools, rapids, and distinct changes in channel direction transform the scenery around every bend of the river.

Large islands such as Minisink, Mashipacong, and Shawnee Islands in addition to numerous smaller islands with diverse vegetation, cobblestone shorelines, bedrock formations, and channel riffles add to the visual diversity.

MUSCONETCONG

NATIONAL WILD AND SCENIC RIVER





MUSCONETCONG NATIONAL WILD AND SCENIC RIVER

The outstandingly remarkable values that make the Musconetcong National Wild and Scenic River worthy of protection under the Wild and Scenic Rivers Act are described on the following pages.

CULTURAL

> Human settlement in the Musconetcong River corridor has been traced back 12,000 years during the Paleo-Indian occupation of the area and the retreat of the Wisconsin glacier. Evidence of human habitation has been found at the Plenge site, along the lower Musconetcong River corridor. This site was one of only two major Paleo-Indian archeological site excavations in New Jersey and is considered to be one of the most important in the northeastern United States.

Subsistence agriculture took root in the lower Musconetcong valley at the dawn of the 18th century. The fertile limestone valley was rapidly cleared for cropland—subsistence agriculture gradually evolved into commercial grain and dairy farming. Villages sprang up around the many grist mills and iron forges built along the Musconetcong River. Outstanding historic features can be found in the river-related villages of Stanhope Borough, Waterloo Village, Asbury, and Finesville, and many others. Many of the features of these villages are listed in the National Register of Historic Places.

Colonists constructed dams beginning in the 1750s to power the engines of commerce, creating economic activity that contributed to the prosperity of settlements along the river. The Morris Canal, constructed in the 1840s, intersected the river at Saxton Falls, accelerating the growth of industry in northeastern New Jersey and giving rise to employment in the large coastal cities. The canal is a National Historic Landmark. At least 18 designated and eligible historic sites and districts associated with the river enhance the historic character of the designated segment of the Musconetcong. Beginning in the early 18th century and continuing today, paper mills harnessed the river's power and flushed processed effluent downstream into the Delaware.

ECOLOGICAL

The natural conditions and characteristics of the Musconetcong River maintain the integrity and health of the river's ecological community.

> The Musconetcong supports a sustainable population of the native eastern brook trout (including a possible heritage population of native trout) and exceptional spawning areas for this native trout species. The river also supports large populations of sensitive insect species such as stoneflies and mayflies.

The Independence and Allamuchy segments of the river contain the federally endangered dwarf wedgemussel, the federally threatened bog turtle, the state threatened barred owl and the state critically imperiled brook floater, a freshwater mussel that requires a rocky and gravelly riverbed. The river's segment B, which stretches from Washington and Mansfield townships downstream to Franklin and Bethlehem townships, contains the federally endangered Indiana bat, the federally threatened bog turtle, the American burying beetle, the American eel (federal evaluation species), and bald eagles (federally protected). Various state listed species in this segment include the fleshy hawthorn (state endangered), and the state threatened wood turtle and Cooper's hawk. The river's eligible segment C, which stretches from Pohatcong and Holland townships to the confluence of the Delaware River, contains the Alpha Grasslands, which is listed as a Natural Heritage Priority Site.

In addition, the Musconetcong River provides good osprey foraging habitat and contributes to the Delaware basin's role as a migratory bird stopover along the Atlantic flyway. The Musconetcong River corridor also provides wintering and foraging habitat for bald eagles and contains one active eagle's nest.

These ecological values can be attributed to the river's intact hydrologic connectivity to the adjacent floodplains and groundwater aquifer. The presence of limestone karst topography and connection to the aquifer support in-channel conditions and habitat. Above Hackettstown and Mansfield townships, the river generally has very good water quality consisting of cold, clear waters. The river is readily connected to its floodplain, with only limited obstructions along the corridor, which helps sustain quality riparian habitat.

Several dams on the river and areas of development (such as in Hackettstown and Mansfield townships) fragment the river's hydrological sources and riparian habitat and are minor sources of water pollution. The dams do not allow passage of native migratory fish up the Musconetcong, which also prevents ecological processes and aquatic habitat values associated with fish migration from occurring in the river. In addition, the artificial stocking of large quantities of nonnative trout in the river diminishes conditions for native species and processes. Nonetheless, lower stretches of the Musconetcong have direct access to the Lower Delaware River and provide some habitat for native migratory fish. Also, the Musconetcong is the most active dam-removal river in New Jersey, with four dams being removed since June 2008 (seven remain, including the sizeable Warren Glenn Dam). If more dams are removed, then it may be possible for migratory fish to return to the river and benefit the overall ecological integrity of the river.

GEOLOGICAL

The bedrock geology of the Musconetcong watershed has ridges paralleling the river valley and consists primarily of Precambrian metamorphic rocks that contain crystalline gneiss and granites, schist, quartzite, and occasional igneous intrusions. These rocks are not as erodible as the ones found in the river valley. Sedimentary carbonate and shale rocks of Cambrian and Ordovician age underlay the river valley floor from the vicinity of Hackettstown down to Rieglesville. This type of bedrock geology is typical of the New Jersey Highlands.

> The terminal moraine of the Wisconsinan Glacier, featured in the upper portion of the Musconetcong watershed, marks the southernmost extent of the most recent ice age glacial period. The geological features of the upper river valley include extensive areas of glacial till, moraines, and stratified drift deposits.

South of the terminal moraine, glacial deposits from earlier ice sheets exist in scattered deposits. Also, gravel outwash from the Wisconsin terminal moraine is found in narrow, intermittent belts the length of the Musconetcong River valley down to the Delaware River confluence.

Photo: Trout Unlimited

Farther downstream, the geology is dominated by limestone bedrock formations known as karst. Limestone bedrock within the river corridor is highly soluble compared to other types of bedrock. The dissolving limestone bedrock causes sinkholes, depressions, caves, solution channels, and irregular bedrock surfaces. Karst provides continuous base flows and cool water, making it ideal trout habitat, but highly susceptible to contamination.

The lower portion of the Musconetcong changes dramatically as it cuts through shale to form a deep, narrow gorge. Below the gorge, the river channel is dominated by shale ledges, boulders, and steep gradients before leveling out as it traverses the Delaware River floodplain.

Photo: Trout Unlimited

RECREATIONAL

The Musconetcong River provides abundant access to a wide variety of recreational opportunities in America's most densely populated region.

> While fishing, birding, camping, and hunting are the most popular riverwide activities, the Musconetcong offers outstanding passive recreational opportunities such as birding, wildlife viewing, and photography.

From Saxton Falls to the Route 46 bridge, the river is flanked by relatively undeveloped shoreline. Allamuchy and Stephens state parks offer visitors an outstanding natural experience, fishing and boating access, and serve as an important put-in for the renowned Musconetcong Water Trail. The river's section A provides visitors with a relative sense of solitude, as the river is surrounded by state parks with only limited shoreline development.

The Musconetcong Water Trail, a state designated and regionally significant water trail, offers paddlers opportunities to paddle through the varied landscapes of the Musconetcong River. The trail flows among the eight state wildlife management areas found between the Miller Farmstead and Stone Bridge, to the North Bloomsbury Historic District. Interspersed among these historic and wildlife management areas are additional stretches of river that offer nature experiences with lesser-developed shorelines.

Photo: Trout Unlimited

From the Route 46 bridge to Bloomsbury, opportunities exist for a variety of recreational activities on the river. The variety of recreational opportunities is augmented by numerous river access points, particularly in the river's segment B. This segment of river, bolstered by trout production streams, also provides anglers with outstanding opportunities to pursue a variety of trout species.

Hiking is also a popular activity on the trail networks found at Point and Schooley's mountains. The trail networks on the Hunterdon and Warren County sides of the river lead hikers to outstanding areas for viewing the river valley and beyond.

Photo: Musconetcong Watershed Assoc.

Birdwatching along the Musconetcong is also a popular activity, especially at Merrill's Creek and Point Mountain overlook where visitors can observe the state-endangered barred owl. Visitors are also drawn to the Musconetcong for its scenery, especially between Franklin and Bethlehem townships, and the historic hamlet of Asbury, where the views are particularly dramatic.

SCENIC

The Musconetcong River valley features memorable scenes of family farms, secluded natural areas, and cozy hamlets. Prominent ridges paralleling both sides of the river unmistakably define the valley landscape, playing a major role in determining its regionally exemplary visual character. Scenic diversity ranges from intimate views of the river and its immediate surroundings to sweeping vistas of the river valley from mountaintop overlooks and glimpses of the river and adjacent landscape from the Warren Heritage Byway.

Segment A: Saxton Falls to the Route 46 Bridge

The thickly forested hills of Allamuchy Mountain and Stephens state parks tightly hug the Musconetcong River, giving the northern end of this segment its remote feeling. Protecting more than 2,500 acres of open space, these parks offer views of a variety of habitats supporting critical wildlife. Remnants of Lock 5, the prism and towpath of the Morris Canal are reminders of the river's function as a water source for this world renowned transportation corridor. Approaching Hackettstown, the mountain ranges drop in elevation and back away from the river's edge, opening up views of this urban community.

Segment B: Washington and Mansfield Townships to Franklin and Bethlehem Townships

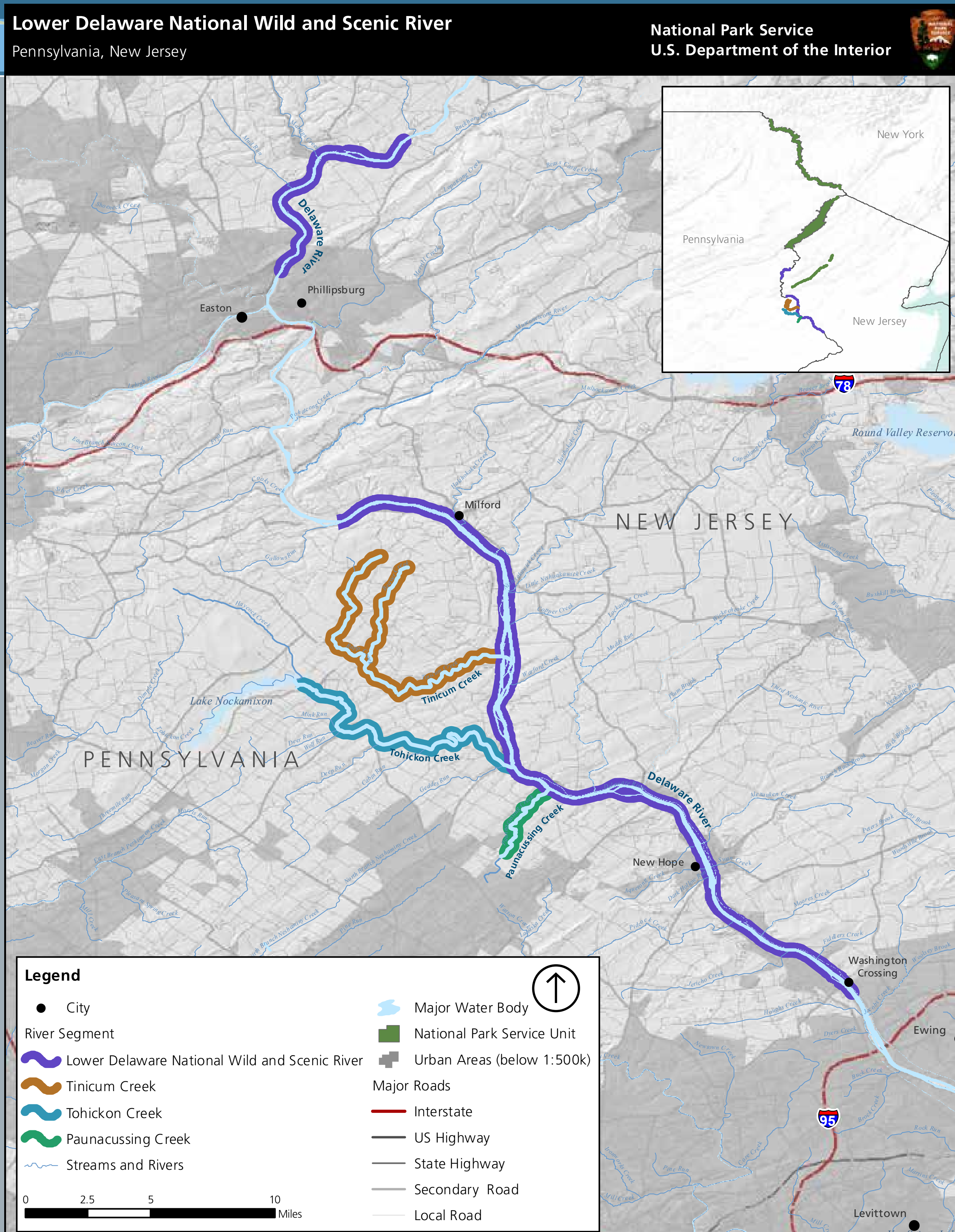
Alternating scenes of headwater tributaries, farmland, forests, and rural hamlets characterize this visually attractive segment. This pastoral cultural landscape is symbolic of the aesthetics of the Musconetcong watershed. Views of seven state wildlife management areas are interspersed with a variety of historically significant human-made features, such as: grist and graphite mills, lime kilns, a triple stone arch bridge, a steel Pony Pratt truss bridge, and a preserved farm complex, complete with main and tenant housing, overshot bank barn, wagon house, and stone-walled family cemetery.

> Riverfront villages contain numerous examples of 18th and 19th century residential, institutional, and commercial architecture found in the area's earliest settlements.

Photo: Musconetcong Watershed Assoc.

LOWER

DELAWARE NATIONAL WILD AND SCENIC RIVER



LOWER DELAWARE NATIONAL WILD AND SCENIC RIVER
(INCLUDING TINICUM CREEK, TOHICKON CREEK, AND PAUNACUSSING CREEK)

The outstandingly remarkable values that make the Lower Delaware National Wild and Scenic River worthy of protection under the Wild and Scenic Rivers Act are described on the following pages.

CULTURAL

Lower Delaware River (including Tinicum Creek, Tohickon Creek,and Paunacussing Creek)

The Lower Delaware River, including Tinicum, Paunacussing, and Tohickon creeks, contains historic resources of national significance; it is a microcosm of American history. Sites along the Lower Delaware River and its tributaries indicate early American Indian use of the river for habitation. These include the Del Haven Paleo-Indian site, a rock shelter along Tinicum Creek, and sites at Sandts Eddy, Hendrick Island, and Padula. Tinicum Creek was the origin point of Thomas Penn's Walking Purchase of 1737, which includes areas on all three Delaware segments.


Photo: D&L NHC

> The southern terminus of the Lower Delaware segment includes the Washington Crossing historic site. Now a state park on both sides of the river, it is the location of the Revolutionary War commander's famed crossing of the Delaware River on Christmas Day 1776, to surprise the British at Trenton.

By the 1830s, the demand for bulk commodity transport led to construction of canals. The canal systems along both sides of the river, including the Delaware Canal, and Delaware and Raritan Canal, helped to fuel the industrial revolution by moving coal and other goods to urban centers. These are unique examples of canals in the northeast such as the Delaware Canal National Historic Landmark. The W&SR-designated section of the Lower Delaware River includes portions of the Delaware and Lehigh Navigational Canal National Heritage Corridor, designated in 1988. The length of this segment is dotted with historic sites associated with river crossings, railroads, and the canal system, including the Uhlerstown, Lumberville, Point Pleasant, Centre Bridge, and New Hope districts. New Hope is significant not only for its association with the Delaware Canal, but also because artists residing and working there and in the vicinity formed the nucleus of the New Hope school of painting, the first truly American expression of Impressionism. The Delaware River and Tinicum, Tohickon, and Paunacussing creeks were popular subjects.

On the New Jersey side, the Delaware and Raritan canal stops included the Stockton-Prallsville Mills and Lambertville historic districts. Fourteen bridges have served historically as important economic and cultural lifelines between communities of the two states.

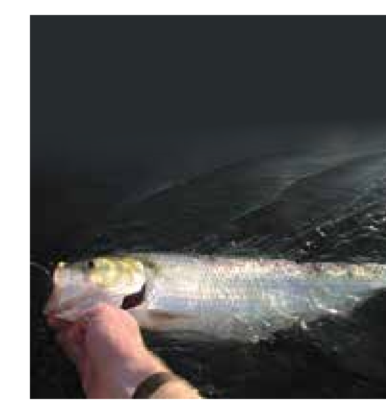
ECOLOGICAL

Lower Delaware River

The Lower Delaware River segment provides the transition through the Ridge and Valley, New England, and Piedmont provinces and encompasses many transition zones for the Delaware River. The sections above the Lehigh River retain many of the ecological qualities in the Upper and Middle Delaware River segments, with high water quality, diverse assemblages of aquatic and riparian species including freshwater mussels, and strong ecological integrity throughout the food web. Below the Lehigh River, water quality and ecological integrity both shift to a lesser status while still maintaining large components of the key riparian and in-stream habitats. Compared to upstream reaches, this reach has higher nutrient concentrations and is warm, with very long pools and fewer riffles. Island habitats are also common and significant for their numbers, acreages, and diversity of species. Among the key ecological players are at least five species of freshwater mussels, including the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*) and the yellow lampmussel (*Lampsilis cariosa*), a federal species of concern. The Lower Delaware supports areas of natural riparian corridors and their characteristic flora and fauna, and a diverse assemblage of native warm water fish, such as walleye (*Sander vitreus*), smallmouth bass (*Micropterus dolomieu*), striped bass (*Morone saxitilis*), perch (*Perca* spp.), and white suckers (*Catostomus commersonii*). Critical to the Lower Delaware River's status in the segment below the Lehigh is the primary spawning ground for the Delaware basin's federally endangered shortnose sturgeon (*Acipenser brevirostrum*) population, which occurs in the zone below the Lambertville-New Hope pool and wing dam.


Photo: D&L NHC

> A unifying feature throughout the full extent of the Lower Delaware River is the broad and complete assemblage of migratory fish, from sea lamprey (*Petromyzon marinus*) to American shad (*Alosa sapidissima*) to multiple river herring species.



These migratory fish contribute directly to the ecological integrity of this river segment by maintaining the transfer of nutrients, energy, and biomass to and from the ocean. In addition, the unobstructed connectivity for migratory fish through the Lower Delaware River up through the Middle Delaware, the Upper Delaware, and into the mountainous headwaters underscores the Lower Delaware's vital contribution to the ecological health and value of the entire region.

The Lower Delaware's important position along the Atlantic flyway is evident in supporting foraging and breeding habitat for rare water-dependent bird species. These include the least bittern (*Ixobrychus exilis*), a threatened species in Pennsylvania, Louisiana waterthrush (*Parkesia motacilla*), and cerulean warbler (*Setophaga cerulean*), a federally listed species of concern. Cliff swallows (*Petrochelidon pyrrhonota*), a threatened species in New Jersey, nest in colonies underneath several Lower Delaware bridges. Rare reptile species are associated with wetland habitats along the Lower Delaware corridor—these species include the federally threatened bog turtle (*Clemmys* *muhlenbergii*) and the wood turtle (*Glyptemys insculpta*), a threatened species in New Jersey.

Tinicum Creek

Tinicum Creek possesses aquatic and riparian habitat values that support a relatively intact natural community. The exceptional quality of wildlife and plant habitat has resulted in the U.S. Department of Agriculture (USDA) Forest Service designation of Tinicum Creek and a tributary, Rapp Creek, as a "critical treasure" within the Highlands region.

> Tinicum Creek supports an array of diverse plant communities, significant numbers of rare plant and animal species, creek-inhabiting amphibians, and more than 70 bird species—13 of which are rare or of special concern.

Forests dotted with the pineland pimpernel (*Samolus parvifloris*), a state endangered plant, flank the Rapp Creek watershed.

The creek has good hard-bottom aquatic habitat with limited fine sediment deposition that creates conditions for a good representation of native warm water aquatic species. The creek has no federally listed species, but does support a variety of state listed species, including the yellow lampmussel (*Lampsilis cariosa*) (threatened in New Jersey) near the creek's mouth, the redbelly turtle (*Chrysemys rubriventris*) (threatened in Pennsylvania), the osprey *(Pandion haliaetus*) (threatened in Pennsylvania), and wetland/riparian plants such as small beggar-ticks (*Bidens discoidea*) (endangered in Pennsylvania) and pineland pimpernel (species of concern in Pennsylvania). At least nine species of salamanders, seven species of frogs and toads, and six species of turtles can be found here. Tinicum Creek also provides a moderate level of access and habitat for a subset of the migratory fish assemblage in the Delaware River basin. The riparian habitat quality is generally very good, with some fragmentation due to interspersed human uses along the corridor.

Photo: D Bales MD Dept of Natural Resources

This segment has unique and some good quality ecological values on a local or statewide scale. However, overall, the ecological values of this segment do not possess rare, unique, or exemplary qualities. Therefore, Tinicum Creek does not qualify as an ecological ORV.

Tohickon Creek

Similar to Tinicum Creek, Tohickon Creek watershed is designated a critical treasure within the Pennsylvania portion of the Highlands by the USDA Forest Service. The Tohickon Creek watershed sustains hundreds of species of mammals, birds, reptiles, amphibians, and invertebrates. Many of these are species of concern or considered rare or threatened, such as the eastern small-footed bat (*Myotis leibii*), which is threatened in Pennsylvania and a candidate for federal listing, and the cerulean warbler, a federal species of concern. Tohickon Creek's riparian habitat and ecological communities are relatively intact and support a good representation of native riparian and warm water aquatic species, including the yellow lampmussel (threatened in New Jersey), eastern floater (*Pyganodon cataracta*) (species of concern in Pennsylvania), and threadfoot riverweed (*Podostemum ceratophyllum*) (threatened in New York). A dam exists at the upper end of the designated reach, which alters some of the natural ecological and hydrologic processes

of the creek; however, the 4.5-mile section through Ralph Stover State Park and Tohickon Valley Park is ecologically intact and has excellent water quality. This section drops some 160 feet to produce a high-gradient stream that supports a variety of aquatic life. The threadfoot riverweed, a freshwater sponge, coats rocks and submerged sticks. Freshwater mussels inhabit areas of the creek where a suitable sandy or gravelly substrate is present. Tohickon Creek overall has good hard-bottom aquatic habitats with limited fine sediment deposition. The creek is representative of good water quality for this stream type. Riparian habitat quality is also good, with minor fragmentation due to interspersed human uses along the corridor.

> The wooded wetlands and streams of Tohickon Creek provide habitats for at least 20 species of salamanders, frogs, and turtles, including the northern cricket frog *(Acris crepitans)*, listed as endangered in Pennsylvania, and Fowler's toad (Anaxyrus fowleri), a Pennsylvania species of concern.

Photo: Ralph Stover

Tohickon Creek provides relatively limited access for a subset of migratory fish, such as the American eel, in the Delaware basin due to its relatively small size. However, the creek does support populations of at least 24 fish species, a good indicator of stream health and water quality. In addition, Tohickon Creek is designated as a cold-water fishery in Pennsylvania. Fish species include creek chub (*Semotilus atromaculatus*), white sucker, blacknose dace (*Rhinichthys atratulus*), longnose dace (*Rhinichthys cataractae*), fallfish (*Semotilus corporalis*), bluegill (*Lepomis macrochirus*), smallmouth and largemouth bass (*Micropterus dolomieu* and *salmoides*, respectively), and redfin pickerel (*Esox americanus*).

Paunacussing Creek

Paunacussing Creek's riparian habitat and ecological communities are relatively intact, and support a good representation of native riparian and warm water aquatic species. The creek has good hard-bottom aquatic habitats with limited fine sediment deposition. The creek is representative of good water quality for this stream type. Riparian habitat quality is also good, with some fragmentation due to interspersed human uses along the corridor. Due to the creek's relatively small size, it provides only limited access for a subset of the migratory fish in the Delaware basin. Paunacussing Creek is classified as a high-quality cold-water fishery in chapter 93 of title 25 of the Pennsylvania Code, which means that water quality sufficient to support a cold-water fishery should be maintained (i.e., trout species). The creek is high-quality habitat for the brown trout and historically native brook trout. The creek also includes some state listed species, but these are noted as not necessarily rare in the region. There is a relatively high diversity of amphibian and reptile species compared to similar watersheds.

Photo: Ralph Stover

This segment has unique and some good quality ecological values on a local or statewide scale. However, overall, the ecological values of this segment do not possess rare, unique, or exemplary qualities. Therefore, Paunacussing Creek does not qualify as an ecological ORV.

GEOLOGICAL

Lower Delaware River

The Lower Delaware River is shaped by the varied geology through which it has carved its way to the Atlantic Ocean. At the northern end of the Lower Delaware River, it cuts through the folded Ridge and Valley formations created by colliding tectonic plates and the rising modern Appalachian Mountains. The hydro-geomorphology of the river is characterized by riffle/pools, deep runs, and huge glacial boulders, rapids, and ledges.

South of Riegelsville, Pennsylvania, the river enters the rolling hills of the Piedmont Province (specifically the Gettysburg-Newark Lowland section). Here, the Triassic Lowlands begin, characterized by hard Brunswick and Lockatong shales that are rich in dinosaur fossils.

> The dramatic curve in the river at Upper Black Eddy, Pennsylvania, is the result of hard diabase intrusions created when molten material pushed up into the older lakebeds and cooled—evidenced by the 300-foot dark cliffs towering above the river. The lowlands and intrusion of molten material were formed during the separation of Pangaea as the Atlantic Ocean was forming.

It is at Frenchtown, New Jersey, where river islands become prominent features, built of materials brought to the valley by ice age glaciers of the Pleistocene Epoch between 11,000 and 500,000 years ago. Just north of Stockton, New Jersey, lies a classic example of the Triassic Stockton Arkose. These are well-developed outcrops and some of the best examples visible anywhere in the Delaware Valley region.

The Devil's Tea Table is an outstanding geologic feature that is rare in the northeast region. This Triassic rock layer, perched on the Milford Bluffs, was caused by the erosion of softer sedimentary rock beneath a harder upper layer of rock, creating the "table" effect. Milford Bluffs are nearly vertical, 300-foot south-facing cliffs that expose Triassic Brunswick shale and border conglomerates. They represent the best red shale cliff community in New Jersey. On the opposite side of the river, the north-facing Nockamixon Cliffs of red shale support alpine-arctic flora that is rare in the Continental United States. The cliffs are part of a state-designated natural area within Delaware Canal State Park. The Pennsylvania Geological Survey has designated Nockamixon Cliffs as an Outstanding Scenic Geological Feature of Pennsylvania.

The Monroe Triassic Border Fault in Durham Township, Pennsylvania, is a National Natural Landmark. It is one of only a few exposed rifts in the eastern United States, most of which are buried deep beneath the continental shelf of the Atlantic Ocean. It represents an outstanding geologic feature associated with the Gettysburg-Newark Lowland section of the Piedmont.

Photo: D&L NHC

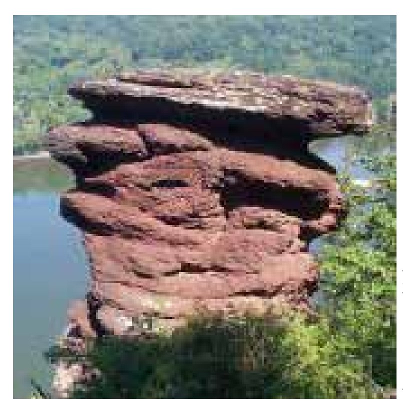


Photo: DE & Lehigh NHC

Tinicum Creek

The Tinicum Creek watershed includes an unusual combination of geologic features that express erosional, volcanic, and glacial processes. The creek lies entirely within the Triassic Lowlands of the Piedmont Physiographic Province, and the geology primarily reflects the separation of Pangaea and the formation of the Atlantic Ocean during the Mesozoic era about 200 million years ago. Sedimentary Triassic rocks in this area include the Lockatong, Brunswick, and Stockton, originating when inland valleys were filled with sediment-bearing lakes and rivers. These deposits are 4,000 to 10,000 feet thick. In the Tinicum Creek watershed, the Brunswick red shale and Lockatong argillite are the primary outcroppings.

> Among the volcanic features, Tinicum Creek has "ringing rocks." These rocks are part of an igneous intrusion of diabase dikes and sills that when struck with a hammer produce musical notes. This boulder field is listed as an Outstanding Geological Feature of Pennsylvania and is a potential National Natural Landmark.

Rapp and Beaver creeks, the designated wild and scenic tributaries to Tinicum Creek, originate in the diabase geological area. After meandering through this boulder-strewn and wet forested area, these creeks continue south and enter the Lockatong Formation, incising a valley that eventually becomes 200 feet deep. In this area

the streambed consists of a series of slightly inclined red and gray rock ledges. These ledges are so angular and square that they appear to be human-made. The rock formations result in a series of scenic low waterfalls and pools. Below the Beaver and Rapp creeks confluence with Tinicum Creek, the streambed is predominately Brunswick red shale, siltstone, and mudstone, creating a striking bedrock channel that contributes to a flashy hydrologic system. Steep, vertical cliffs are exposed along the streambed and within the Brunswick Formation.

Tohickon Creek

Tohickon Creek is entirely within the Gettysburg-Newark Lowland section of the Piedmont Physiographic Province—Lower Tohickon Creek cuts through 12 alternating bands of Triassic shales, sandstones, and argillites of the Brunswick and Lockatong formations. The result is a striking landscape of steep, forested slopes interspersed with sheer rock walls. There is a narrow band of diabase in the southeastern portion of the watershed near Point Pleasant, which is part of a larger formation that extends eastward across the Delaware River. This dense igneous rock is associated with dikes and sheets that intruded and metamorphosed the rocks. The resistance of the rock has directed the course of the streams in the area such that most of the streams and ridges in the area are parallel to the strike of the bedding rather than cutting across the beds. These vertical cliffs form a chute along the creek. Lockatong geology is responsible for the distinct pavement-like look of the creekbed in some places. There are also unusual rock formations such as Sentinel Rock. Argillite, Balcony, and Cedar Overlooks in Tohickon Valley Park provide access to these geological formations.

Paunacussing Creek

Paunacussing Creek does not contain outstandingly remarkable geologic values because it does not possess rare, unique, or exemplary geologic qualities. Despite this, the Paunacussing Creek watershed is a good example of the Northern Piedmont landscape within the Delaware River basin. The landscape is within the Newark basin portion of the Triassic Lowland Province. This broad basin is defined by its relatively "young" sedimentary shale bedrock geology (about 220 million years old)—namely the Lockatong Formation and Stockton Formation.

The Stockton and Lockatong formations are generally reddish brown sandstones, also containing conglomerates, shale and mudstone. These shales are moderately resistant to erosion and weathering. Weathering parent material from these Triassic shales directly forms the reddish brown soils that characterize the area. Near the confluence, the elevation drops 300 feet from the top of the palisade to the level of the Delaware riverbed over a relatively short distance of less than 1,000 feet.

RECREATIONAL

Lower Delaware River

The Lower Delaware River's variety of outdoor experiences is significant because of the intimate interrelationship between outdoor recreation, cultural resources, and nature. The range of active and passive recreational experiences is augmented because visitors and residents alike can access the river corridor through a wide range of travel options, including a leisurely drive along the national and state scenic byways; bicycling, hiking, and horseback riding on the extensive multiuse canal towpath trails and various hiking trails on either side of the river. Road cyclists can follow the river south along Adventure Cycling's Atlantic Coast route. In addition, entry to the river is available through numerous public access points.

There are 28 state and locally managed access points along the approximately 70 miles of the Lower Delaware mainstem between Delaware Water Gap and Washington Crossing State Park in New Jersey, including the Sandts Eddy and Frost Hollow access areas north of Easton and various access points along the Delaware Canal (Pennsylvania) and Delaware and Raritan Canal (New Jersey) state parks.

On the Pennsylvania side of the Lower Delaware, there are two state-designated scenic byways that provide access to scenic resources, parks, and recreational destinations almost the entire length of the river corridor. These include the 17-mile Delaware River Valley Scenic Byway and State Routes 32 and 611 of the Delaware River Scenic Drive, totaling 86 miles. In New Jersey, 35 miles of Route 29 is designated a national and state scenic byway—the Delaware River Scenic Byway. Paralleling these scenic byways and the river on the Pennsylvania side, is the 60-mile-long Delaware Canal system from Easton to Bristol, Pennsylvania, and on the New Jersey side the 70-mile-long Delaware and Raritan feeder canal from Frenchtown south to Trenton. The Delaware Canal and the Delaware and Raritan Canal are both designated national recreation trails. A unique part of the Delaware Canal experience is a mule-drawn canal boat ride at New Hope, Pennsylvania.

Trailheads along the Lower Delaware River provide entrée into the vast regional trails network beyond the canal towpath trail system, including the 27-mile Paulinskill Valley Trail in New Jersey, the trail system within Marble Hill Natural Area in Warren County, and trails through Washington Crossing State Park Natural Area. Together with the Delaware River Water Trail that connects all three NPS administered areas, the trails and byways offer multiple ways in which to enjoy the natural beauty of the river valley. In addition to trails, numerous public parks and recreational facilities such as Theodore Roosevelt State Park, Ralph Stover State Park, Nockamixon Lake State Park, Tohickon Valley County Park, Merrill Creek Environmental Preserve, and Giving Pond Recreation Area, to name a few, are available for outdoor activities. These parks offer environmental and history education programs, nature walks, photographic workshops, picnicking, rock climbing, camping, cross-country skiing, and wildlife observation. The parks, which encompass some of the Delaware River islands including Marshall Island, Treasure Island, and Bulls Island. The parks and islands present many options for water-related activities such as fishing, swimming, boating, and bird-watching.

Along with outdoor recreation, there are long-running cultural events that are intimately connected to the river. Annual shad festivals held in Lambertville, New Jersey, and the Forks of the Delaware River Shad Fishing Tournament in Easton, Pennsylvania, are examples of how recreation and natural resources are interconnected.

> Washington Crossing Historic Park in Pennsylvania and its counterpart, Washington Crossing State Park in New Jersey, are major tourist destinations that include the annual December re-enactment of General George Washington's crossing of the Delaware River.

The historic river towns and hamlets, such as New Hope, Lambertville, Stockton, and Frenchtown, are also unique to the region and draw visitors from throughout the tri-state area of New York, New Jersey, and Pennsylvania.

From Portland, Pennsylvania, south to Point Pleasant, Pennsylvania, several outfitters provide boat rentals and are available to organize the visitor's experience on the river, from tubing, rafting, kayaking, and canoeing to sports fishing. Various challenges are available for boaters with different levels of experience, from class I slow-moving waters suitable for beginners such as Upper Black Eddy to class II rapids like those at Foul Rift and the Lambertville wing dam for more experienced boaters.

Tinicum Creek

Access to Tinicum Creek and its tributaries is limited, public recreation facilities are few, and the area is relatively rural and undeveloped. In spite of these limiting factors, Tinicum Creek can offer diverse recreational experiences. Throughout the seasons, people visit Tinicum Creek watershed to experience the unusual geologic features, wildlife, historic villages, historic structures, and covered bridges that make the area distinctive and scenic.

Erwinna Historic District with its covered bridge is memorable for dramatic views of Swamp Creek as it zig zags over a series of stepped bedrock shelves. Frankenfield is one of the best loved and photographed covered bridges in the area. Masonry walls of the distinctive local stone form buttresses that support the wooden structure painted a deep red. The covered bridge spans a serene and still section of Tinicum Creek. The pony truss bridge over Geigel Hill Road allows views of a swiftly moving section of Tinicum Creek and historic building built into the rock ledge on one side of the creek. Tinicum Park, at the confluence with the Delaware River, is enjoyed by visitors for its expansive view framed by the river on one side and a steep mountain ridge on the other. Lush greenery contrasts with the deep reds of the historic John Stover House and the distinctive red barn, which are framed by trees. The forested cliffs and

Photo: DE & Lehigh NHC

Photo: DJ Maschek

hills lining both sides of Tinicum Creek contribute to a sense of isolation and being in a different time period. However, because of limited access and a lack of regionally rare, unique, or exemplary recreation opportunities, Tinicum Creek does not contain a recreation ORV.

Tohickon Creek

Visitors to the Tohickon valley come for the recreational opportunities, which are plentiful in the public lands lining Tohickon Creek. The alternating argillite and shale bands of the underlying geology offer striking visual contrast with the surrounding greenery and unusual rock formations such as Sentinel Rock. Recreational opportunities include fishing, rock climbing, and kayaking.

> Tohickon Creek offers some of the best kayaking opportunities in the northeast corridor. During high-flow periods and dam releases, typically quiet Tohickon Creek turns into a raging class 3 and 4 whitewater river.

Paddlers from as far away as Maine travel to Tohickon creek to paddle the stretch from Ralph Stover State Park to Point Pleasant.

Ralph Stover State Park includes 45 acres along Tohickon Creek. The park offers easy access to the creek for warm water fishing and kayaking, and easy walking paths. Adjacent to the state park is Tohickon Valley Park, 612 acres of county parkland that includes a playground, picnicking, hiking, fishing, restrooms, and both tent and cabin camping. Also contained within Tohickon Valley Park is a 200-foot rock wall known as "High Rocks." Climbers from throughout the region visit Tohickon valley for this challenging climbing experience. In addition, Stover-Myers Mill County Park offers 26 acres with picnicking, fishing, and tours of the historic mill. The park is distinguished by the early 1800s mill, which is listed in the National Register of Historic Places.

Paunacussing Creek

While Paunacussing Creek has low recreational value regionally, the scenic setting does contribute significantly to its local value. The forested cliffs and hills lining both sides of the Paunacussing below Carversville and the natural setting in many locations contribute to a sense of isolation and being in a different time period, yet it is relatively accessible from nearby canal towns through the Delaware Canal towpath trail. The clear water with its riffles and pools drops in elevation revealing large boulders, distinctive red shale outcroppings, and a wealth of historic resources, which draw visitors from around the area. From Fleecy Dale Road and Old Carversville Road along Paunacussing Creek, a visitor enjoys views of the creek with steep drops, historic farmsteads, and the hand-crafted rock features scattered along the roadways. The historic districts of Mechanicsville and Carversville include stone arch bridges and exceptional examples of period architecture. Because of these scenic features, the reputation of the Paunacussing with artists is noteworthy. However, public recreation access is nearly nonexistent due to the large tracts of privately owned land along the creek; therefore, recreation is not considered an ORV.

SCENIC

Lower Delaware River

The Lower Delaware River corridor is recognized for its unique diversity of scenic resources that are accessible by road, river, trail, and canal. Narrow roads, some of which are designated scenic byways, parallel the entire Lower Delaware River corridor. The Delaware Canal National Historic Landmark, parallels the Lower Delaware River south of Easton, while the Delaware and Raritan Canal follows the river on the New Jersey side. These linear features and their associated landscapes are narrowly framed by wooded steep slopes and cliffs and provide numerous glimpses of the river and opposite shore.

Photo: DE & Lehigh NHC

> Particularly notable are the forested islands, the renowned rock features of cliffs and falls, tumbling streams, steep ravines, and spectacular seasonal foliage. Dramatic features include, but are not limited to: Milford Bluffs, Devil's Tea Table, Tumble Falls, Nockamixon Cliffs, and Cuttalossa Falls.

The river's rapids, pools, and riffles are interspersed with numerous forested islands, including Marshall Island and Bull's Island.

Photo: DE & Lehigh NHC

Many of the historic canal towns with their associated bridges are national historic districts and complement the scenery, giving a flavor of earlier times. Notable features include, but are not limited to, Roebling suspension bridge at Riegelsville, Washington Crossing and Bridge, New Hope / Lambertville Bridge and historic districts, Uhlerstown Village and rural historic district, Frenchtown / Uhlerstown Bridge, Lumberville – Raven Rock Bridge.

Lower Delaware Tributaries (including Tinicum Creek, Tohickon Creek,and Paunacussing Creek)

The tributaries along the Lower Delaware River offer a dramatic rolling landscape of fields and woods, with north-facing slopes of hemlock. Compared to the mainstem of the Delaware, the ravines along these tributaries are notably steeper. Cliffs formed by pronounced outcrops of Stockton bedrock are accessible by narrow winding roads. The area includes high gradient rocky creeks and clear water. The valleys include a mix of smaller historic farms and villages linked by stone-arch and covered wooden bridges. This area is the focus of the New Hope School of Pennsylvania impressionistic painting. Distinctive features include Tinicum Creek's red rock outcrops and Erwinna Historic District; Tohickon Creek, including 200-foot-high sculpted cliffs at Ralph Stover State Park; Doans Cave; Cabin Run and Loux covered bridges; Tohickon Aqueduct as part of the Delaware Canal; striking alternating argillite and shale bands and unusual rock formations such as Sentinel Rock; and Paunacussing Creek – Mechanicsville and Carversville historic districts, stone arch bridges, and Township Scenic Corridor Fleecy Dale Road and Old Carversville Road.

FREE-FLOWING
CONDITION

FREE-FLOWING CONDITION

Definition of free flowing according to the Wild and Scenic Rivers Act, "...existing or flowing in a natural condition without impoundment, diversion, straightening, rip-rapping or other modification of the waterway."

The Delaware River Basin drains 12,756 square miles across the states of Pennsylvania, New York, New Jersey, and Delaware and flows unimpeded for 330 miles from Hancock, New York, to Delaware Bay. The Delaware is the longest undammed river east of the Mississippi. The headwaters contain a number of impoundments and flows are highly regulated by a 1954 U.S. Supreme Court Consent Decree between the Decree Parties of Delaware, New York, New Jersey, the Commonwealth of Pennsylvania, and New York City. Although altered to some extent in the headwaters, the undammed mainstem of the Delaware continues to provide unimpeded flows that support ecological, scenic, recreational, geologic, and cultural ORVs.

Photo: Jim Davis

Draining 0.4% of the nation's land area, the Delaware River provides drinking water for more than 16 million people—more than 5% of the U.S. population.

Regulated releases also provide a critical buffer to prevent saltwater intrusion downstream of the confluence of the Schuylkill and Delaware rivers in Philadelphia, Pennsylvania, protecting the municipal water supplies of Philadelphia and Camden, New Jersey. Four dams exist on tributaries to the Upper Delaware River (table 1), impounding water from approximately 38% of the Upper Delaware watershed. Flows in the Upper Delaware River—especially in the uppermost section—are impacted by two New York City (NYC) reservoirs: the Cannonsville Reservoir on the west branch of the Delaware and the Pepacton Reservoir on the east branch of the Delaware. Flows in the lower section of the Upper Delaware River and the upper section of the Middle Delaware River are impacted by releases from a hydroelectric generating facility (not a NYC reservoir) on the Lackawaxen River, and to a much lesser extent by releases from the Rio hydroelectric generating facility (not a NYC reservoir) on the Mongaup River. A third NYC reservoir on the Neversink River impacts flows downstream of its confluence with the Delaware River, just upstream from the Delaware Water Gap. The decree provides for the diversion of up to 800 million gallons of Middle Delaware River water per day (annual average) to the NYC metropolitan area and requires a minimum daily flow of 1,750 cfs (in nondrought conditions) at Montague, located at the northern end of the Delaware Water Gap National Recreation Area.

In recent years, New York City has diverted an average of about 650 million gallons of water per day, which is equal to about 55% of the "natural" average daily flow at the upstream boundary of the Upper Delaware River (Hancock, New York).

Since the 1954 decree, reservoir releases have been managed through a series of evolving programs based on unanimous agreement by the parties. The Flexible Flow Management Program provides the current framework for managing diversions and releases from NYC reservoirs. This program was designed by the states to support multiple flow management objectives, including water supply; drought mitigation; flood mitigation; protection of the cold tail-water fishery; a diverse array of habitat needs in the mainstem, estuary and bay; recreational goals; and salinity repulsion in the Delaware estuary. The region's annual precipitation can vary greatly from year to year, challenging the Flexible Flow Management Program. In drought years, flow formulas and release patterns from upstream reservoirs may not adequately protect river ecology.

The decree designates the U.S. Geological Survey (USGS) as the River Master to implement the provisions of the 1954 decree. In 1961, the Delaware River Basin Commission (DRBC) was created and includes a representative from each state and one from the federal government (currently the U.S. Army Corps of Engineers). The Delaware River Basin Commission is the primary management entity for the Delaware River. The commission plans and regulates water conservation and use and distribution in the basin based largely on the 1954 decree.

Table 1. Reservoirs Upstream of the Upper Delaware River

Reservoir Name	State	Tributary	River Mile at Tributary Mouth	Date of First Operation	Drainage Area (mi²)	Capacity (billions of gallons)	Main Purpose
Cannonsville	NY	West Branch Delaware River	330	Sept. 1963	454	99	Diversion to NYC
Pepacton	NY	East Branch Delaware River	330	Sept. 1954	372	150	Diversion to NYC
Lake Wallenpaupack	PA	Wallenpaupack Creek to Lackawaxen River	278	1926	228	88	Hydro-electric generation
Rio System	NY	Mongaup River (3 reservoirs)	261	Jan. 1930	116	11	Hydro-electric generation

Due to its proximity to large metropolitan centers and because of the Delaware River Compact, the Delaware River basin is well gauged. Table 2 provides a list of existing USGS gauges of the Upper Delaware.

Table 2. USGS Discharge Gauges on the Delaware River and Tributaries Upstream of / Within the Upper Delaware River

USGS Gauge Station No.	Gauge Name	River Mile	Elevation (ft)	Watershed Area (mi²)	Period of Record	Years of Record
01421000	East Branch Delaware River at Fishs Eddy	NA	956	784	1912-	99
01426500	West Branch Delaware River at Hale Eddy	NA	946	595	1912-	99
01427200	Equinunk Creek near Equinunk, PA	NA	890	56.3	1946-	66
01427207	Delaware River at Lordville	322	842	1,590	2006-	5
01427510	Delaware River at Callicoon	304	735	1,820	1975-	37
01428500	Delaware River above Lackawaxen River Near Barryville	279	600	2,020	1940-	71
01432110	Lackawaxen River at Rowland	NA	670	589	2007-	4


Photo: D&L NHC

A number of modifications to the waterway exist on the Delaware River. The following modifications exist within the Upper Delaware River.

Waterway modifications within the Upper Delaware River:

- Village of Hancock sewage treatment plant outfall; river mile 330.5
- New York State Route 97 berm, various points; river mile 258–330.5
- Pennsylvania Route 191 berm, various points; river mile 322–330.5
- New York Central (former Erie) Railroad line berm, various points along either side of river; river mile 258–330.5
- approximately 50 unimproved public, commercially owned and private accesses exist throughout the corridor; river mile 258–330.5
- several buildings, decks, former bridge abutments, stairways and other structures; river mile 258–330.5
- communications and powerlines cross the river at approximately 15 locations
- Lordville Bridge connecting Equinunk, PA, and Lordville, NY; river mile 322
- Kellams Bridge connecting Stalker, PA, and Kellams, NY; river mile 313
- Callicoon Bridge; river mile 304
- Town of Delaware flood diversion channel; river mile 303
- Damascus/Cochecton Bridge; river mile 299
- Milanville/Skinners Falls Bridge; river mile 295
- Eel Weir; river mile 293
- Narrowsburg New York State Department of Environmental Conservation (DEC) Boat Launch and bulkhead; river mile 290
- Narrowsburg Bridge; river mile 289.7
- Narrowsburg sewage treatment plant outfall; river mile 289.5
- Eel Weir; river mile 288
- No. 9 Railroad Bridge; river mile 284
- Roebling's Delaware Aqueduct (Roebling Bridge); river mile 277
- Delaware and Hudson Canal berm, walls and appurtenances, various points; river mile 258-277.5
- D&H Canal Timber Crib Dam Remnants; river mile 277.5
- Shohola/Barryville Bridge; river mile 273
- Pond Eddy Bridge; river mile 265.5
- No. 2 Railroad Bridge at Millrift; river mile 258 (Southern Terminus of the Upper Delaware River)
- Columbia Gas Transmission Corporation; river mile 258.6

Between the southern terminus of the Upper Delaware Scenic and Recreational River and the northern boundary of the Middle Delaware, an additional tributary reservoir modifies the flow regime of the Middle Delaware, into and through the Delaware Water Gap Recreation Area (table 3).

Table 3. Reservoir that modifies the flow of the Middle Delaware River							
Reservoir Name	**State**	**Tributary**	**River Mile at tributary mouth**	**Date of First Operation**	**Drainage Area (sq. mi.)**	**Capacity (billion of gallons)**	**Main Purpose**
Neversink	NY	Neversink River	253.6	1954	92	34.9	Diversion to NYC

A number of USGS stream gauges also exist on the Middle Delaware and its tributaries. Table 3 provides a list of existing USGS gauges in and tributary to the Middle Delaware River (table 4).

Table 4. Existing USGS Gauges in and Tributary to the Middle Delaware River						
USGS Gauge Station No.	**Gauge Name**	**River Mile**	**Elevation (ft.)**	**Watershed Area (sq mi)**	**Period of Record**	**Years of Record**
01437500	Neversink River at Godeffroy, NY	NA	459.66	307	1937-	75
01434000	Delaware River at Port Jervis, NY	254.8	415.35	3,070	1904-	98
01438500	Delaware River at Montague, NJ	246.4	369.93	3,480	1939-	73
01440000	Flat Brook Near Flatbrookville, NJ	NA	347.73	64	1923-	89
01439500	Bush Kill at Shoemakers, PA	NA	421.13	117	1908-	104
01440200	Delaware River Near Delaware Water Gap, PA*	214.7	293.64	3,850	2001-	11
01442500	Brodhead Creek at Minisink Hills, PA	NA	301.84	259	1950-	62

* 01440200 discharge period of record 1964–1996; only gauge height recording has been maintained since 2001

A number of waterway modifications exist within the Middle Delaware River as listed below.

Waterway Modifications within the Middle Delaware River:

- Milford Beach Access Area, PA; river mile 246.4
- Rt. 206 Bridge connecting Milford, PA and Montague, NJ; river mile 246.2
- Dingman's Bridge, a private bridge at Dingmans Ferry, PA; river mile 238.6
- Dingmans Access Area, a paved access and boat ramp, PA; river mile 238.6
- Bushkill Access Area, a paved access and boat ramp, PA; river mile 227.6
- Power transmission lines cross river at mile 222.6
- Smaller communication and power lines cross the river at 3 other locations.
- Poxono Access, NJ; river mile 219
- Turtle Beach, NJ; river mile 218.9
- Smithfield Access Area, paved access and boat ramps, PA; river mile 218.1
- Worthington State Park, NJ, paved access area; river mile 214.8
- Shawnee Inn and paved ramp, golf course on river island, PA; river mile 214.7
- Shawnee Inn golf course, small bridge spans channel along PA shore; river mile 214.4
- Private docks along PA shore; river mile 213.2
- Interstate 80 Bridge; river mile 212.2
- Kittatinny Point NPS Visitor Center with boat ramp; river mile 211.5
- Railroad embankment along PA shore; river mile 212.6-209.5
- Tennessee Gas Transmission Line, mile 248.3

Passing downstream from the Delaware Water Gap National Recreation Area at river mile 209.5, the river enters an eligible but undesignated segment of river in the vicinity of Portland, Pennsylvania. The next wild and scenic designated river segment starts just below the PPL Martins Creek generating station at river mile 193.8. The Lower Delaware River's flow regime is modified by reservoirs in tributary watersheds (table 5). Numerous water diversions are within the Lower Delaware: Merrill Creek pumped storage intake; City of Easton water supply; Point Pleasant Diversion (public supply and power generation); Portland, Martins Creek and Gilbert power generating stations; and the New Jersey Water Supply Authority water diversion. There are also numerous municipal and industrial wastewater dischargers to the Lower Delaware and its tributaries. Those that discharge directly to the Lower Delaware include Portland Borough; Portland Generating Station; Martins Creek Generating Station; City of Easton, PA; City of Phillipsburg, NJ; Town of Frenchtown, NJ; and City of Lambertville, NJ. There are also a few small industrial dischargers and some abandoned industrial facilities.

Table 5. Reservoirs that Modify the Flow of the Lower Delaware River							
Reservoir Name	**State**	**Tributary**	**River Mile at Tributary Mouth**	**Date of First Operation**	**Reservoir Drainage Area (mi²)**	**Capacity Billions of Gallons**	**Main Purpose**
Columbia Lake	NJ	Paulins Kill	207.2	Unknown	177.0	Unknown	Hydropower generation
Beltzville Reservoir	PA	Pohopoco Creek, Lehigh River	183.6	1971	96.4	33.8	Flood Control, Decree Party flow augmentation
Merrill Creek Reservoir	NJ	Lopatcong Creek	182.0	1988	3.7	15.0	Decree Party flow augmentation
Lake Nockamixon	PA	Tohickon Creek	157.5	1973	73.3	21.7	Recreation; Decree Party flow augmt.

The Lower Delaware and its tributaries are also well gauged. Table 6 provides a list of existing USGS gauges in and tributary to the Lower Delaware River.

Table 6. USGS Discharge Gauges on the Delaware River and Tributaries Upstream of/within the Lower Delaware Recreational River*						
USGS Gauge Station No.	**Gauge Name**	**River Mile**	**Elevation (ft)**	**Watershed Area (mi²)**	**Period of Record**	**Years of Record**
01443500	Paulins Kill at Blairstown, NJ	NA	335.9	126	1921-	91
01443900	Yards Creek nr Blairstown, NJ (reservoir outlet)	NA	606.8	5.34	1966-	46
01446000	Beaver Brook near Belvidere, NJ (Pequest River Tributary)	NA	303.4	36.7	1922-	90
01445500	Pequest River near Pequest, NJ	NA	398.8	106	1921-	91
01446500	Delaware River at Belvidere, NJ	197.8	226.4	4,535	1922-	90
01446776	Bushkill Creek Below SR2017 Bridge at Tatamy, PA	NA	335.0	31.1	2005-	7
01446995	Delaware River at U.S. Route 22 Bridge Phillipsburg, NJ	184.0	155.4	4,717	2005-	7
01454700	Lehigh River at Glendon, PA	NA	164.3	1,359	1966-	46
01455090	Lopatcong Creek at Strykers Road at Port Warren, NJ	NA	243.2	9.59	2011-	1
01457000	Musconetcong River near Bloomsbury, NJ	NA	274.8	141	1903-	109
01457500	Delaware River at Riegelsville, NJ (gh)	175.0	125.1	6,328	2002-	10
01458500	Delaware River at Frenchtown, NJ (gh)	165.1	99.9	6,420	2007-	5
01459500	Tohickon Creek near Pipersville, PA	NA	258.96	97.4	1935-	77
01460880	Lockatong Creek at Raven Rock, NJ	NA	100.0	22.9	2005-	7
01461300	Wickecheoke Creek at Stockton, NJ	NA	80.0	26.6	2006-	6
01461500	Delaware River at Stockton, NJ (gh)	152.0	54.0	6,656	2008-	4
01462000	Delaware River at Lambertville, NJ (gh)	148.7	49.0	6,680	2008-	4
01462500	Delaware River at Washington Crossing, NJ (gh)	141.7	26.14	6,735	2010-	2

* Some tributaries have multiple USGS gauges. In those cases, only the gauge nearest to the Delaware River is listed.
(gh) USGS gauge measures continuous gauge height only, not discharge.

A number of waterway modifications listed below exist within designated segments of the Lower Delaware River. In addition to facilities listed, there are extensive reaches of river confined within road, railroad, and canal embankments. Some sections of the Lower Delaware are relatively urbanized. Private docks and boat launch facilities are common, as well as homes, towns, quarries, and various active and abandoned industries.

Waterway modifications within designated segments of the Lower Delaware:

- railroad bridge; river mile 190.6
- industrial wastewater or stormwater outfalls, NJ; river mile 189.7
- Sandts Eddy PA Fish and Boat Commission Access; river mile 189.1
- pipeline crossing; river mile 189.0
- bridge connecting Upper Black Eddy, PA, and Milford, NJ; river mile 168.3
- industrial outfall, NJ; river mile 167.5
- Superfund site, NJ, extensive rock bank stabilization; river mile 167.0
- wastewater or stormwater outfall, NJ; river mile 165.5
- bridge connecting Uhlerstown, PA, and Frenchtown, NJ; river mile 165.1
- wastewater or stormwater outfall, NJ; river mile 164.9
- wastewater outfall, NJ; river mile 164.5
- Kingwood access area, NJ, improved boat ramp; river mile 164.2
- commercial hot dog stand along center channel on private island; river mile 160.7
- major canoe and tube outfitters landing, PA; river mile 157.7
- Byram access area, NJ, improved boat ramp; river mile 156.5
- wing dams extend from PA and NJ shore for NJ diversion; river mile 156.2
- Bulls Island Foot Bridge links PA and NJ state parks; river mile 155.7
- Lockatong Creek overspill from Delaware and Raritan Canal; river mile 154.2
- Wickecheoke Creek overspill from Delaware and Raritan Canal; river mile 152.5
- bridge at Stockton, NJ; river mile 152.0
- pipeline crossing; river mile 150.1
- bridge linking Lambertville, NJ, and New Hope, PA; river mile 148.7
- municipal wastewater discharge outfall, river mile 148.2
- wing dams extend from PA and NJ shores for defunct paper mill raceway, PA; river mile 148.0
- Washington Crossing Bridge; river mile 141.8

Downstream from the southern terminus of the designated wild and scenic segments, the Delaware River flows free to the head of tide at Trenton, NJ, at river mile 134.3.

The Musconetcong River drains northeast to southwest and drains 157 square miles. The river valley is narrow, not more than 6 miles wide at its widest point. The Musconetcong is prone to flash flooding due to the karst geology and narrow width. Flow has been altered since the arrival of European settlers in the early 18th century. Europeans, and possibly the Delaware Nation before them, built fish weirs at various places along the river. Development impacts are still seen today; 11 known dams existed on the Musconetcong River at the time of the river's designation in late 2006. Since 2006, four dams have been removed (Seiber, Gruendyke, Riegelsville, and Finesville). Two larger dams (Hughesville and Warren Glen) remain in the lower segment of the river and serve as the dividing lines between the designated segments B and C.

Of the seven dams left on the Musconetcong, only the two at Hughesville and Warrant Glenn alter the river's flow, which is why segment C was not designated. Penwell Dam, in the upper part of segment B, is large enough that paddlers must portage. One project at the Warren County Rod and Gun Club included excavations and the placement of boulders in the river. Three other projects involved excavation and bio-stabilization measures to improve riparian habitat at Gruendyke and Seber Mill dam sites.

Based on the gauge at Bloomsbury (141 mi^2), the Musconetcong River flows at the down-stream end of segment B average 250 cfs. Low flows typically occur in July and August, and averaged 160, 151, and 157 cfs, respectively, in 2010/2011. High flows typically occur in March, April, and May and averaged 350, 354, and 272, respectively, in 2010/2011. The floods of 2011 were a marked departure from flows seen at any time in the past. The highest flow on record of 8,230 cfs occurred August 28, 2011, during a hurricane event. Substantial property damage was sustained and residential wells were contaminated, especially in the area of Bloomsbury.

Flows of the Musconetcong River are affected by drawdown releases at Lake Hopatcong. Every fifth year, Lake Hopatcong is drawn down 60 inches in late September, and annually in the fall, 26 inches for dock and marina maintenance, increasing flows temporarily. The Lake Hopatcong management plan requires certain flows at various times of the year. The dozens of boat ramps and bridge crossings of the Musconetcong River were all present at the time of designation.

WATER QUALITY

Photo: David B. Soete

WATER QUALITY

Water quality in the nontidal portion of the Delaware River is perhaps the purest of all the large rivers in the mid-Atlantic and northeastern United States.

At most times water quality exceeds federal and state criteria levels. The Delaware River serves as a regional reference condition river for water quality and biological assessments. The uses that are most dependent on the extraordinarily clean water are water-based recreation, water supply that requires little treatment, and excellent habitat for thriving aquatic life.

Because of such exceptional water quality, keeping the Delaware River uncontaminated is the primary policy of regulatory agencies. This policy is known as anti-degradation, and is consistent with the Wild and Scenic River Act anti-degradation policy. The entire 197-mile nontidal portion of the Delaware River between Hancock, New York, and Trenton, New Jersey, is classified by the Delaware River Basin Commission as "Special Protection Waters." This represents the longest contiguous reach of anti-degradation waters in the United States. The Upper Delaware Scenic and Recreational River and the Delaware Water Gap National Recreation Area are accorded the highest level of anti-degradation protection by the Delaware River Basin Commission as outstanding basin waters. The Lower Delaware River is classified by the Delaware River Basin Commission as significant resource waters. Both classifications are equivalent to Environmental Protection Agency (EPA) tier III anti-degradation protection of water quality and allow "no measurable change in existing water quality except toward natural conditions."

Outstanding basin waters include the additional provision disallowing mixing zones for approved dischargers whereas mixing zones are allowed in significant resource waters. Many tributaries in Pennsylvania, New York, and New Jersey are also afforded a similar level of water quality protection through state regulations, but only those tributaries within the boundaries of Delaware Water Gap National Recreation Area are included as outstanding basin waters by the DRBC Special Protection Waters regulations. Primary regulatory protection of other tributaries within the basin is maintained by the states, although the Delaware River Basin Commission does have some regulatory authority on point source dischargers to tributaries in order to protect the shared interstate waters of the mainstem. The DRBC Special Protection Waters regulations are unique in that they are monitored to determine if "measurable change" is occurring. This monitoring program is conducted through an informal partnership between the National Park Service and the Delaware River Basin Commission called the Scenic Rivers Monitoring Program. Both the Special Protection Waters regulations and the Scenic Rivers Monitoring Program are crucial to maintaining the level of water quality in the designated waters of the mainstem Delaware River.

Photo: David B. Soete

Photo: David B. Soete

The anti-degradation policy is very important, not only for river recreation and aquatic life, but also for the water supply for approximately 16 million people in New York, Pennsylvania, New Jersey, and Delaware. The Delaware River watershed is relatively small, comprising only 0.4% of continental U.S. land area; its clean water is a drinking water source for 5% of the U.S. population.

In comparing water quality of the Delaware River and tributary wild and scenic segments, both the Upper and Middle Delaware river segments are the cleanest and healthiest. The Lower Delaware is much more urbanized and historically industrialized and farmed, so water quality is not as good, although it still supports the most stringent of uses. The Musconetcong River water quality is good, supporting reproducing trout populations, but not as good as the Lower Delaware River.

Tohickon Creek is one of the highest water quality streams in Pennsylvania and is classified as a cold water fishery by the state's Department of Environmental Protection. A DRBC study of water quality in the Lower Delaware in 2004 found that, of the 18 Lower Delaware River segments and tributaries analyzed, Tohickon Creek was ranked fourth in overall water quality. Tinicum Creek is designated an exceptional value stream and Paunacussing Creek is designated as a high quality cold water fishery.

Photo: David B. Soete

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historic places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

962/116359; September 2012

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DELAWARE RIVER BASIN | NATIONAL WILD AND SCENIC RIVER VALUES


Photo: David B. Soete

EXPERIENCE YOUR AMERICA

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mcmullan
CONSULTING ENGINEERS

January 16, 2019

Ed Rodgers
Delaware Riverkeeper Network
925 Canal Street, Suite 3701, Bristol, PA 19007
215 369 1188 ext 102

RE: Golden Pheasant Bridge
M&A #3575-1

Dear Ed:

At your request, I met you at the Golden Pheasant Bridge on January 12, 2019 to review the recently completed interim repair project. I also briefly reviewed the corresponding documentation for the project that you provided. This letter report summarizes my observations.

The bridge crosses the Delaware Canal and is located adjacent to the Golden Pheasant Inn. The canal towpath extends below the bridge on the east side. The superstructure consists of concrete cast on steel deck that is supported by four 30-inch deep structural steel beams made of weathering steel. The steel beams are supported on a concrete cap that is 3 feet wide and varies in thickness from 18 to 21 inches. The concrete cap is supported by the original stone masonry abutments.

The construction plans indicate that the average daily traffic count is 2147 vehicles and that the bridge is rated for Pennsylvania maximum legal loads.

According to the documentation provided, the bridge was constructed in 1932, but since the adjacent Golden Pheasant Inn was constructed in 1857, it is likely that the stone masonry abutments were constructed earlier during the canal era to support a bridge access the canal and allow access to the inn. The bridge is listed as a contributing element to the Erwinna Historic District.

The bridge width was measured to be about 16’-8” between concrete curbs with a clear width between steel guardrails of about 16’-0”. There is a stop sign at each end of the bridge. We witnessed considerable traffic during our time at the bridge. Each vehicle stopped before proceeding across the bridge using the full width as a single lane. When vehicles arrived at both ends of the bridge at the same time, one vehicle would cross while the vehicle in the other travel direction waited at the stop sign.

The stones at the base of the abutments are typically larger than at the top. Stone sizes were measured from 2 inches to 10 inches in height and varied up to 54 inches in length. There is a concrete apron or skirt at the base of the west abutment that predates the repair project. The coursing of stones at the west abutment above the concrete skirt slopes toward the middle, and may indicate past settlement of the masonry.

In photos of the masonry abutments taken after installation of the concrete caps, there are numerous cracked stones, deteriorated stones, and mortar joints with missing mortar. This stone masonry was later repaired by filling the joints between stones with mortar. There are still cracked and deteriorated stones, but the abutment is providing adequate support to the superstructure.

Construction plans and specifications for the masonry repairs were not provided with the other project documents. This documentation did include an email request from the Friends of the Delaware Canal dated July 24, 2018 requesting information about proposed masonry repairs: "*In order to better understand the effects on the existing abutments that bookend the Delaware Canal as well as the wingwall, would the consultant or engineer please provide additional details about the extent of work and procedures involved in "Repoint and repair stone masonry abutments and reconstruct partially collapsed wingwall at southwest corner of the structure*". The response email dated July 30, 2018 states: "*Thank you for your email. I shared your email with the PennDOT project manager and the design consultant. The only work proposed for the abutments is resetting loose and missing stones and repointing, as necessary. The partially collapsed wingwall at the southwest corner of the bridge will be reconstructed in-kind*."

There are a number of common elements shared between the Golden Pheasant Bridge and the Headquarters Bridge:

1. Spans – Although the Golden Pheasant Bridge span is 45 feet and the Headquarters span is 25 feet, and longer spans produce heavier loads, both bridges support simple span superstructures supported on historic stone masonry substructures.
2. Stone sizes and coursing – both bridges have similar sized larger stones near the base of the abutment and similar sized smaller stones near the top.
3. Stone damage – the stone masonry for both bridges contains cracked and deteriorated stones. Both bridges supported traffic loads on these masonry abutments prior to repairs, and the Golden Pheasant now supports full PennDOT legal truck loading on the repaired stone masonry.
4. ADT – the average daily traffic on the Golden Pheasant is 2174 vehicles and Headquarters is 643 vehicles according to the PennDOT 2012 Biennial report.
5. Lane width – There is a 16-foot lane with on the repaired Golden Pheasant bridge and a similar 16-foot lane width to match the historic width was proposed for Headquarters bridge.
6. Concrete cap – A concrete cap was placed on Golden Pheasant and a similar cap was proposed for Headquarters. These elements distribute the loads from the superstructure into the abutments.
7. Contributing elements to Historic District – The Golden Pheasant Bridge was identified as a contributing element to the Erwanna Historic District and the Headquarters Bridge was identified as a contributing element to the Ridge Valley Rural Historic District.

Although the Golden Pheasant Bridge project plans were labelled "Interim Emergency Repair", the bridge superstructure repair was constructed using standard PennDOT details and materials. If maintained, this bridge will provide adequate service for a long period of time. A similar approach could be employed at the Headquarters bridge. From the project email documentation provided, the design and construction of the Golden Pheasant Bridge repair was completed in less than 6 months.

The recent repair project at the Golden Pheasant bridge demonstrates a successful combination of a modern 16-foot wide superstructure supported on a repaired stone masonry substructure that allows the preservation of historic materials. If a similar repair project was implemented at the Headquarters Bridge, it could be further improved by the following:

1. Using painted or galvanized steel stringers, or precast concrete stringers to avoid rust stains from weathering steel

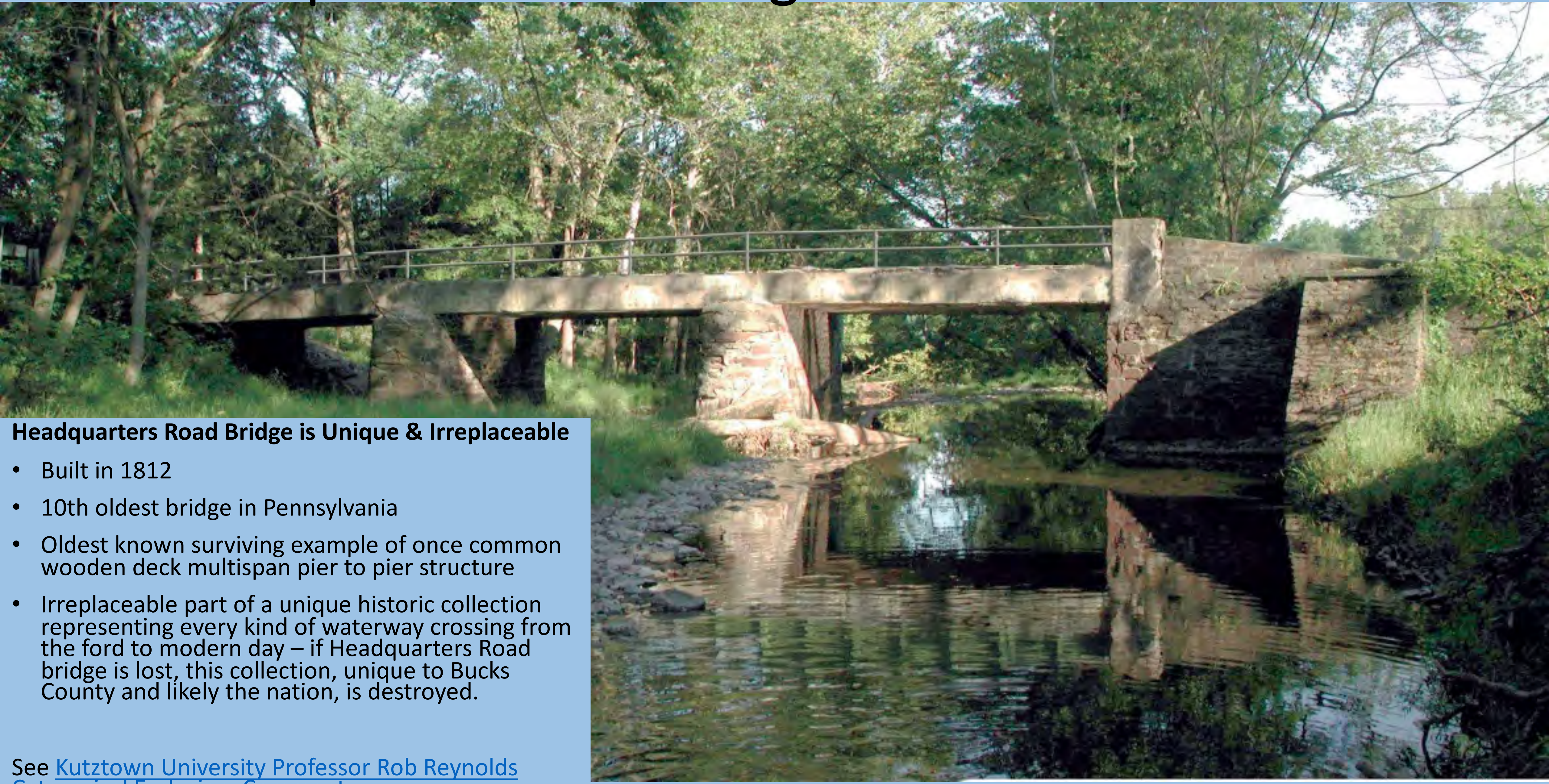
2. Basing mortar repair materials on a cementitious material which allows for better vapor transmission than Portland cement, such as natural cement
3. Installing grouting repairs to the stone masonry prior to placing the concrete caps
4. A more attractive bridge barrier could be used such as PennDOT standard PA Type 10M rather than W-beam.

Sincerely,
McMULLAN & ASSOCIATES, INC.

Douglas E. Bond

Douglas E. Bond, PE
Vice President

Headquarters Road Bridge – A National Treasure



Headquarters Road Bridge is Unique & Irreplaceable

- Built in 1812
- 10th oldest bridge in Pennsylvania
- Oldest known surviving example of once common wooden deck multispan pier to pier structure
- Irreplaceable part of a unique historic collection representing every kind of waterway crossing from the ford to modern day – if Headquarters Road bridge is lost, this collection, unique to Bucks County and likely the nation, is destroyed.

See [Kutztown University Professor Rob Reynolds Categorical Exclusion Comment]

A Problem With A Solution – All That's Missing is Leadership

- Headquarters Road Bridge has been closed to traffic since 2011 – by PADOT's choice.
- All agree the bridge needs to be reopened as soon as possible, but it is not on a track to achieve that.
- What's the local opinion? While some prioritize history and environment, and some are singly focused on transportation, the **community demand is for an open bridge** regardless of the number of lanes.
- The quickest way to reopen is to repair or rehabilitate, as PennDOT just did with the very similar Golden Pheasant Bridge on River Road in Tinicum. So far, PennDOT hasn't been willing to consider rehabilitation of the 1812 Headquarters Road bridge.
- 2005 PennDOT made the determination and commitment, with the political support of state representative McIlhinney, to secure demolition and replacement (not repair).* This early determination seems to be inhibiting a modern reconsideration of the value and importance of preserving our nation's history.
- The 2005 decision was before any studies had been done, before the general public had been notified or consulted, before local government or the community had a chance to comment as required by law. PennDOT had no idea of the long, distinguished and unique history of the bridge, its relation to the historic district, or the environmental issues.

See Keller Memo McIlhinney l Scoping Mtg

At Stake: Our Historic Bridge & Our Protected Community

A one-lane Headquarters Road Bridge fits the context of our community and honors the dedicated commitment of our community to preserve our historic, rural and environmental character.

Little has changed in the 200 years since the bridge was built, including the roads and the creek itself -- giving ecotourists and historic enthusiasts visiting the area a unique and real-time experience of what the area was like in the historic past. With the bridge rehabilitated Tinicum and Bucks County have a unique marketing opportunity to bring attention and visitors to enjoy and spend in our community.

- Tinicum Twp is a town of one-lane bridges – 2/3 of all bridges and ½ of PennDOT bridges are one lane and fit the local transportation routes.
- The township is characterized by narrow, winding country roads (including gravel roads and fords!) appropriate for the rural nature of the area.
- Regional (Delaware Valley Regional Planning Commission), county, and township plans **<u>all</u>** call for conservation.
- More than 1/3 of the township is already preserved open space and little development pressure is forecast by DVRPC **.**

See Report, Tinicum Township and Headquarters Road Bridge: Planning the Future.

Unique & Historic Character: Legally Recognized & Protected.

Headquarters Road bridge, the surrounding ground, creek, and buildings are all protected by acts of Congress and the US Dept of the Interior.

PennDOT's demolition-replacement plan would cause serious permanent damage to these protected resources without any overall benefit in safety or utility.

Congressman Mike Fitzpatrick chose this view from the Headquarters Road bridge because of its iconic historic and environmental beauty and importance to the community.

- Tinicum Creek is designated by Congress as a Federal Wild and Scenic River.
- Stretch of creek is within the Ridge Valley National Register Rural Historic district.
- The bridge and the farms on either side of it are listed on the National Register.
- Tinicum Creek protected as an Exceptional Value stream by Commonwealth of PA

Three Potential Solutions

3 solutions that will allow us to reopen a safe and secure bridge in the near term, negate the need for the ongoing litigation, and protect historic and natural resources all at the same time:

1. **Update the Stone Arch Bridge Program** to include other unique, historic, masonry structures, including Headquarters Road Bridge and others which are older than many of the stone arch bridges currently protected by this program;
2. **Follow the Golden Pheasant Bridge Model** – declare the need for emergency repairs and rehabilitate Headquarters Road Bridge using a similar concept, i.e. new bridge deck on original masonry;
3. **Put in place a temporary bridge** that covers the existing bridge while the debate rages on.

PennDOT Does Rehab One Lane Bridges, and It Can Do It Well. Expanding the Stone Arch Bridge program will showcase Pennsylvania's Irreplaceable Historic Bridges Built with Stone Masonry & PennDOT's rehabilitation skills.

PennDOT has successfully rehabilitated many one-lane bridges in Bucks County carrying far more traffic than the Headquarters Road bridge.

Projects done under the Stone Arch Bridge program show that PennDOT can sensitively and appropriately rehabilitate one-lane bridges.

Photos show one-lane bridges, located in Bucks County, recently rehabilitated by PennDOT under the Stone Arch Bridge Program. Most have higher traffic volumes than Headquarters Road Bridge.

Expanding this program to include a wider array of historic masonry structures will allow rehabilitation of Headquarters Road Bridge and avoid other similar debates.

Golden Pheasant Rehabilitation is a Good and Viable Model *For Headquarters Road Bridge*

→ December 2018, PennDOT Completed Rehabilitation/Repair of the Golden Pheasant Bridge

→ Repair needs for Golden Pheasant Bridge & Headquarters Road Bridge are similar

The Headquarters Road Bridge and the Golden Pheasant Bridge are so similar that the 2018 Golden Pheasant Rehab/Repair is an ideal model for Headquarters Road Bridge.

Picture: Golden Pheasant Bridge

Golden Pheasant Bridge and Headquarters Road Bridge have structural and location similarities that demonstrate the Golden Pheasant repair/rehabilitation approach used by PennDOT in 2018 is a good model for Headquarters Road Bridge that will deliver what both the community and the agency seek.

The Headquarters Road Bridge and the Golden Pheasant Bridge are similar in size, structure and physical setting.

The biggest difference is in use – the recently rehabbed Golden Pheasant bridge has a use that is <u>more than 4 times</u> that of Headquarters Road Bridge.

	Golden Pheasant	Headquarters Road
Crossing Lanes	16’ single lane	16’ single lane
Similar Masonry Substructure	Stone Masonry Stone Abutments (Not Stone Arch)	Stone Masonry Stone Abutments & Piers (Not Stone Arch)
Repair needs	Masonry substructure & Deck	Masonry substructure & Deck
Similar Physical Setting With Government Recognitions	Sensitive physical setting protected by Dept of Interior & recognized contributing element to the historic district	Sensitive physical setting protected by Dept of Interior& recognized contributing element to the historic district -- ***EXCEPT, Headquarters is older, has been specifically recognized by DOI for its engineering significance, and has less traffic***
Similar Site/Setting	Golden pheasant has tight turn radii on both sides, steeper approach grade, at a minor traffic intersection.	Headquarters Road has similar turn radii but on one side only (making it less difficult), has a less steep approach grade, at a minor traffic intersection.
Similar vehicle use	2,132*	495*

* http://www.projects.penndot.gov/projects/BridgeConditionsMap.aspx

Repair needs for Golden Pheasant Bridge & Headquarters Road Bridge are Similar

Golden Pheasant Bridge "Emergency Repairs" include extensive rehabilitation

As these and the following photos demonstrate:

- ✓ Golden Pheasant Bridge, like Headquarters Road Bridge, needed deck and substructure repairs.
- ✓ Masonry walls and structures at Golden Pheasant were completely rehabilitated by PennDOT using historic preservation engineering strategies.
- ✓ The same can be done at Headquarters Road Bridge.

Golden Pheasant Masonry Abutments are similar to Headquarters Road Bridge. PennDOT's repair entailed significant stonework.

During Rehabilitation/Repair, Golden Pheasant abutment interiors exposed

After wingwall rebuilt

Golden Pheasant Bridge abutment repair/rehab work was extensive

Golden Pheasant Bridge NW abutment and wing wall before:

And after:

PennDOT's repair work on the Golden Pheasant bridge included replacing the deck. The PennDOT design is essentially the same concept as the design recommended by historic experts for Headquarters Road Bridge:* using poured concrete caps on original stone masonry to support new steel stringers and distribute the deck loads into the stonework below.

Two views of Golden Pheasant Bridge rehabilitation

* See [January 12, 2017 Delaware Riverkeeper Network Draft Categorical Exclusion Evaluation Headquarters Road Bridge.]

Golden Pheasant and Headquarters Road bridge stone masonry is similar, needing similar repair work.

Stone Photos

Cracked and crushed stone in NW wingwall.

Cracked and crushed stone at Ottsville abutment.

Page 29

This structure inspection document is confidential pursuant to 65 P.S. §66.1 et seq., 75 Pa. C.S. §3754 and 23 U.S.C. §409 and may not be disclosed or used in litigation.

Above: Problem areas of stonework identified by PennDOT in their 2006 report on the Headquarters Road Bridge.

The stones in the abutments at Golden Pheasant Bridge have the same types of damage as found in the stones at the Headquarters Road Bridge abutments and piers.

As the photo above shows, cracked stones in the Golden Pheasant bridge are similar to Headquarters Road Bridge cracks. At the Golden Pheasant Bridge, these cracked stones were determined adequate and left in place to support the bridge deck.

Golden Pheasant Bridge Solution for Scour also an Option for Headquarters Road Bridge if the Need is Confirmed.

Although PennDOT has cited scour as a particular problem at the Headquarters Road bridge, only small holes were identified in the 2004 Biennial Report. In 200 years, there is no evidence that the bridge itself, which sits directly on bedrock, has sustained significant scour damage. However, installation of grout bags against the masonry just below the waterline ten years ago has dramatically increased turbulence at the bridge resulting in undermining of the grout bags and should be removed.

Scour concerns at Headquarters Road Bridge could be addressed by concrete encasement of the masonry below the water line down to the bedrock on which the piers and abutments sit. This photo shows a similar concrete apron, although extending above the waterline, in an old repair to the west abutment at the Golden Pheasant bridge.

In addition, the use of natural channel design principles could redirect and restore the stream flow to all 3 bridge spans, removing the direct pressure on the abutment while at the same time providing flow and habitat benefits to Tinicum Creek.

Doug Bond, Vice President of McMullan & Associates Engineers inspected the Golden Pheasant bridge after the emergency repair construction.

Bond found that the success of the Golden Pheasant restoration confirms that similar techniques are a good option for restoring Headquarters Road Bridge to safe, one-lane use.

Golden Pheasant Rehabilitation is a Good and Viable Model *For Headquarters Road Bridge*

Inspection by historic bridge expert confirms, PennDOT personnel and/or contractors have successfully restored the Golden Pheasant historic stonework, and used expertise and techniques similar/parallel to those needed to do repairs on the Headquarters Road Bridge, including maintaining the one-lane size.

Current Demolition/Replacement Proposal for Headquarters Road Bridge: Purely Politics &/Or Simple Semantics

Penn DOT has designated the Golden Pheasant Bridge project as “emergency repairs”.

In exchange, it provided a historic rehabilitation of a one-lane bridge that honored the context sensitive setting.

The same could be done for Headquarters Road Bridge, providing a near term, safe, environmentally and historically protective crossing.

There is No Genuine Regulatory Obstacle; Problem is Purely Politics &/or Simple Semantics

PennDOT relies upon internal rules – particularly the Bridge Design Manual – to deny rehabilitation at the Headquarters Road bridge.

The Bridge Design Manual virtually forbids rehabbing one-lane bridges, BUT …. PennDOT has ways to rehab one-lane bridges when they choose to do so, including:

A. Following the ***Stone Arch Bridge Maintenance Manual***, which authorizes everything from repairs to reconstruction for one-lane stone arch bridges. The uniqueness of Headquarters Road Bridge -- including that it is the oldest known surviving example of this unique historical type -- could be used to justify its inclusion in the Stone Arch Bridge program.

B. Calling a project ***"emergency interim repairs"*** in order to support near-term historic rehabilitation -- this strategy was used to rehab the historic, one-lane, Golden Pheasant bridge which, using this terminology, was substantially rebuilt by PennDOT in order to rehabilitate/repair the historic abutment masonry. The same approach could be used for Headquarters Road Bridge.

C. In addition, the ***use of state money*** speeds up these projects and does NOT cause the loss of any federal funding.

If Stone Arch Bridge Program & Golden Pheasant Model Rejected, then Option 3:

<u>A Temporary Bridge</u> Is the Next Best Available, Economic & Near Term Option

- In 2018 Griffin Engineering determined a temporary bridge could be erected at the footprint of the current bridge in three months.
- Township officials have supported the temporary bridge idea in order to open up needed emergency services and to support community traffic and ecotourism.
- PADOT claims that permitting would prevent a temporary bridge option are not supported by the facts.
- A temporary bridge provides space for all parties agreeing to a successful solution.

Back to the Facts

One-Lane, Historic, Headquarters Road Bridge Has Well Served the Needs of our Community from Colonial to Historic Times.

PennDOT's Plans Provide No Travel Benefits But Make Our Community LESS SAFE.

Headquarters Road Bridge before it was closed – note the Jersey Barriers in place reducing the width.

Safety. Expert reviews have confirmed that the historic one-lane structure coupled with the geometric site constraints have provided traffic calming benefits to neighboring landowners and commuting traffic. In fact, according to experts, PennDOT's oversized bridge and roadway modifications will undermine the site's traffic calming benefits, creating a more dangerous travel situation.

Service. Even with its deck width shrunk from 16' to 10' by Jersey Barriers, the one-lane Headquarters Road Bridge well served the needs of our community -- accommodating, pedestrian, bike, car, truck and safety vehicles.

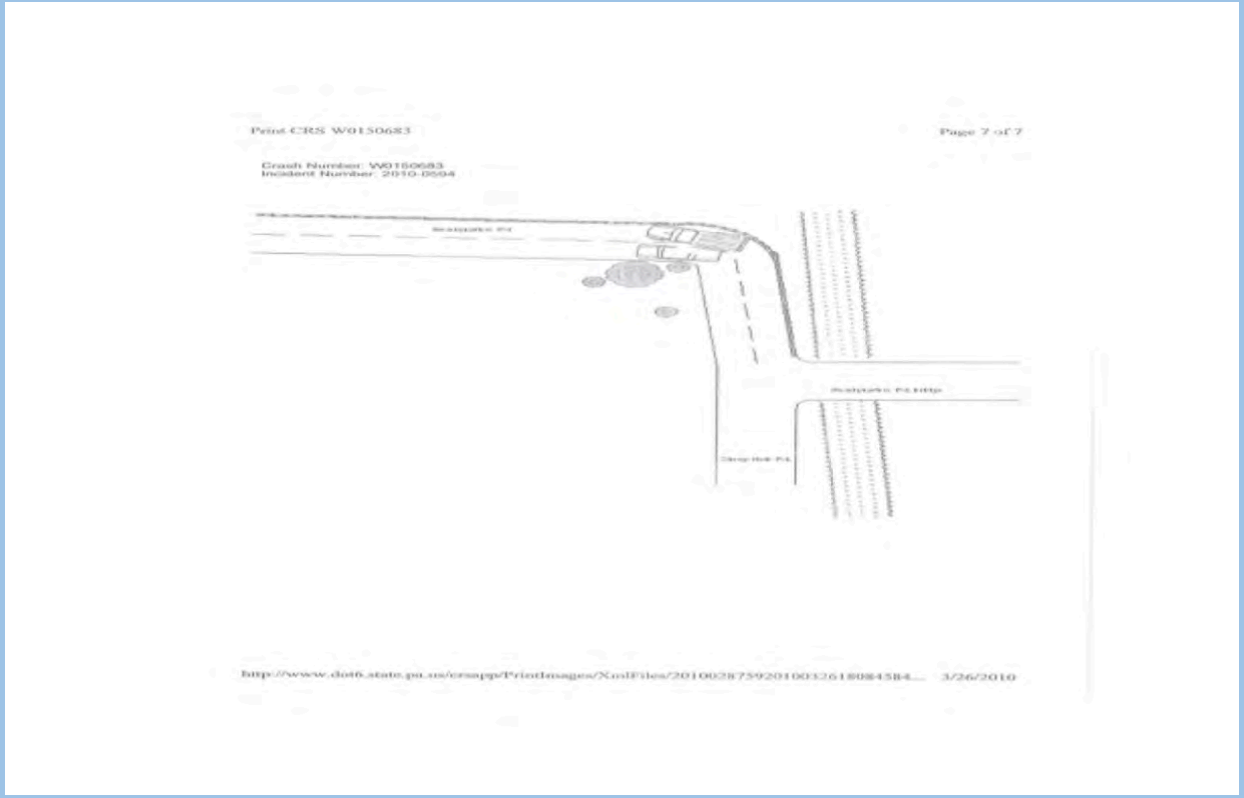
A Two-Lane Bridge Is Not Needed for Emergency Vehicles

Fire trucks are able to use the historic bridge without an oversized replacement

All Tinicum fire trucks, including the largest recently purchased ladder truck, are able to utilize a one-lane Headquarters Road Bridge. PennDOT's assertions to the contrary have been debunked by statements in public and on the record from the fire chief, Township officials, and the Township Roadmaster. All affirm that the largest fire truck would be able to make the turn with a one-lane bridge, at the current location, with the current geometry. Furthermore, additional improvements can be made to enhance turning ease without impeding historic preservation.

In fact, emergency vehicles and the town's largest fire truck were able to use the bridge without problem before it was closed, even after PennDOT narrowed the travel lane to ten feet with the Jersey Barriers.

There is no accident justification for the PennDOT proposal.



(Tinicum Township Police report sketch of 2010 accident on Headquarters Road east of the bridge)

PennDOT wrote a report asserting that accident records show an unusually high number of accidents at the Headquarters Road Bridge, thereby justifying the need for a two-lane structure. Police records prove this justification to be FALSE.*

The same accident records demonstrate that even after the addition of Jersey Barriers narrowing the travel lane to ten feet, NONE of the accidents were caused by the bridge itself -- not its size, not its location, not its geometry. In fact, most of the accidents PennDOT cited actually happened at the curve just to the east*, not on the bridge, and not in a section of roadway that PennDOT is planning to even touch as part of this project.

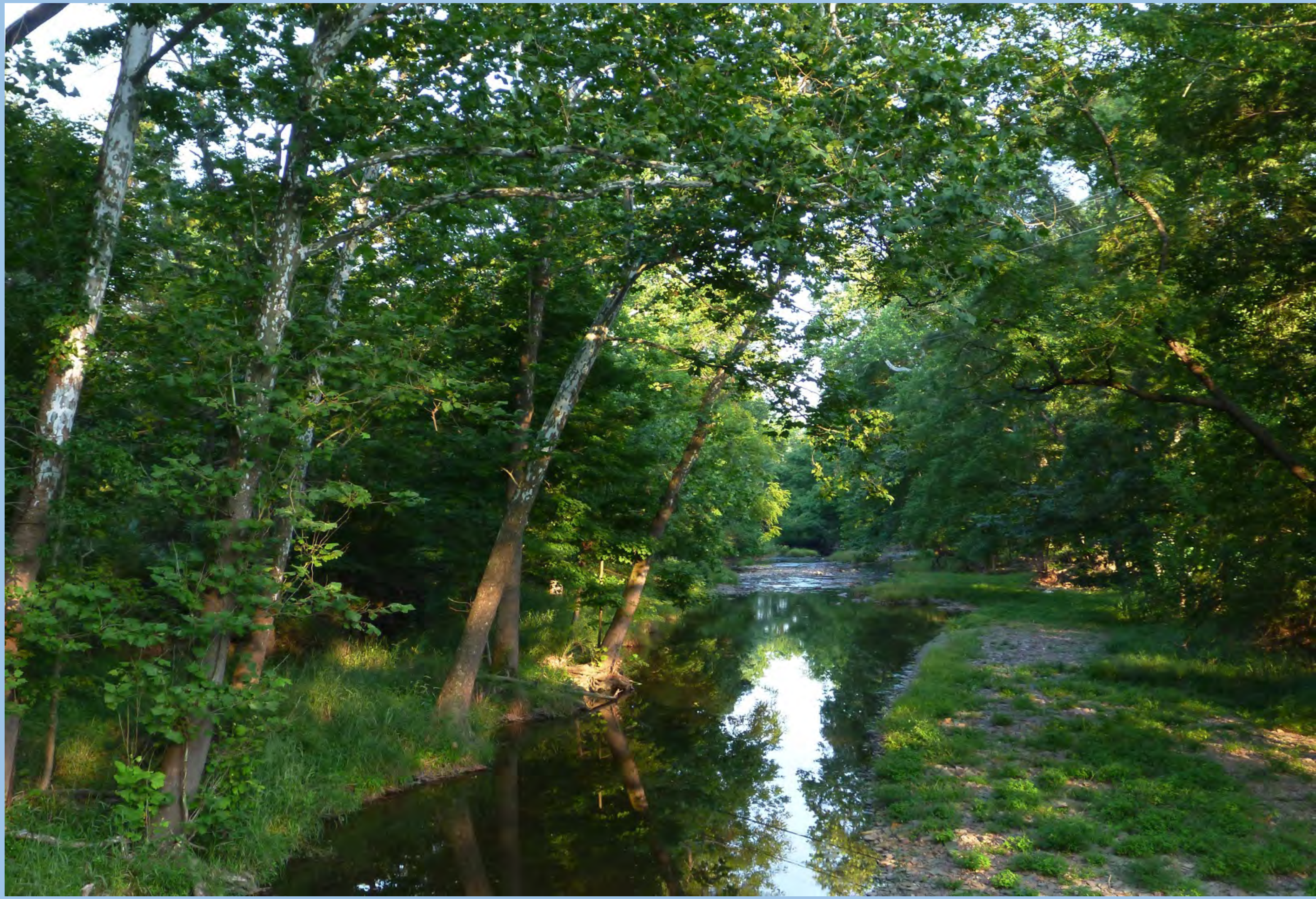
See Site Specific Safety Issues at the Headquarters Road Bridge, Mark L. Stout, PhD

A Solution To Solve a Non Existent Traffic Problem

PennDOT has yet to design a viable replacement plan that would handle expected traffic significantly better than the existing bridge. In fact, no-one has found a more efficient bridge solution than what is already there.

The current plan solves NO problem, but does create them, e.g. inflicting extensive permanent damage to Tinicum Creek and the historic resources around it, and creating new traffic safety concerns due to higher speeds.

The protected resources around the bridge can't realistically be removed, or reshaped to make more room for the oversized two-lane structure proposed.



Existing view downstream from Headquarters Road Bridge.

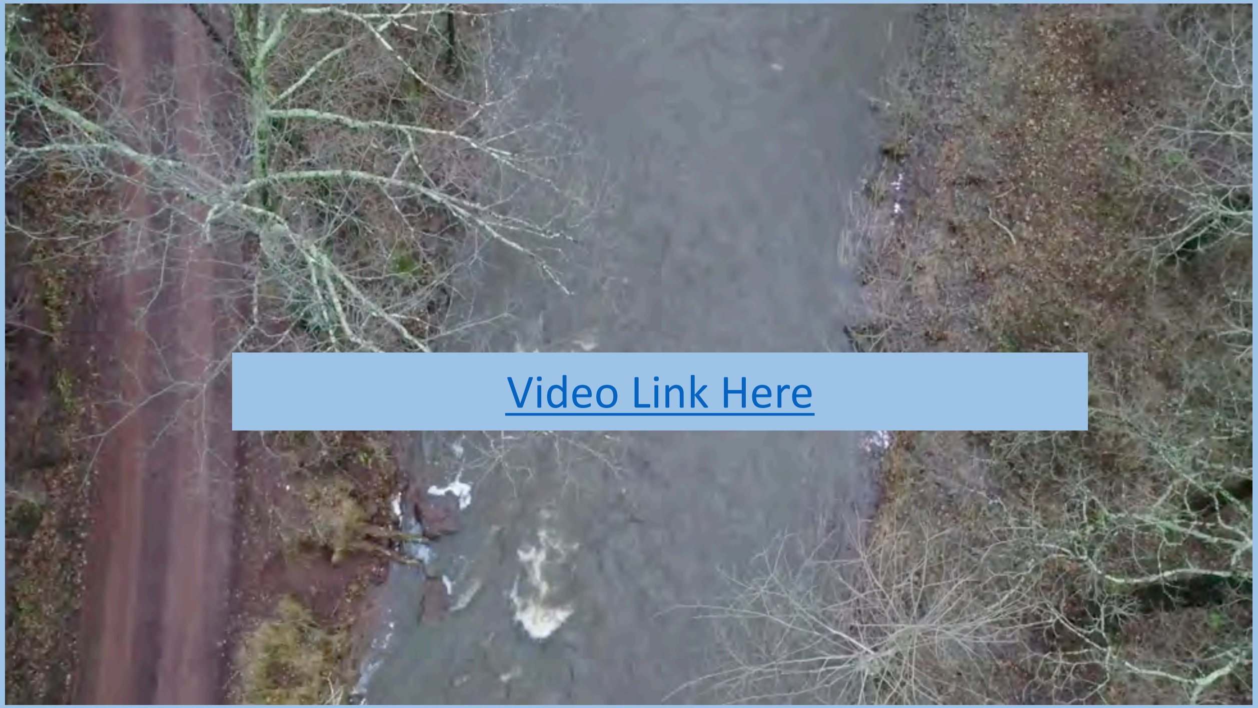
What PennDOT Didn't Consider in 2005 When It First Proposed Demolition of Headquarters Road Bridge

In 2005, when the political decision to demolish and replace Headquarters Road Bridge was made, the critical resources shown in this photograph, including the Historic District designation, were largely ignored and/or dismissed as evidenced by their disregard and/or dismissal in the original Purpose and Need statement used to justify the demolition proposal.

Subsequent amendments to the Purpose and Need Statement continue to ignore the irreplaceable history and natural values that will be irreparably harmed.

The only nod to our historic, environmental and rural heritage, and the tremendous community investment in their preservation has been to add a goal of being "sensitive to the historic and rural nature of the surrounding area."

Little Changes Create Big Problems in this Physically Constrained Site



Upstream of the bridge, boulders dumped in Tinicum Creek have diverted stream flow in the last 20 years, redirecting it from center channel to the downstream bridge abutment.

PennDOT's proposed response fails to consider less invasive and less costly natural channel design solutions and instead proposes to demolish the bridge and move the entire replacement 15' to the west to align it with the newly diverted channel.

Video demonstrates:

- Sensitivity, and volatility, of stream flows in response to channel modifications,
- That PennDOT proposal to pull back the historic bridge abutment 15 feet will wipe out the historic, and privately owned, downstream agricultural lands, and totally destabilize the stream channel so as to inflict erosion on downstream landowners and have unassessed downstream consequences,
- There are natural channel modification solutions for flow conditions that PennDOT has totally overlooked and ignored despite public and expert comment.

Changes Create Big Problems in this Physically Constrained Site

PennDOT's replacement structure moves the bridge abutment 15' to the west.

The impact?

To erode out the downstream buffer, preserved lands and private property, resulting in cascading downstream flow, erosion, habitat and water quality harms which are all being ignored.

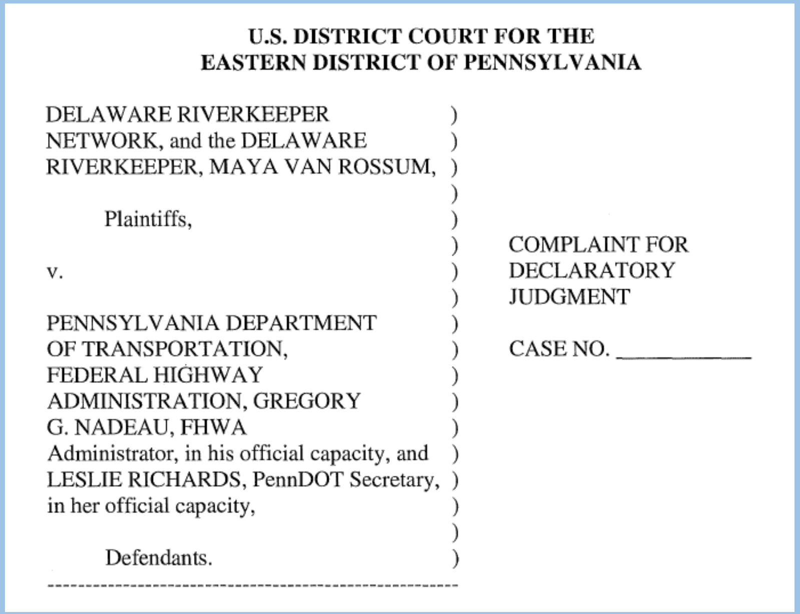
PennDOT's Plans Are So Controversial They are Untenable for the Community, Political Leaders, as well as Historic & Environmental Advocates The Outcome Will Be Years of Litigation Rather Than A Near-Term Solution

PennDOT's plans to:

- demolish this irreplaceable historic structure,
- inflict irreparable harm on an EV and Wild & Scenic designated stream,
- subject property owners to the State's onerous power of eminent domain,
- irreparably alter a nationally recognized historic district and collection of historic bridges unparalleled anywhere in the nation, and
- deprive our community of the economic values provided by these unrivaled historic and environmental resources,

are so controversial and problematic that years of delay are inevitable due to:

- Political Opposition,
- Community Opposition,
- Environmental Opposition,
- Litigation Opposition (including a first case already filed in the US District Court for the Eastern District of Pennsylvania challenging the decisionmaking process and failure of the state and federal agencies involved to fulfill their legal procedural legal obligations), &
- Eminent Domain Opposition


U.S. DISTRICT COURT FOR THE
EASTERN DISTRICT OF PENNSYLVANIA

DELAWARE RIVERKEEPER NETWORK, and the DELAWARE RIVERKEEPER, MAYA VAN ROSSUM,

Plaintiffs,

v.

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION, GREGORY G. NADEAU, FHWA Administrator, in his official capacity, and LESLIE RICHARDS, PennDOT Secretary, in her official capacity,

Defendants.

COMPLAINT FOR DECLARATORY JUDGMENT

CASE NO. ____________

The Needs of Our Community, Protection of the Historic Headquarters Road Bridge and Preservation of the Exceptional Value Tinicum Creek can all be achieved through rehabilitation of the one-lane Headquarters Road Bridge, within its current footprint, coupled by natural channel restoration of Tinicum Creek to enhance flow and habitat.

All That is Needed is Leadership.

Comments on the PennDOT Determination of Effects Report on the Headquarters Road Bridge

A report prepared for the Delaware Riverkeeper by:

Mark L. Stout, PhD
Mark L. Stout Consulting

14 December 2015

The Determination of Effects report asserts that there is a "site-specific safety problem" at the Headquarters Road Bridge. This is a critical assertion – one that leads the authors to conclude that the bridge fails a critical test in the AASHTO Design Policy: "AASHTO states that existing bridges can remain in place without widening unless there is evidence of a site-specific safety problem related to the bridge." The evidence cited for a site-specific safety problem is "the existing design deficiencies and statistically high crash rates related to these deficiencies." The report refers the reader to a previous PennDOT document, the Bridge Width Evaluation report, for a summary of reported crashes.

The PennDOT "site-specific safety problem" argument, as set out briefly in the DOE report and discussed in more detail in the Bridge Width Evaluation report, has four main components:

1. There are many geometric deficiencies in the existing bridge design and its approach roadways, which could induce more frequent crashes,
2. The crash rate in the vicinity of the bridge is higher than at comparable locations,
3. There is a history of crashes which is consistent with these findings, and
4. A one-lane bridge impedes emergency vehicle access.

These arguments will be addressed in turn.

1. Geometric deficiencies

The report states that a one-lane bridge at this location does not meet PennDOT design standards and implies that this "design deficiency" contributes to a site-specific safety problem. Although a design manual is a useful and important document for establishing standards, it is not a substitute for site-specific design and does not guarantee the "safest" outcome in a particular set of circumstances. In fact, as we have argued in a previous report (*Tinicum Township and the Headquarters Road Bridge: Planning the Future*, 14 April 2014), it is by no means certain that a two-lane bridge is safer than a one-lane bridge in all cases:

> A literature review was conducted to see if there was previous research and/or analysis of roadway safety at one-lane bridges and research and/or analysis of one-lane versus two-lane bridges. No applicable specific research was found on either subject, but some anecdotal information about the traffic calming effects of one-lane bridges was found. It was asserted that due to the narrowing of the roadway to one lane, traffic naturally slows down. An analogy would be the installation of a one-lane "choker" and/or a neck-down. A choker narrows the width of a roadway, generally at mid-block locations, to "allow travel in only one direction at a time, operating similarly to one-lane bridges." Neck-downs are similar in nature but are at intersections. The Institute of Transportation Engineers (ITE) estimates that speed is reduced by 14% when one-lane chokers are implemented for roadway

widths under 20 feet and greater than 17 feet. Speed reduction can enhance safety and, if a crash does occur, severity has a tendency to be reduced at the lower speeds. The same ITE reference also states that one-lane chokers can have a traffic volume reduction of 20%. A reduction in volume also decreases the risk of a crash and can enhance the safety of the location.

The DOE report does not explicitly address other potential design deficiencies in the area, but it should be presumed that the "deficiencies" referenced here include those addressed in the Bridge Width Evaluation report. These include sight distance, horizontal curves, and approach grades (turning radius will be discussed below in connection with emergency vehicle access). This is, in fact, a rural area, with wooded slopes and steep and winding roads. The report notes that "many" of the alternatives analyzed "are not able to fully address these existing substandard criteria." There is no discussion of how or to what extent the preferred alternative (presumably Alternative 6) addresses these issues. All of these alternatives, including Alternative 6, would likely require design exceptions to address the real issues of designing a project in this type of environment. In fact, a STOP sign in advance of the bridge on the western approach would resolve the sight distance issue, while improved road markings and signage should reduce the incidence of run-off-the-road events and other problems that might be associated with horizontal curves and grades near the bridge.

2. Crash rate

The DOE report refers to "statistically high crash rates," which is presumably based on the safety discussion in the Bridge Width Evaluation report. The BWE report provides a summary of crash data and argues that both the accident rate and crash intensity rates are "well above the statewide average." It is important to note that this analysis is based on a total of 10 crashes reported over 10-year period. It seems excessive to base significant conclusions on such a small sample. Indeed, even the BWE report states that no "crash clusters" could be identified because the small numbers could not meet the minimum threshold for that status. And although the statistics cited by PennDOT provide a minimal control for the overall level of development (rural) and traffic counts, these do not account for the local terrain (steep slopes and winding valleys) or the status of the roadway network (shifting bridge closures and attendant detours). A statistical analysis, in fact, provides only a general look at an area and should be subordinate to an analysis of the actual crashes at the location.

3. Crash history

As the Determination of Effects report notes, a narrative summary of the crash history for the area in the last 10 years before the bridge was closed is provided in the BWE report. The BWE narrative is based on another report, the "PennDOT Crash History Summary," which is listed as Attachment 7 to the BWE report. Portions of this document have been made available to us to review, but the actual crash records have not.

We were able, however, to review 10 crash reports which were supplied by Tinicum Township for the period 2003 to 2010 in the area of the bridge. A comparison of the 10 records supplied by Tinicum Township and the summary analysis in the "PennDOT Crash History Summary" suggests that the two lists may not be identical, although without seeing the actual records reviewed by PennDOT it is impossible to be certain.

Our review of the crash records received from Tinicum Township yields a very different conclusion from the one set out in the BWE and DOE reports.

Of the 10 crash reports reviewed, 3 are located on or at the Headquarters Road Bridge, 1 is nearby, and 6 are unrelated.

Following are the reported crashes on or at the bridge:

- 24 October 2003 – A vehicle driving westbound on Headquarters Road attempted a left turn onto the bridge and slid on an icy road surface on the bridge, resulting in contact with the bridge wall (see figures 1 and 2).
- 1 April 2006 – An unregistered, uninsured vehicle left the scene of the crash while the driver and passengers were out for a "joyride." Details of the crash are minimal but do indicate that contact was made with the Jersey barrier on the bridge.
- 7 May 2006 – A motorcyclist reported losing control of his eastbound motorcycle on loose gravel as he entered the bridge (see figures 3 and 4).

While the width of the bridge (a 10-foot cartway at the time) may have been a minor factor in these crashes, it does not appear that bridge width was the primary causal factor in any of these crashes.

The partial "PennDOT Crash History Summary" also identifies only 3 crashes at the bridge, a fact which was not included in the summary discussions in the BWE and DOE documents.

A fourth crash, on 6 July 2007, appears to have been near the bridge. A vehicle driving westbound was reported as having made contact with a fence or wall near the bridge. Based on the limited description and the police sketch (figure 5), the vehicle probably made contact with the fence on the western end of the bridge (figure 6).

Of the 6 remaining crashes, 1 occurred on Sheephole Road (10 February 2003), as two vehicles collided under icy conditions. The remaining 5 were all associated with the curve located approximately 250 feet east of the intersection of Headquarters Road and Sheephole Road:

- 24 May 2005
- 26 September 2008
- 21 January 2009
- 5 May 2009
- 16 March 2010

Of the crashes at the curve, 3 occurred when the road surface was wet and all 5 involved a westbound vehicle crossing the centerline (see figures 7 and 8). These crashes are all well beyond the influence of Headquarters Road Bridge, but do indicate a "hotspot" where PennDOT should consider upgrading such safety measures as signing and striping.

Our conclusion from reviewing the crash history in the vicinity of the Headquarters Road Bridge is that this history provides no evidence of a site-specific safety problem at that bridge.

4. Emergency vehicle access

The DOE report repeats PennDOT's assertion, made in previous documents, that one of the needs of the project is the fact that the existing structure "cannot safely and effectively accommodate current and future traffic needs including emergency response vehicles." With a curb-to-curb width of 16 feet, the bridge "cannot accommodate Tinicum Township's largest fire response vehicle, a 41.5-foot ladder truck." In fact, this ladder truck – Ladder 49 of the Ottsville Volunteer Fire Company – operated across the Headquarters Road Bridge when it had a 10-foot cartway. In an interview (a summary of which is attached), the fire chief of the Ottsville Fire Company confirmed that Ladder 49 could operate on a 16-foot bridge, although it would need to back up once to make the left turn into Sheephole Road, a common procedure in the township. He would also find a cutback of the embankment on the east side of the bridge desirable.

A wider bridge is <u>not</u> necessary to accommodate fire company operations. A traffic engineering analysis conducted for us by MBO Engineering in 2013 found the following:

> MBO Engineering has reviewed the 2009 turning radius study done by Urban Engineers for the Headquarters Road Bridge, discussed the possible scope of

work of a bridge rehabilitation project with McMullan Engineering, and undertaken multiple field visits in the vicinity. Based on this work, MBO Engineering believes that it is possible to satisfy the turning radius needs identified by Urban within the scope of a bridge rehabilitation project that includes some reconstruction of the wingwalls at the eastern end of the bridge, some reduction of the slope in the northeast quadrant of the bridge, and possibly some adjustment of the curb-to-curb width of the proposed new bridge deck.

Figures

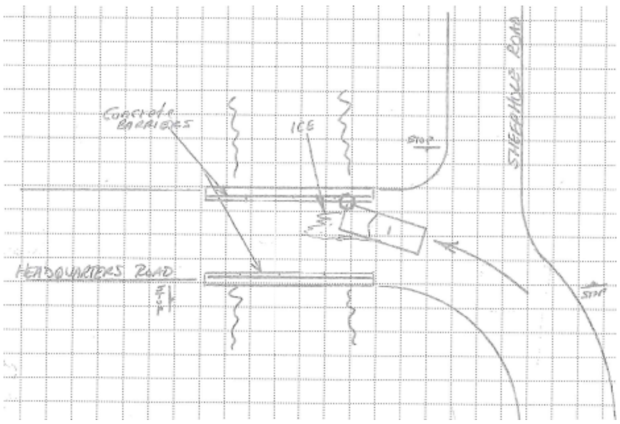


Figure 1
Police sketch of 24 October 2003 crash, vehicle skidding
on icy surface into Jersey barrier

Figure 2
Jersey barrier on Headquarters Road Bridge, showing impact scrapes,
possibly resulting from the 24 October 2003 crash

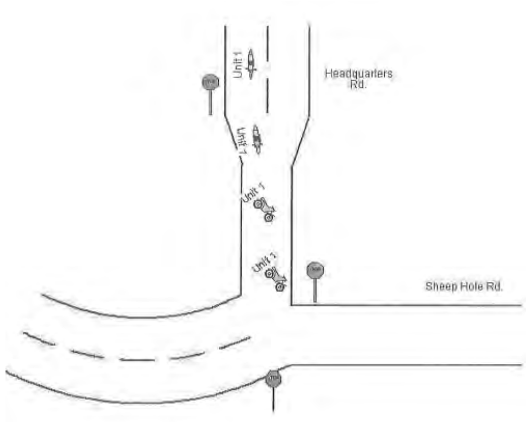


Figure 3
Police sketch of 7 May 2006 crash, motorcyclist losing control on loose gravel

Figure 4
Eastbound view of Headquarters Road Bridge in the area in which the motorcyclist lost control in the 7 May 2006 crash

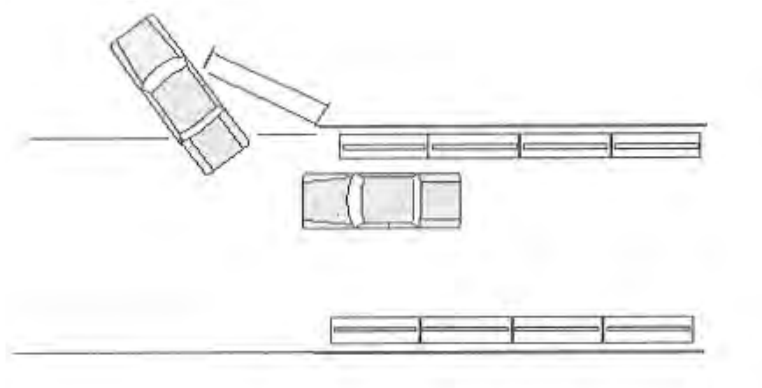


Figure 5
Police sketch of 6 July 2007 crash, impact on the fence to the west of the bridge

Figure 6
The fence to the west of the bridge, the apparent site of impact in the 6 July 2007 crash

Figure 7
Westbound view of the curve on Headquarters Road located 250 feet east of the intersection with Sheephole Road, the site of 5 crashes within the reporting period

Figure 8
Guiderail along the Headquarters Road curve, showing signs of multiple impacts

Attachment A
Meeting with Ottsville Fire Chief Bill Shick
14 October 2015

Bill Anderson and Mark Stout met with Bill Shick, Fire Chief of the Ottsville Volunteer Fire Company, at the Ottsville Firehouse on October 14 for approximately one hour. Following the meeting, he took us on a tour of local roads on Ladder 49, the Company's longest truck.

Key points:

- Chief Shick stated that as fire chief, he has no preference whether a one-lane or a two-lane bridge is built; his priority is to get a bridge opened as soon as possible. He thinks it is important to inject a sense of urgency into the discussions. I explained that in my view, the rehabilitation option would be completed more quickly.
- Ottsville will soon open a second firehouse in the northern portion of the district. The equipment being relocated to the new firehouse will not include Ladder 49 or Rescue 49, the two vehicles identified as having turning radius issues.

Chief Shick discussed in detail the routing issues associated with the Headquarters Road Bridge:

- With the closing of the Headquarters Road Bridge, the main detour route for Ladder 49 from the Ottsville Firehouse to Sheephole Road is Geigel Hill Road – Tankhannen Road – Ridge Valley Road – Headquarters Road. The detour route takes 3 minutes longer than the route over Headquarters Road Bridge. Since Tankhannen Road is unpaved, with tight curves and steep grades, Chief Shick explained that individual drivers of Ladder 49 may choose a slightly longer detour route (Geigel Hill Road – Ridge Valley Road – Headquarters Road) if they feel it is safer. The longer detour route adds another 2 minutes.
- Ladder 49 cannot enter or exit Sheephole Road at Geigel Hill Road. This means that the vehicle must reverse direction in a private driveway on Sheephole Road (a time consuming maneuver) in order to leave Sheephole Road the way it arrived, via Headquarters Road.
- Rescue 49 is a shorter vehicle but with a long wheelbase, so it also has turning radius challenges, although not as serious as Ladder 49. Rescue 49 can enter Sheephole Road via the Geigel Hill Road intersection, but needs to exit via Headquarters Road.
- The jurisdiction of the Ottsville Company extends to the east along Headquarters Road as far as Municipal Road, where Del Val company (based in Erwinna) assumes primary coverage. Even with the detours related to Headquarters Road Bridge, the Ottsville Company can reach this area of Headquarters Road faster than equipment from Erwinna.

We spent some time onsite at the Headquarters Road Bridge and talked about structural and geometric options:

- Chief Shick repeated that he would be happy with any width bridge that allowed the connection to reopen, even though some Ottsville equipment picked up “scrapes and bangs” when the bridge was open and the Jersey barrier was in place.
- With a 16-foot wide bridge, Ladder 49 needed to back up once to make the left turn onto Sheephole Road. Chief Shick does not consider that to be a problem, as the same situation exists in a number of places within the fire company’s coverage area.
- Chief Shick would welcome a cutback of the embankment on the east side of the Bridge. He estimated that a 5-foot cutback would enable the largest fire apparatus to make the left turn without a backup.
- Chief Shick would be happy with a 16-foot wide bridge, although he thinks 18 feet would be better. He sees no benefit for his trucks in widening to 24 feet.

Attachment B
Mark L. Stout Consulting team qualifications

Mark Stout is an independent transportation consultant and is principal of Mark L. Stout Consulting. His consulting practice addresses a wide range of transportation policy issues, including state and federal funding challenges, climate change, organizational transformation, and Smart Growth planning. His clients include state transportation departments, national and state nonprofit and advocacy groups, and metropolitan planning organizations. His recent work includes providing strategic planning advice to a state DOT; directing a regional multimodal strategic land development plan for a local government; coaching a medium-sized MPO in setting up a Smart Growth transportation program; providing policy support for a national transportation reform group, including making recommendations for supporting state DOT transformation in reauthorization legislation; helping state DOTs to collaborate with environment and energy agencies on a regional basis in addressing transportation and climate change issues; and coaching several state advocacy groups in the skills needed to engage state DOTs in project selection and capital programming.

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William E. Anderson is a traffic engineer who had a 31-year career at the New Jersey Department of Transportation involving traffic engineering and traffic safety. He managed statewide highway safety programs and led a multi-disciplinary team responsible for reviewing high-profile crash locations. He served as Manager of the Bureau of Traffic Engineering and Safety Programs from 1993 to 2001, responsible for approval of all traffic control devices on state, county, and municipal roadways.

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He has been a member of the Adjunct Faculty of the Rutgers University School of Government Services, where he developed and taught two courses: Traffic Engineering for Police Officers and Advanced Traffic Engineering for Police Officers. These courses provided training in the application of the Manual on Uniform Traffic Control Devices and the identification and analysis of traffic safety problems.

He is currently a member of the National Committee on Uniform Traffic Control Devices and the New Jersey Governor's Highway Traffic Safety Policy Advisory Committee.

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To: Maya van Rossum, Delaware Riverkeeper
From: Mark Stout
Subject: Supplement to my 14 December 2015 ñComments on the PennDOT Determination of Effects Report on the Headquarters Road Bridgeò report
Date: 18 January 2016

In our report to you entitled ñComments on the PennDOT Determination of Effects Report on the Headquarters Road Bridge,ò dated 14 December 2015, we analyzed the assertion in PennDOTôs report that there is a ñsite-specific safety problemò at the Headquarters Road Bridge and found it unpersuasive. An important element of that analysis was a review of the crash history at the bridge. We reviewed (1) ten Tinicum Township police reports of accidents in the vicinity of the bridge for the period 2003 to 2010 provided to us by the township and (2) those elements of the ñPennDOT Crash History Summaryò which were available to us at the time. Since the submission of our 14 December report, we have received previously missing information from the ñPennDOT Crash History Summary,ò specifically, the ñCDART Crash Resume Data,ò a summary of the ten accidents PennDOT used in reaching the conclusions stated in the Determination of Effects report. The purpose of these supplementary remarks is to review our assessment in light of the fresh data received.

You will recall that in our analysis of the 10 accident reports provided by Tinicum Township we determined that 3 were located on or at the Headquarters Road Bridge, 1 was nearby, and 6 were unrelated to the bridge. This determination was based on a review of the narratives and sketches included in the police reports as well as field visits. My colleague Bill Anderson, an experienced traffic engineer and former Manager of the Bureau of Traffic Engineering at the New Jersey Department of Transportation, played a critical role in this analysis.

The partial ñPennDOT Crash History Summaryò available to us for our 14 December 2015 report also identified only 3 crashes actually located at the bridge out of a total of 10 crashes summarized. However, as we stated at the time, comparison of the 10 records supplied by Tinicum Township and the summary analysis in the ñPennDOT Crash History Summaryò suggested that the two lists might not be identical.

The new data enables us to compare the two lists in detail. The newly available PennDOT ñCDART Crash Resume Dataò provides summary data for 10 accidents, including exact location by milepost and ñoffsetò (distance in feet from the nearest milepost).

A collision diagram illustrating the crashes found in the lists is attached. The diagram is based on details identified in the crash reports and on locations referenced to the PennDOT Straight Line Diagram.

We find the following in comparing the two lists:

- Only 3 crashes are on both the Township and PennDOT lists.
- All 3 duplicate reports are of crashes at or near the bridge.
- Of the 7 PennDOT reported crashes which are not on the Township list (and are also not at or near the bridge), 5 are located to the west of the bridge (4 of these west of the intersection with Red Hill Road) and 2 are located east of the bridge in the area of the curve discussed in our 14 December 2015 report. **None of these 7 crashes has any relation to Headquarters Road Bridge.**

The 3 crashes identified on both lists are:

1. 24 October 2003. Our description (from the 14 December 2015 report): ñA vehicle driving westbound on Headquarters Road attempted a left turn onto the bridge and slid on an icy road surface on the bridge, resulting in contact with the bridge wall.ò This crash occurred at the bridge but in our opinion was not caused by the geometry of the bridge. There is nothing in the CDART Crash Resume Data report to contradict this assessment.
2. 7 May 2006. Our description: ñA motorcyclist reported losing control of his eastbound motorcycle on loose gravel as he entered the bridge.ò This crash occurred at the bridge but in our opinion was not caused by the geometry of the bridge. There is nothing in the CDART Crash Resume Data report to contradict this assessment.
3. 6 July 2007. Our description: ñA vehicle driving westbound was reported as having made contact with a fence or wall near the bridge. Based on the limited description and the police sketch, the vehicle probably made contact with the fence on the western end of the bridge.ò PennDOT evidently considers this crash to be at the bridge. We believe it occurred at some point west of the bridge, not at the bridge. The location data provided by PennDOT is ambiguous, but the police narrative, sketch, and coding (ñhit fence or wall,ò as distinguished from other possible choices, such as ñhit bridge pier or abutment,ò ñhit parapet end,ò ñhit bridge rail,ò or ñhit concrete or longitudinal barrierò) all suggest contact with the fence west of the bridge. In any event, in our opinion the crash was not caused by the geometry of the bridge. There is nothing in the CDART Crash Resume Data report to contradict this assessment.

There is one crash on the Township list ï but not on the PennDOT list ï which we determined to be at the bridge:

1 April 2006. Our description: ñAn unregistered, uninsured vehicle left the scene of the crash while the driver and passengers were out for a ñjoyride.ò Details of the crash are minimal but do indicate that contact was made with the Jersey barrier on the bridge.ò This crash occurred at the bridge but in our opinion was not caused by the geometry of the bridge.

We draw the following conclusions from this analysis:

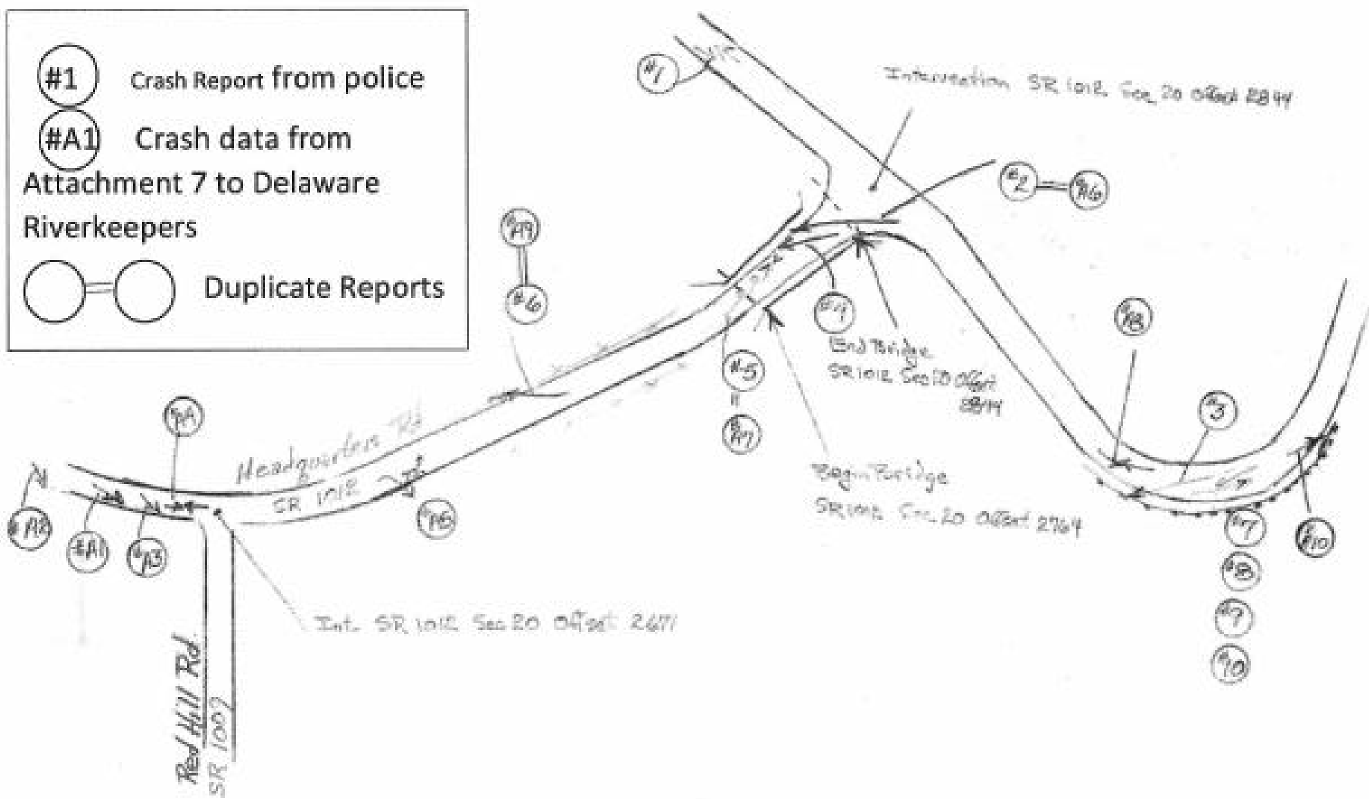
First, there were ï at most ï 4 crashes on or at the Headquarters Road Bridge during the last ten years of its service.

Second, the ñPennDOT Crash History Summaryò leaves the impression that 10 crashes occurred on or at the bridge, when the CDART Crash Resume Data report clearly identifies only 3.

Third, there is no evidence that the 3 (or 4 using a more generous definition) crashes that occurred on or at the bridge were caused in any way by the geometry or condition of the bridge.

Fourth, the crash history points to problems at the curve to the east of the bridge (which we discussed in the 14 December 2015 report) and at the curve west of Red Hill Road (which we did not analyze but which show several accidents in the PennDOT data), not at the bridge.

Finally, the additional data provided in the CDART Crash Resume Data report reinforces our opinion that the crash history does not support the conclusion that there is a site-specific safety problem at the Headquarters Road Bridge.



COLLISION DIAGRAM

Headquarters Rd near Bridge over Tinicum Creek

Tinicum Twp., Bucks Co.

12/21/2015

Site-Specific Safety Issues at the Headquarters Road Bridge

A report prepared for the Delaware Riverkeeper Network by:

Mark L. Stout, PhD
William E. Anderson
Mark L. Stout Consulting

7 July 2016

"Safety" has been frequently invoked by PennDOT as part of its case for demolishing the Headquarters Road Bridge and replacing it with a larger structure. Our analysis shows that there are no persuasive safety arguments to support such a project.

In a very general sense, safety has been included in "purpose and need" statements, as in the Determination of Effects (DOE) report:

> The purpose of this project is to provide a crossing for Headquarters Road over Tinicum Creek, which is structurally sound and capable of **safely** and effectively handling the expected vehicular need of the public and emergency services of the surrounding area [emphasis added].[1]

More specific safety issues have been raised to support the assertion that there is a "site-specific safety problem" at the bridge. If the existence of a site-specific safety problem could be established it would not only support PennDOT's purpose and need statements, it would also provide a plausible reason for denying the agency's ability to apply flexible design standards there. As stated in the DOE report:

> AASHTO [the American Association of State Highway and Transportation Officials] states that existing bridges can remain in place without widening unless there is evidence of a site-specific safety problem related to the width of the bridge.[2]

PennDOT's rationale for concluding that there is a site-specific safety problem has changed over time. In the DOE report, the agency asserted that: "Given the existing design deficiencies and statistically high crash rates related to these deficiencies, there is a site-specific safety problem."[3]

The more recent Comment Response Document (CRD) puts forward two new rationales. First:

> Based on existing sight distance issues, sharp horizontal curvature along the eastern approach leading into the bridge, the inability of the Ottsville Ladder 49 truck to negotiate the turn from Sheephole

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[1] Determination of Effects Report (DOE), November 2015, 6.

[2] DOE, 15.

[3] DOE, 15.

> Road onto Headquarter (sic) Road Bridge in one complete turn, and evidence of repeated impacts to the bridge prior to a reduction in its width in 2000 and 2001, there is a site specific safety issue.[4]

And later:

> It is our professional engineering judgement given the intersection and bridge configuration and estimated traffic volumes, that the site specific safety problem is related to a one-lane bridge. We have received feedback from local residents about near head-on collisions from speeding drivers approaching the one-lane crossing. A two lane bridge would mitigate this hazard.[5]

These rather loose definitions of "site-specific safety problem" have been accompanied by a number of specific safety-related arguments, some of which have been abandoned, some of which of been added, and some of which have changed over time. The purpose of this paper is to summarize and analyze all of the shifting safety arguments that have been put forward by PennDOT. We believe that our analysis will demonstrate that there is no site-specific safety problem at the Headquarters Road Bridge.

We will refer to three PennDOT documents:

- The Determination of Effects report (DOE), November 2015, which sets out the basic arguments for the replacement project,
- The Comment Response Document (CRD), June 2016, which provides responses to comments (including ours) submitted to the DOE report, and
- The Bridge Width Evaluation report (BWE), April 2015, which was used as a source document for the DOE report.

Some of the analysis included in this report was included in previous reports made by Mark L. Stout Consulting to the Delaware Riverkeeper Network, all of which were submitted to the project record.

The following PennDOT arguments will be treated:

1. One-lane bridges are inherently less safe than two-lane bridges,
2. A statistical analysis shows a high accident rate at the Headquarters Road Bridge,
3. Analysis of the crash history supports the findings stated in 1 and 2 above,

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[4] Comment Response Document (CRD), June 2016, 10.

[5] CRD, 58.

4. A wider bridge is needed to accommodate emergency vehicles,
5. Sight distance and alignment are substandard on either side of the bridge,
6. A head-on collision was reported to be narrowly averted at the bridge,
7. There were reports of other collisions at the bridge, and
8. School buses have been reported to have had difficulties using the bridge.

1. Bridge width

PennDOT has noted that a one-lane bridge at this location does not conform to its current design manual and has implied that this raises a safety issue:

> Due to the existing structure's geometry and limited roadway width, it cannot safely and effectively accommodate current and future traffic needs.[6]

Specifically:

> PennDOT uses roadway classification and ADT estimates [traffic volumes] to assess [presumably using the PennDOT Design Manual] **safe** roadway and bridge widths [emphasis added].[7]

The implication - never directly stated - is that this "design deficiency" contributes to a site-specific safety problem. Although a design manual is a useful and important document for establishing standards, it is not a substitute for site-specific design and does not guarantee the "safest" outcome in a particular set of circumstances. In fact it is by no means certain that a two-lane bridge is safer than a one-lane bridge in all cases. A literature review was conducted to see if there was previous research regarding roadway safety at one-lane bridges or one-lane versus two-lane bridges. No applicable specific research was found on either subject. We would argue, in fact, that one-lane bridges can have a "traffic calming" effect by reducing traffic speeds.

2. Statistical accident analysis

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[6] DOE, 7.

[7] DOE, 15.

The DOE report, as previously noted, refers to "statistically high crash rates" related to design deficiencies.[8] As we pointed out in a previous report, which was submitted as a comment to PennDOT, this statement is apparently based on the safety discussion in the Bridge Width Evaluation report.[9] The BWE report provides a summary of crash data and argues that both the accident rate and crash intensity rates are "well above the statewide average." It is important to note that this analysis is based on a total of 10 crashes reported over 10-year period. It seems excessive to base significant conclusions on such a small sample. Indeed, even the BWE report states that no "crash clusters" could be identified because the small numbers could not meet the minimum threshold for that status. And although the statistics cited by PennDOT provide a minimal control for the overall level of development (rural) and traffic counts, these do not account for the local terrain (steep slopes and winding valleys) or the status of the roadway network (shifting bridge closures and attendant detours). A statistical analysis, in fact, provides only a general look at an area and should be subordinate to an analysis of the actual crashes at the location.

While PennDOT appeared to lay great store in this statistical analysis in the DOE and BWE reports, in the CRD report they have conceded that statistical analysis was merely a "starting point."[10] They attempt to retain some credibility for their statistical analysis by noting out that in the BWE report "the crash rate was calculated for 3 crashes in the most recent 5 year period," which, when compared with the low traffic volume in the area, results in "a crash rate that is significantly higher than the statewide average."[11] It is not clear which three crashes PennDOT is alluding to, but given that only three crashes in the list of ten that they analyzed for a ten-year period were even located at the bridge – and none of them apparently related to the geometry of the bridge – this is a very slender reed to base a statistical analysis on. As we shall see, the "starting point" that this analysis supposedly provided leads nowhere when the actual crash history is examined.

3. Crash history

[8] DOE, 15.

[9] Bridge Width Evaluation (BWE) report, April 2015, 6.

[10] CRD, 13.

[11] CRD, 13.

PennDOT's assertions regarding the crash history in the vicinity of the Headquarters Road Bridge were only presented in summary form in the Bridge Width Evaluation and Determination of Effects reports and as a result prevented any ability to understand or assess the accuracy of PennDOT's determinations regarding the implications of the accident for its claim of unsafe conditions due to the Headquarters Road Bridge. It required a Freedom of Information Act process for the Delaware Riverkeeper Network to obtain the actual list of crashes upon which PennDOT's conclusions were based.

Of the 10 crashes on PennDOT's list, only 3 occurred on or at the Headquarters Road Bridge. Of the 7 PennDOT reported crashes which were not at or near the bridge, 5 were located to the west of the bridge (4 of these west of the intersection with Red Hill Road) and 2 were located east of the bridge. **None of these 7 crashes has any relation to Headquarters Road Bridge.**

We were able to analyze the 3 crashes at or near the bridge using police records. Our analysis showed the following:

1. 24 October 2003. A vehicle driving westbound on Headquarters Road attempted a left turn onto the bridge and slid on an icy road surface on the bridge, resulting in contact with the bridge wall. This crash occurred at the bridge but was not caused by the geometry of the bridge. There is nothing in the CDART Crash Resume Data report, obtained from PennDOT using the Freedom of Information Act, to contradict this assessment.
2. 7 May 2006. A motorcyclist reported losing control of his eastbound motorcycle on loose gravel as he entered the bridge. This crash occurred at the bridge but was not caused by the geometry of the bridge. There is nothing in the CDART Crash Resume Data report to contradict this assessment.
3. 6 July 2007. A vehicle driving westbound was reported as having made contact with a fence or wall near the bridge. Based on the limited description and the police sketch, the vehicle probably made contact with the fence on the western end of the bridge. PennDOT evidently considers this crash to be at the bridge. We believe it occurred at some point west of the bridge, not at the bridge. The location data provided by PennDOT is ambiguous, but the police narrative, sketch, and coding ("hit fence or wall," as distinguished from other possible choices, such as "hit bridge pier or abutment," "hit parapet end," "hit bridge rail," or "hit concrete or longitudinal barrier") all suggest contact with the fence west of the

bridge. In any event, in any event, the crash was not caused by the geometry of the bridge. There is nothing in the CDART Crash Resume Data report to contradict this assessment.

In its most recent document, PennDOT has now conceded that "upon a more detailed investigation" (presumably following our detailed investigation) that "the police do not report that the accidents were directly caused by the bridge."[12] PennDOT does hold open the possibility that the 3 crashes at the bridge may have some value for their case, however: "Even though the width of the bridge may not have been the direct cause of the crashes on the bridge, it is not possible to rule out that there could be geometry and/or drainage issues (i.e., wide turns coming off the single lane bridge; icy roadways and debris indicate drainage issues that can form a site-specific safety concern and should be addressed)."[13] A review of the description of the three accidents cited above will reveal that none of these conjectures has any basis in the police reports.

4. Emergency vehicle access

PennDOT has continually expressed concern about the ability of the Headquarters Road Bridge, assuming a curb-to-curb width of 16 feet, to accommodate emergency vehicles. Although sometimes stated in broad terms, the specific issue always raised is the ability of the Ottsville Fire Company's longest vehicle, Ladder 49, to make (1) a left-hand turn from the bridge onto Sheephole Road in one continuous move and (2) a left-hand turn from Headquarters Road onto the bridge.

Our research showed that the bridge did in fact accommodate the largest vehicles available to the Ottsville company, even when at a reduced 10-foot width, although not all turns could be done in one move. With the bridge closed, of course, no emergency vehicles at all can cross it. The fire chief has stated repeatedly that his highest priority is not to secure a wider bridge but to have the bridge reopened as quickly as possible.

However, we have suggested in the past that if accommodating Ladder 49 is the highest priority, that can be accomplished by making minor improvements to the intersection of Headquarters Road and Sheephole

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[12] CRD, 10.

[13] CRD, 15.

Road, without altering the footprint of the bridge. An engineering study by Roberts Engineering, which will be presented for the record, has been done to establish that point.

5. Sight distance and alignment

The roadway network of Tinicum Township is characterized by narrow, winding, hilly roads which traverse a very rural, heavily wooded landscape. PennDOT has periodically called attention to sight distance and alignment issues in the vicinity of the bridge. For instance, the "sight distance and horizontal curve radius of the western approach…does not meet PennDOT safety criteria"[14] and the "sharp horizontal curvature along the eastern approach"[15] is also a concern. None of these identified approach roadway issues is asserted to be actually at the bridge or related in any way to traffic traversing it.

PennDOT concedes that sight distance and alignment will continue to be "substandard" for every alternative considered and that any effort to address these would substantially increase project size, cost, and impact. Therefore, "correcting the alignment and sight distance are not part of the project need but are part of the overall determination as to whether a site specific safety issue is present when considering design exceptions for other design criteria."[16]

We are left to conclude that PennDOT justifies demolishing the Headquarters Road Bridge and replacing it with a bigger structure at least in part because they have identified sight distance and alignment issues on the approach roads which (a) are typical of roads in Tinicum Township, (b) unrelated to the bridge itself, and (c) will not be addressed by the proposed bridge project.

6. Reported near head-on collision

In the Comment and Response document, PennDOT notes a comment by Marilyn Herd, a local resident, that she was "almost killed" by a speeding

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[14] DOE, 7.

[15] CRD, 10.

[16] CRD, 5.

motorist who failed to stop at the STOP sign at the western end of the bridge. They respond that "Incidents such as these which go unreported to police are important to consider in evaluating whether there is a site-specific safety issue."[17] Ms. Herd's comment is elsewhere cited as corroborating "an issue with vehicles negotiating turns onto the bridge,"[18] which it does not in fact appear to do. At another place, PennDOT uses "the feedback from local residents who have experienced near head-on collisions on the bridge"[19] to challenge the idea that a one-lane bridge can be safe here.

Are there other local residents in addition to Ms. Herd who have recounted these events? If not, this one reported incident is given far great significance than it should, especially since the immediate cause of the incident was a motorist's failure to comply with an authorized traffic control device (STOP sign), and there is in fact no information whatsoever to substantiate when, where, and if this incident happened as later recounted.

7. Reported 2001 collisions

PennDOT also makes reference in the Comment and Response document to (1) collision damage documented in 2000 and 2001 inspection reports and (2) a 2001 collision "which resulted in guiderail dislodging from the bridge and falling into the creek, and the subsequent placement of concrete barriers."[20] Without any further documentation it is impossible to assess whether these reports are at all useful in evaluating what has happened or may happen in the future at the bridge.

8. School buses

PennDOT has also made reference, in the Comment and Response document, to reported school bus problems. Although not included in their summary criteria for site-specific safety problems, the related

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[17] CRD, 49.

[18] CRD, 10.

[19] CRD, 19.

[20] CRD, 10.

discussion includes a reference to a comment by consulting party Tim Cashman in 2013 that school buses had "impacted the bridge when it was still open to traffic."[21] Again, without any further documentation it is impossible to assess whether this report is at all useful in evaluating what has happened or may happen in the future at the bridge.

Mark L. Stout Consulting team qualifications

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[21] CRD, 10.

PennDOT/NJDOT Smart Transportation Guidebook: Planning and Designing Highways and Streets that Support Sustainable and Livable Communities.

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Dr. Stout is a nationally recognized expert in transportation and land use planning, transportation and climate change, and transportation policy and legislation. He has published and spoken widely on transportation issues and produces his own "Smart Transportation Blog" (at www.mlstoutconsulting.com). He holds a BA in political science from Washington University in St. Louis and a PhD in political science from the London School of Economics.

William E. Anderson is a traffic engineer who had a 31-year career at the New Jersey Department of Transportation involving traffic engineering and traffic safety. He managed statewide highway safety programs and led a multi-disciplinary team responsible for reviewing high-profile crash locations. He served as Manager of the Bureau of Traffic Engineering and Safety Programs from 1993 to 2001, responsible for approval of all traffic control devices on state, county, and municipal roadways.

At Stantec Consulting he was the project supervisor for NJDOT planning and for operational review of task order assignments. He developed Traffic Impact Statements and Access Permits for private developer projects in New Jersey, Pennsylvania, and Virginia. He also conducted analyses of road-off-road crashes for the New Jersey Turnpike Authority on the Turnpike and Garden state Parkway.

He has been a member of the Adjunct Faculty of the Rutgers University School of Government Services, where he developed and taught two courses: Traffic Engineering for Police Officers and Advanced Traffic Engineering for Police Officers. These courses provided training in the application of the Manual on Uniform Traffic Control Devices and the identification and analysis of traffic safety problems.

He is currently a member of the National Committee on Uniform Traffic Control Devices and the New Jersey Governor's Highway Traffic Safety Policy Advisory Committee.

Roberts
ENGINEERING GROUP LLC
Women Business Enterprise Certified

1670 Whitehorse-Hamilton Square Rd.
Hamilton, New Jersey 08690
609-586-1141 fax 609-586-1143
www.RobertsEngineeringGroup.com

Preliminary Design for Intersection Improvements at Headquarters Road Bridge and Sheephole Road

Prepared for

Mark L. Stout Consulting

June 21, 2016

Our File No.: P1611

Mark L. Stout Consulting commissioned Roberts Engineering Group, LLC to evaluate alternatives other than the replacement of the Headquarters Road Bridge with a two-lane bridge. The Pennsylvania Department of Transportation has proposed the removal of the existing one-lane bridge and replacement with a larger two-lane bridge in order to accommodate emergency vehicles (PennDOT ID No. MPMS13716). Specifically, PenDOT has called attention to the movement of the largest vehicle in use by the Ottsville Volunteer Fire Company – Ladder 49 – which is currently unable to make the left-hand, westbound turn from Headquarters Bridge Road onto Sheephole Road in one continuous movement. The Delaware Riverkeeper Network (DRN) is seeking to preserve and rehabilitate the existing one-lane bridge rather than the replacement with a larger bridge.

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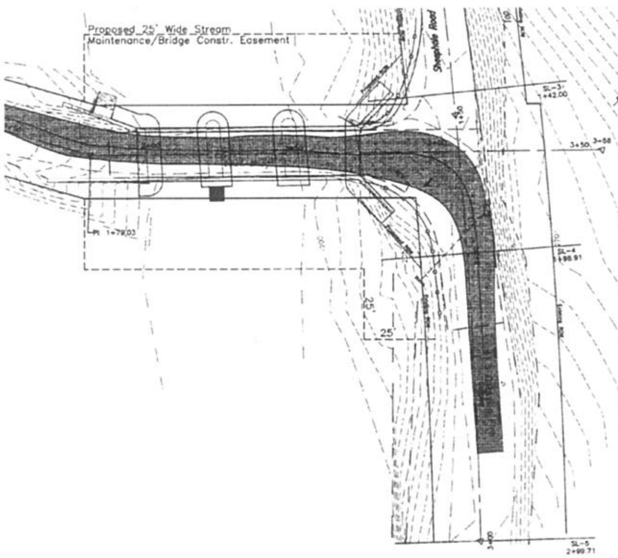
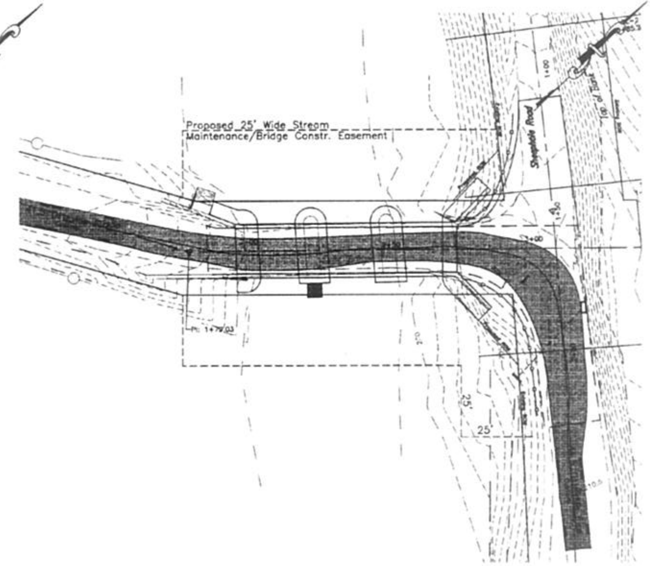


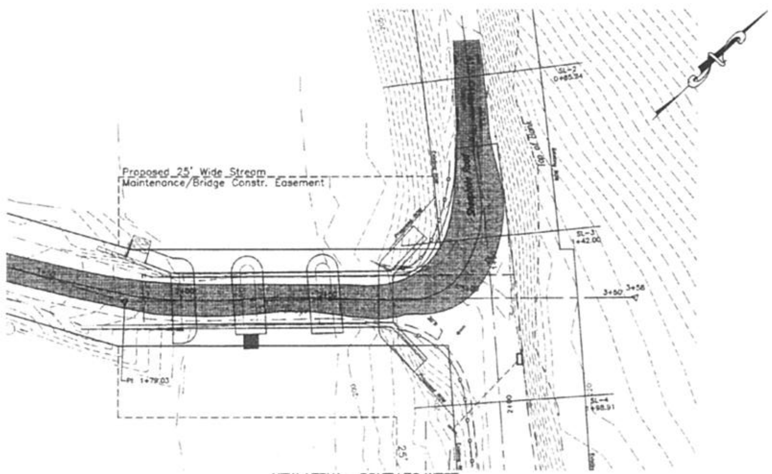
NEW AERIAL - EAST TO SOUTH

SCALE: 1"=20'



NEW AERIAL - SOUTH TO EAST

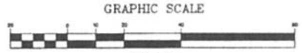
SCALE: 1"=20'



NEW AERIAL - SOUTH TO WEST

SCALE: 1"=20'

GRAPHIC SCALE



(IN FEET)
1 inch = 20 ft.

GENERAL NOTES:

1. THIS PLAN REFLECTS EXISTING SITE CONDITIONS AS THE RESULT OF AERIAL PHOTOS, TAX MAPS, AND A FIELD SURVEY PERFORMED BY ROBERTS ENGINEERING GROUP, LLC. DATED APRIL 21, 2016
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3. THIS PLAN IS SUBJECT TO ANY EASEMENTS OR AGREEMENTS, WHICH MAY OR MAY NOT BE OF THE PUBLIC RECORD AND DISCLOSED AT THE TIME OF AN ABSTRACT OF TITLE OR TITLE SEARCH, WHICH MAY BE LOCATED BELOW THE SURFACE OF THE LANDS AND NOT VISIBLE AT THE TIME OF SURVEY. THE LOCATIONS OF UNDERGROUND UTILITIES AS SHOWN HEREON ARE BASED UPON ABOVE GROUND STRUCTURES VISIBLE AT THE TIME OF THE FIELD SURVEY AND RECORD OR AS-BUILT DRAWINGS PROVIDED TO ROBERTS ENGINEERING GROUP, LLC.
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5. ALL BUILDINGS, SURFACE AND SUBSURFACE IMPROVEMENTS, ON OR ADJACENT TO THE SITE ARE NOT NECESSARILY SHOWN.
6. RIGHT-OF-WAY AND PROPERTY LINE INFORMATION ARE APPROXIMATE AND ARE BASED UPON TAX MAP INFORMATION AND LIMITED FIELD SURVEYING, AND HAS BEEN TAKEN FROM VARIOUS SOURCES AND IS NOT GUARANTEED FOR COMPLETENESS OR ACCURACY.
7. BOTH HORIZONTAL AND VERTICAL DATUM ARE ASSUMED SITE SPECIFIC.
8. TRUCK TURNING PLANS ARE BASED ON THE 41.5' FIRE TRUCK AS PER OTTSVILLE.

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD

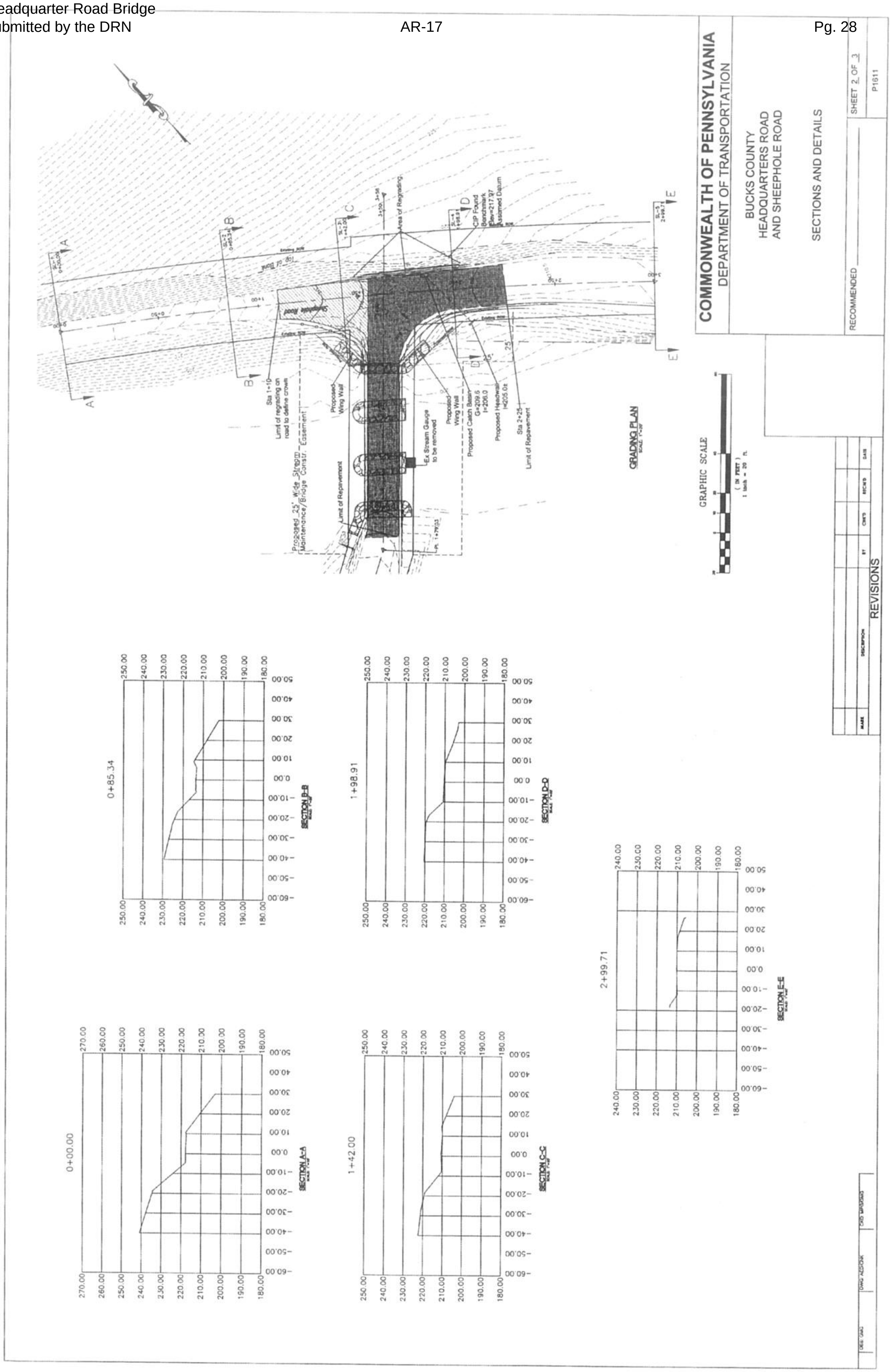
TRUCK TURNING PLAN

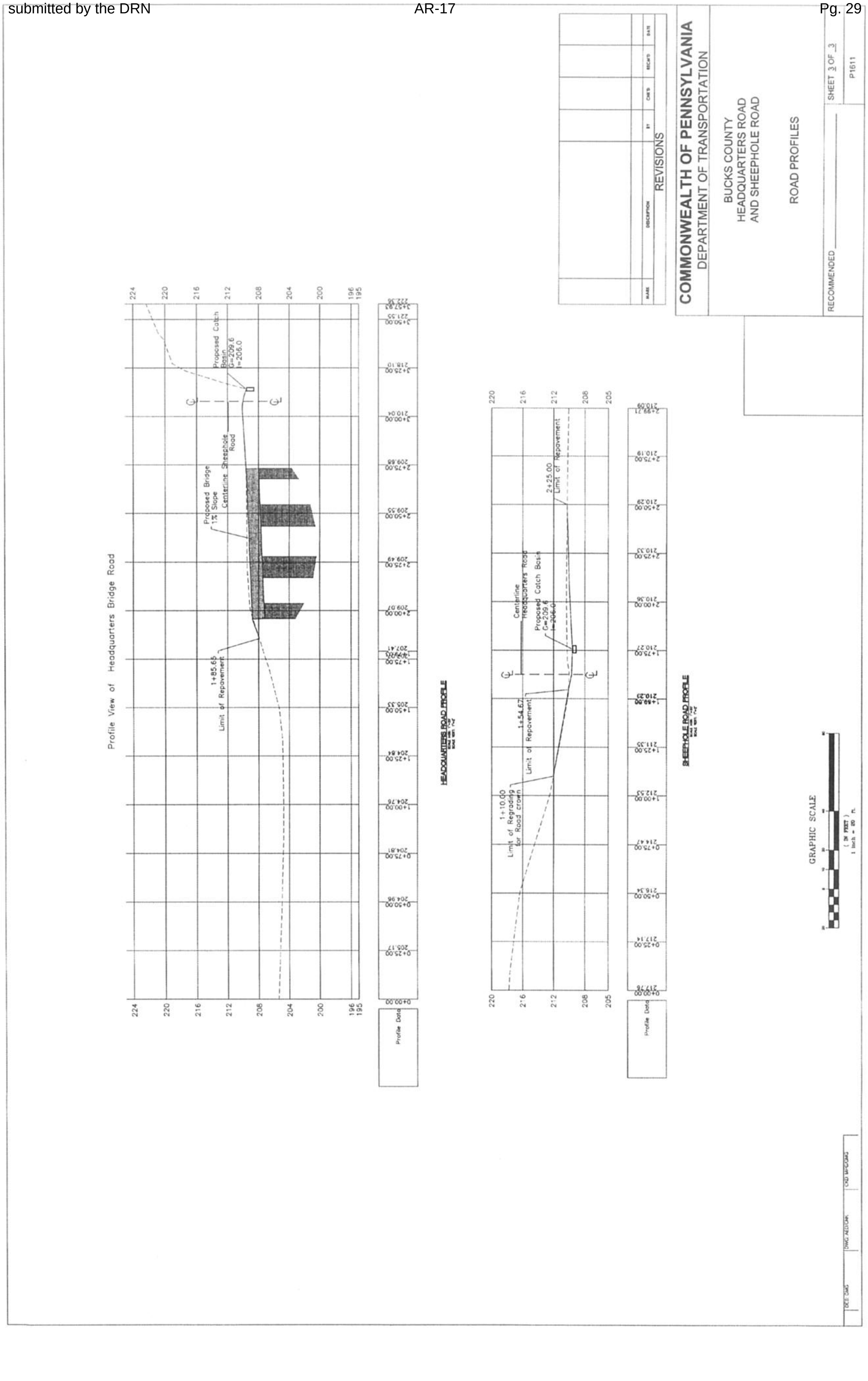
RECOMMENDED ____________________

SHEET 1 OF 3

P1611

DLE: GMG	DWG: AED/CNA	CKD: MPG/GMG


COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD
SECTIONS AND DETAILS
SHEET 2 OF 3
P1611
RECOMMENDED
REVISIONS
GRADING PLAN
GRAPHIC SCALE
Proposed 25' Wide Stream Maintenance/Bridge Constr. Easement
Limit of Repavement
Ex Stream Gauge to be removed
Proposed Wing Wall
Area of Regrading
0+00.00
SECTION A-A
0+85.34
SECTION B-B
1+42.00
SECTION C-C
1+98.91
SECTION D-D
2+99.71
SECTION E-E


Profile View of Headquarters Bridge Road
Proposed Catch Basin
G=209.6
I=206.0
Proposed Bridge
1% Slope
Centerline Sheephole Road
1+85.65
Limit of Repavement
HEADQUARTERS ROAD PROFILE
Profile Data
2+25.00
Limit of Repavement
Centerline Headquarters Road
Proposed Catch Basin
G=209.6
I=206.0
1+54.67
Limit of Repavement
1+10.00
Limit of Regrading for Road crown
SHEEPHOLE ROAD PROFILE
Profile Data
GRAPHIC SCALE
REVISIONS
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
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HEADQUARTERS ROAD
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ROAD PROFILES
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SHEET 3 OF 3
P1611

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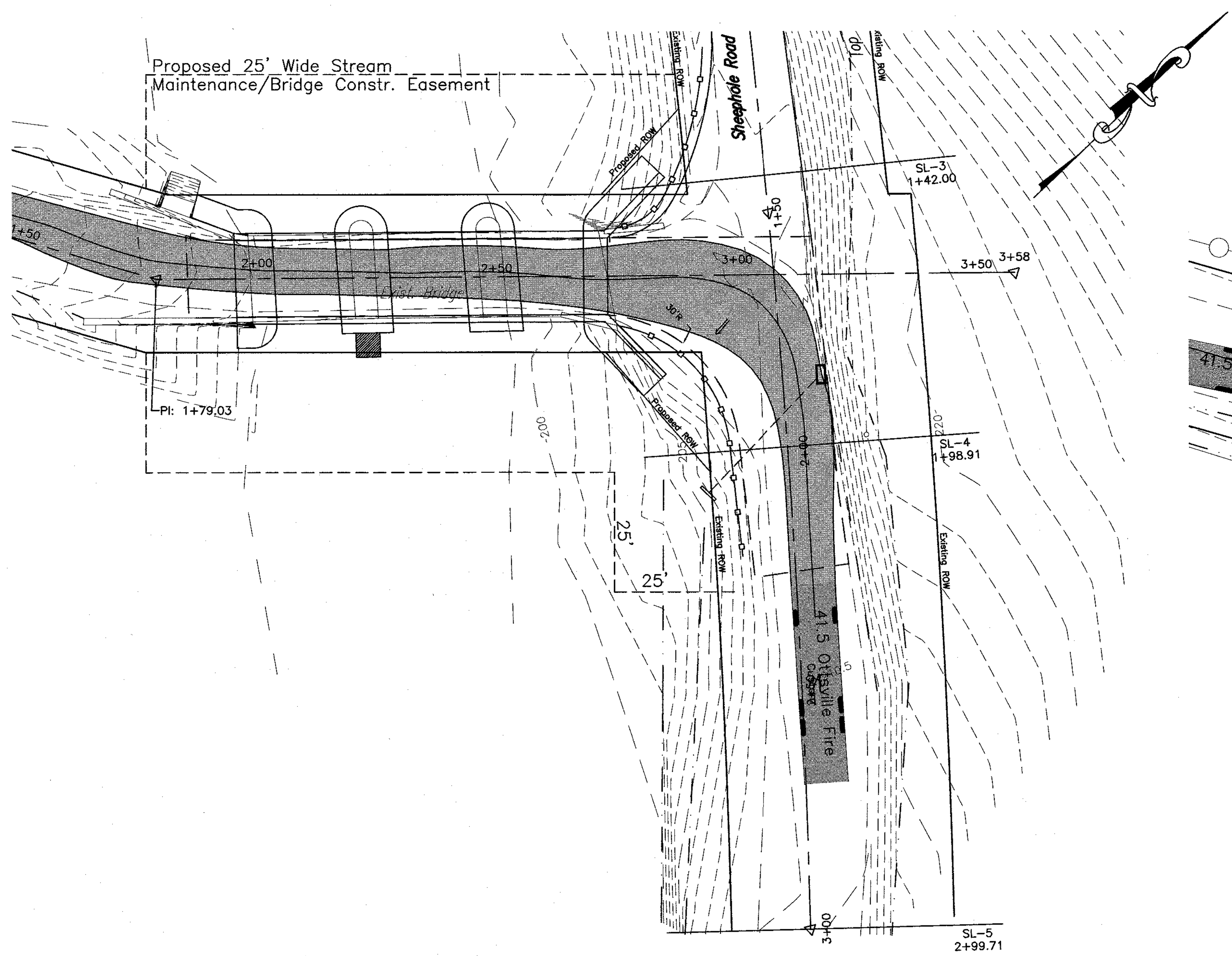

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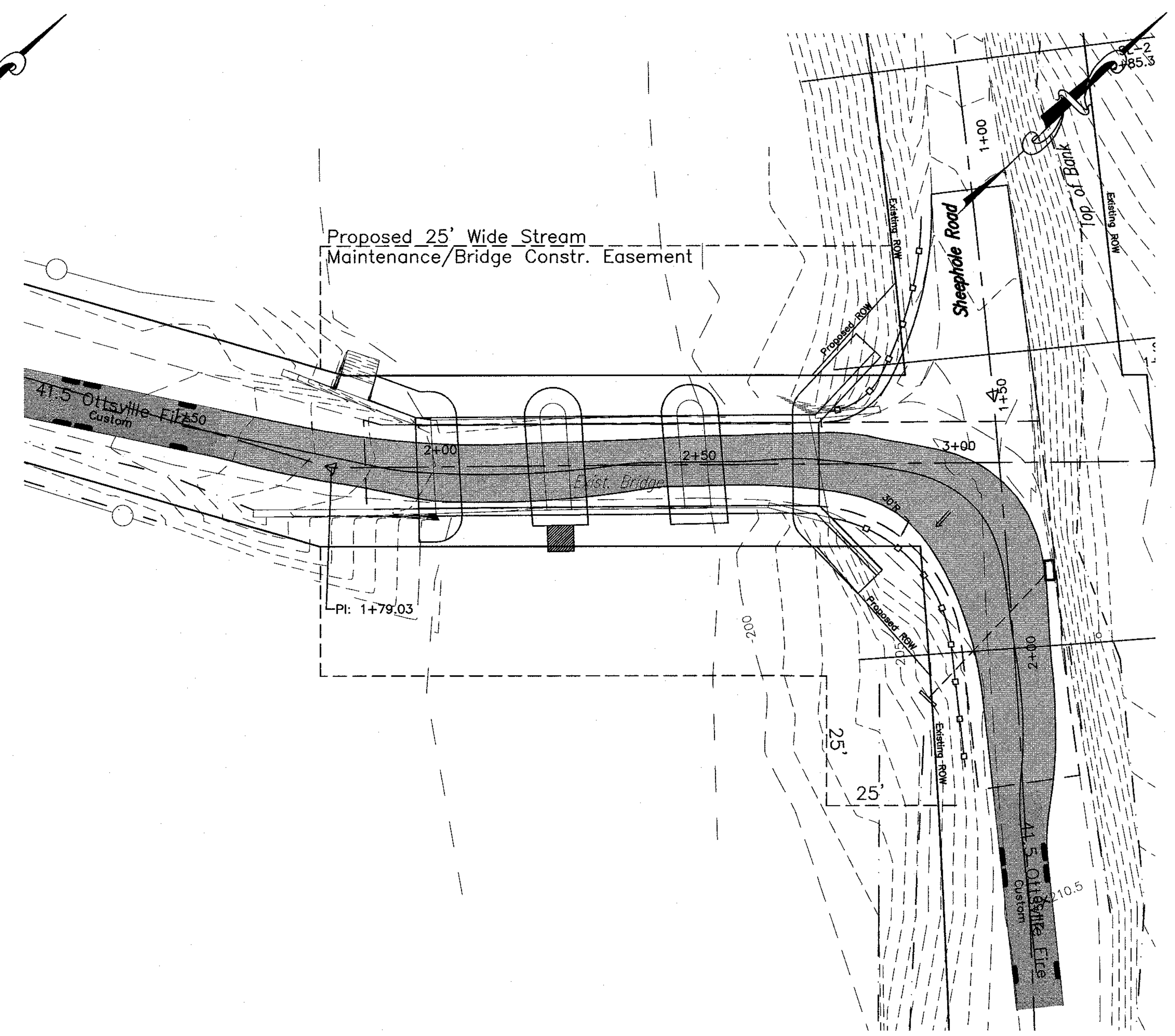

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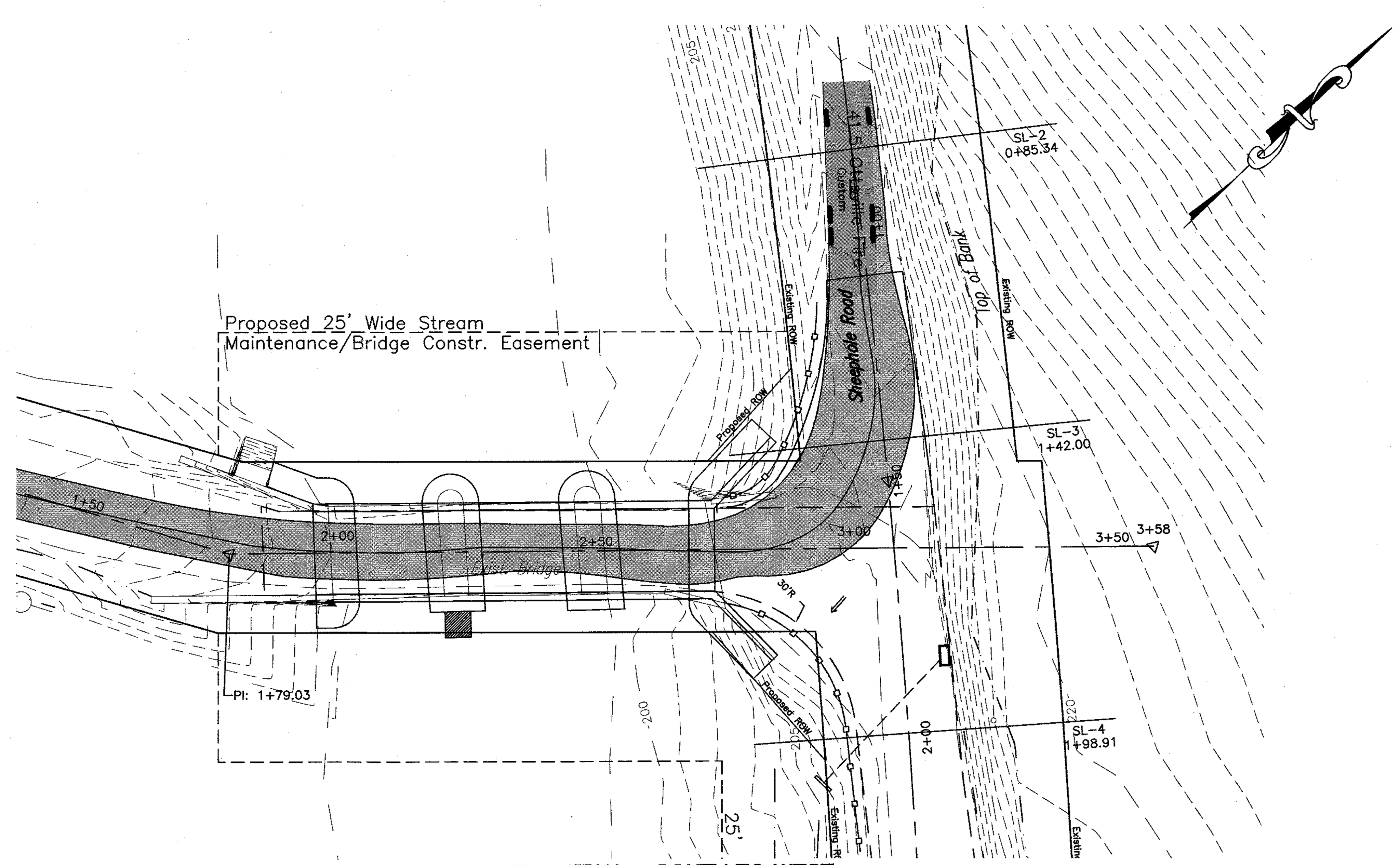


NEW AERIAL - SOUTH TO WEST

SCALE: 1"=20'

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD

TRUCK TURNING PLAN

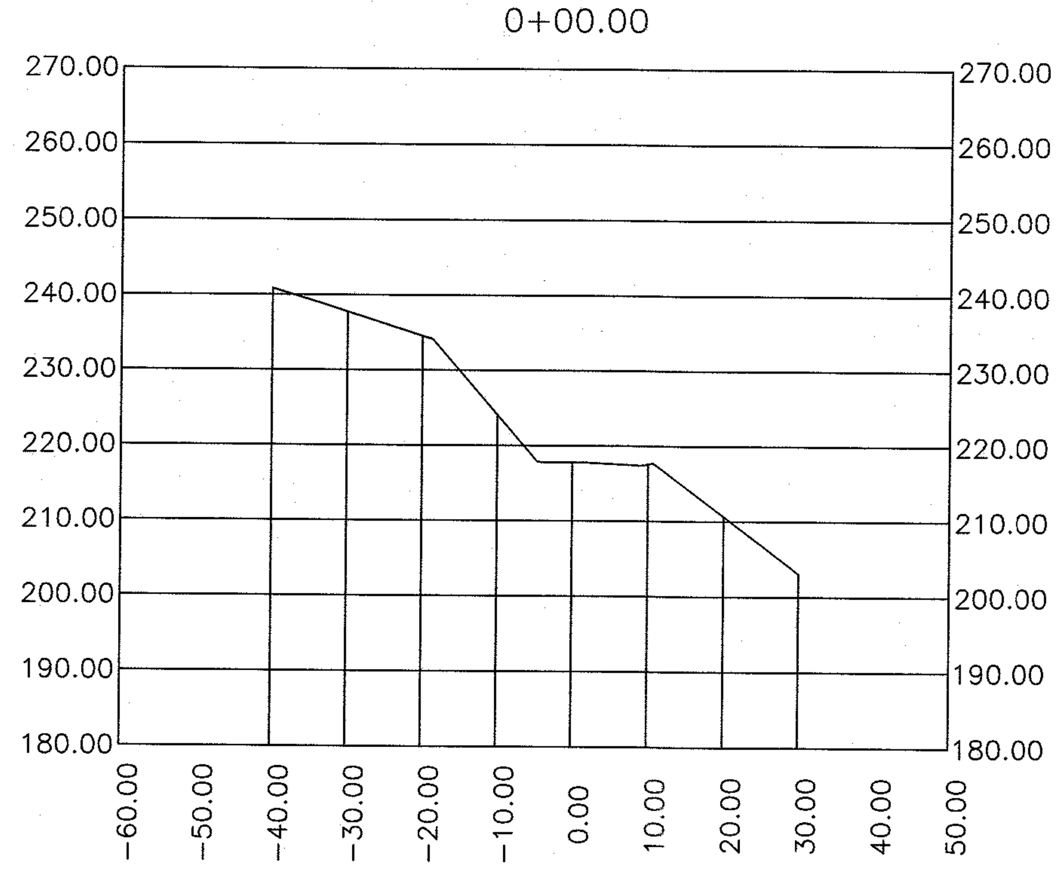
RECOMMENDED ____________

SHEET 1 OF 3

P1611

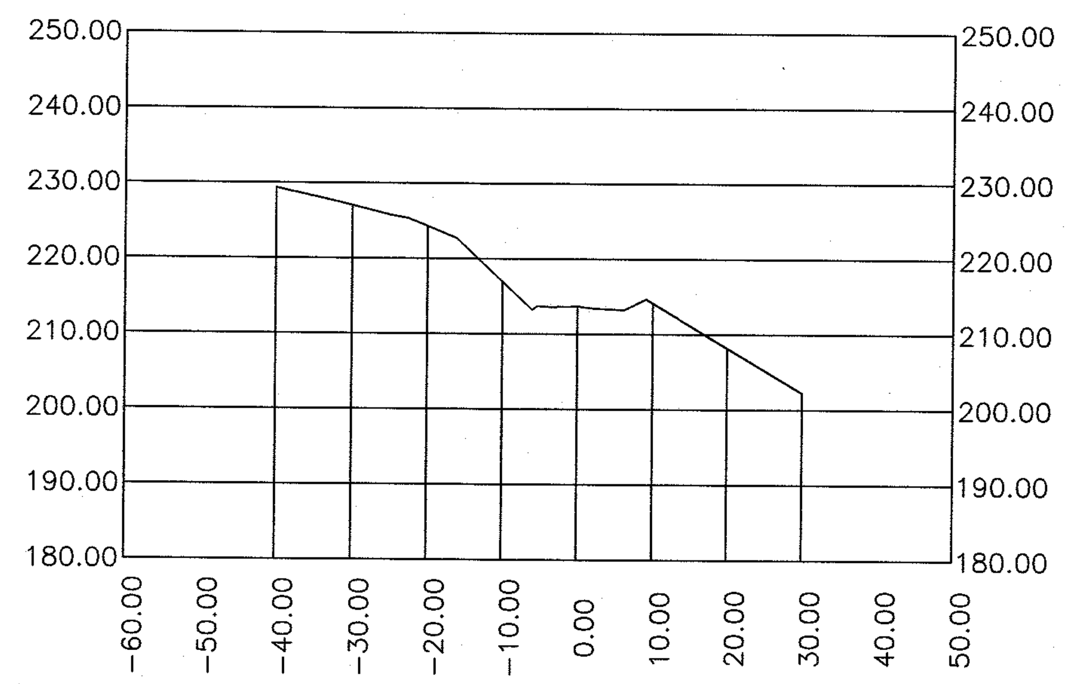
DES: GMG	DWG: AED/CNK	CKD: MPG/GMG

0+00.00



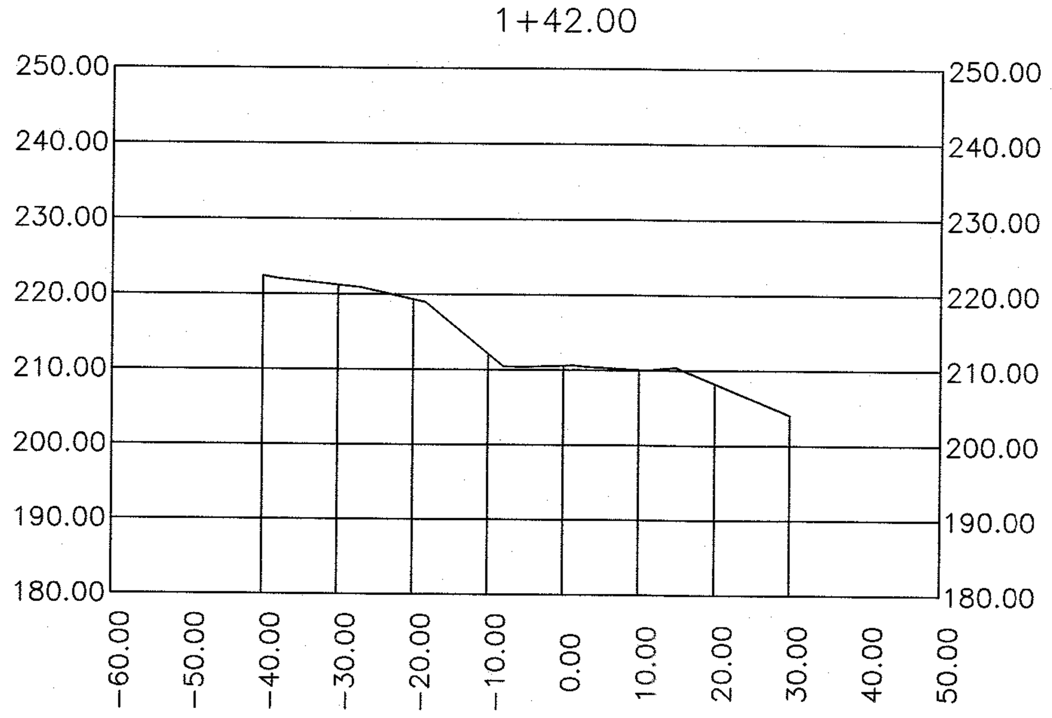
SECTION A-A
SCALE: 1"=20'

0+85.34



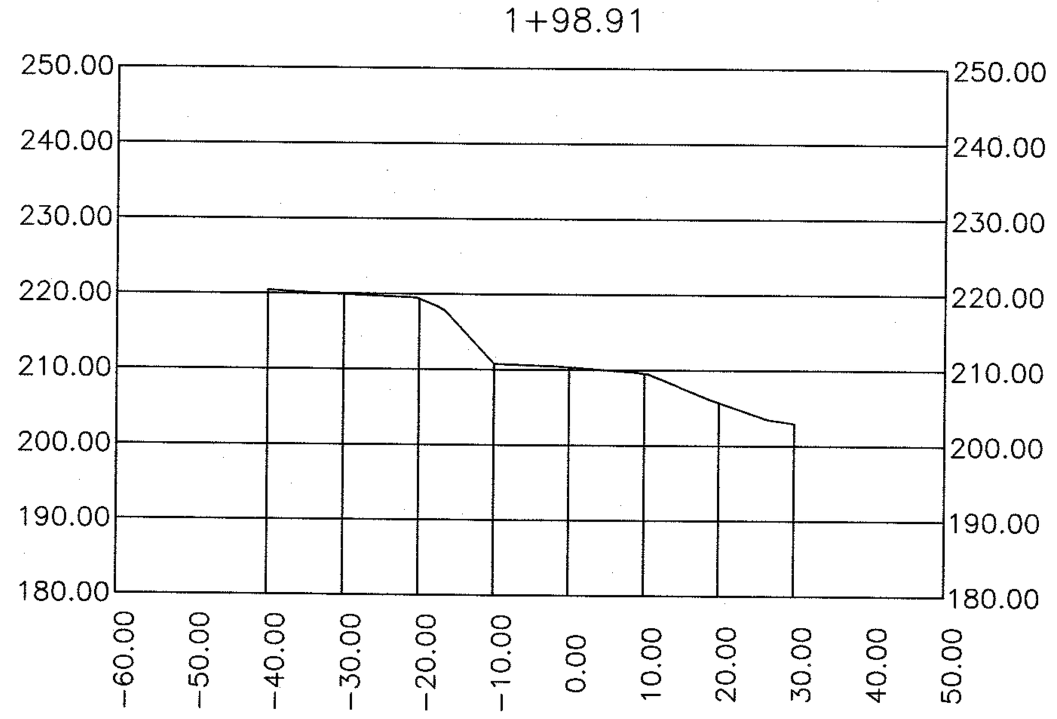
SECTION B-B
SCALE: 1"=20'

1+42.00



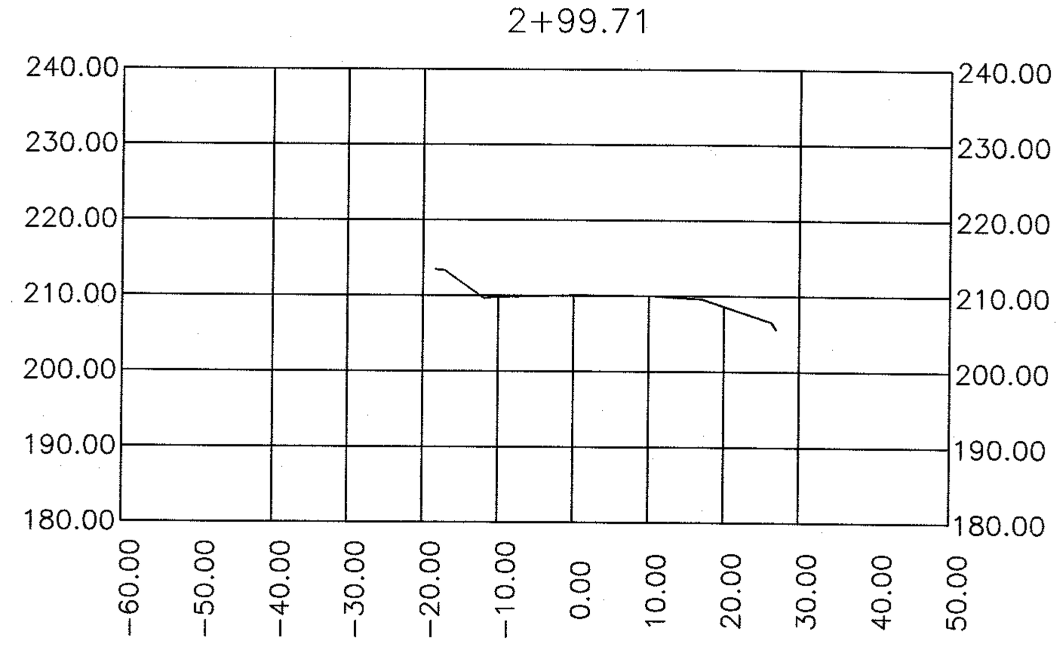
SECTION C-C
SCALE: 1"=20'

1+98.91

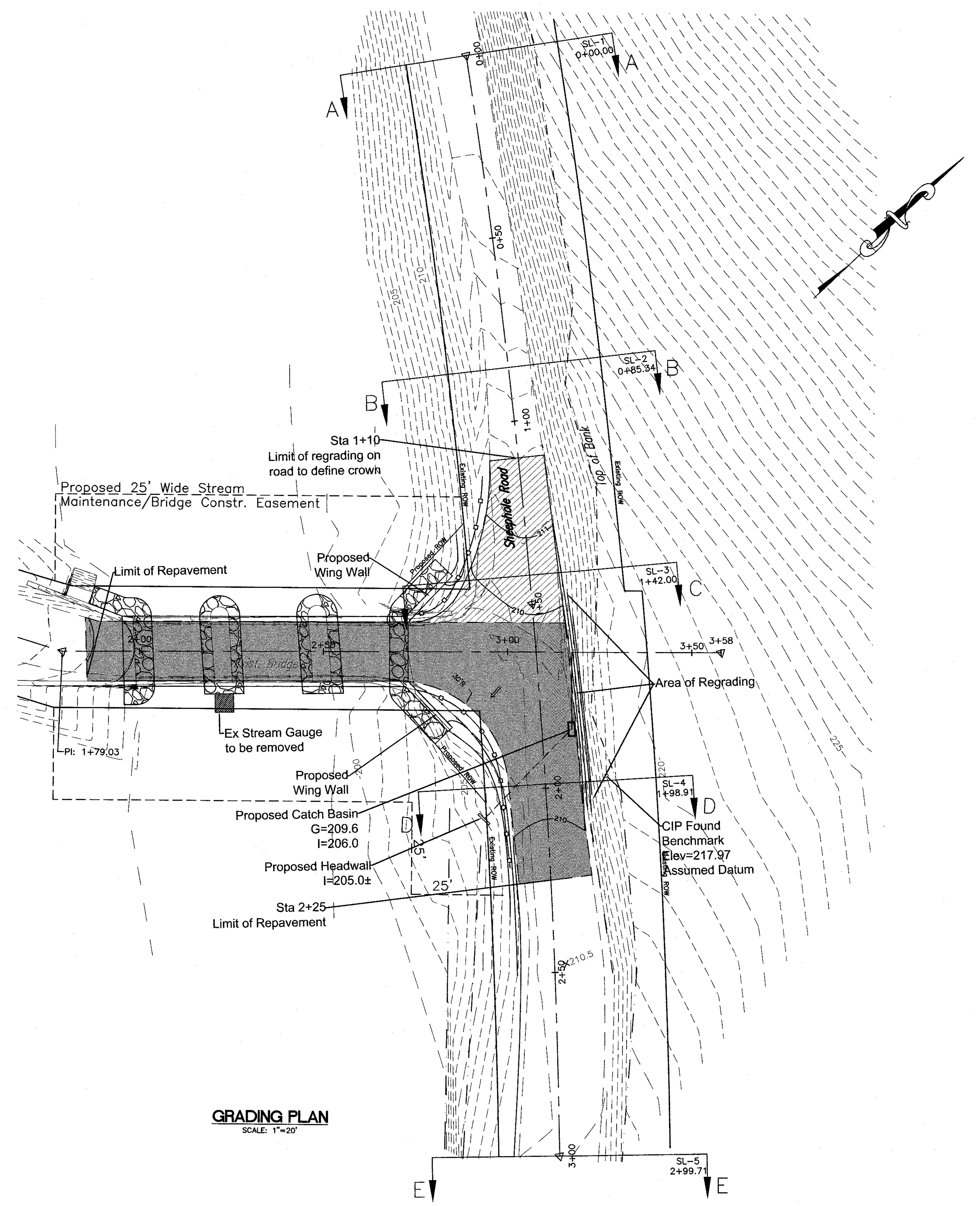


SECTION D-D
SCALE: 1"=20'

2+99.71



SECTION E-E
SCALE: 1"=20'



GRADING PLAN
SCALE: 1"=20'

GRAPHIC SCALE
20 0 10 20 40 80
(IN FEET)
1 inch = 20 ft.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD

SECTIONS AND DETAILS

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

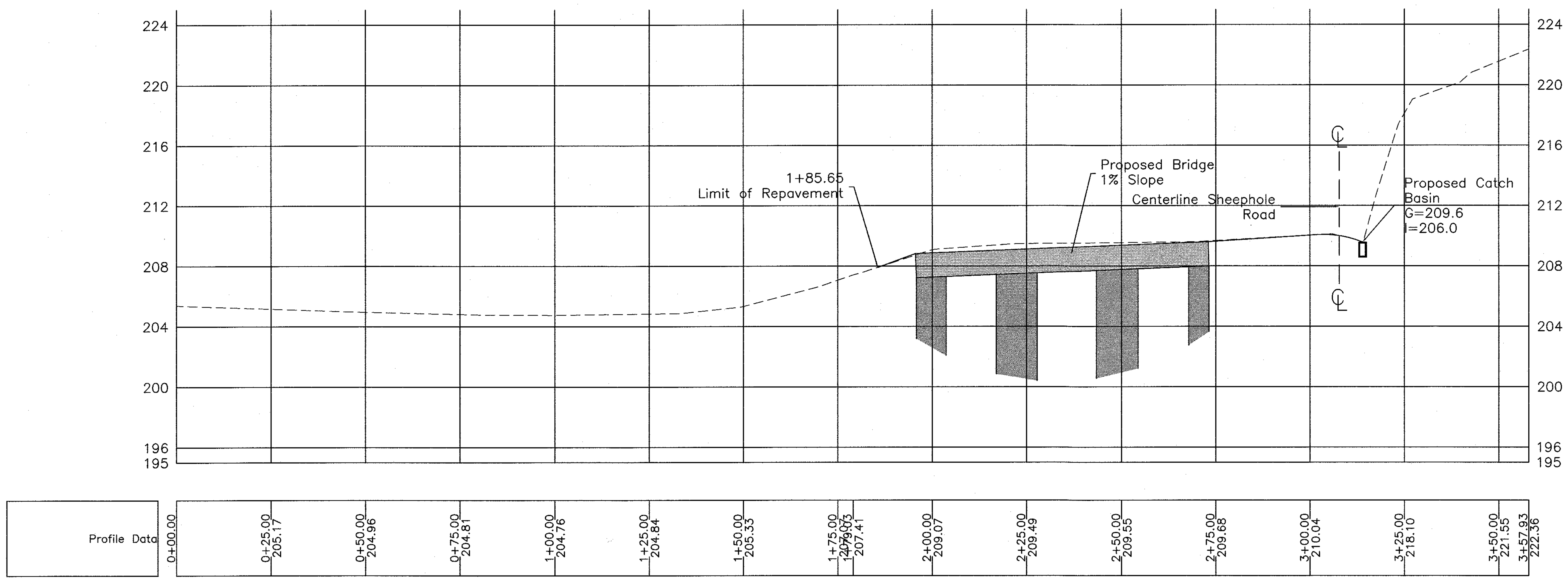
RECOMMENDED ______________________

SHEET 2 OF 3

P1611

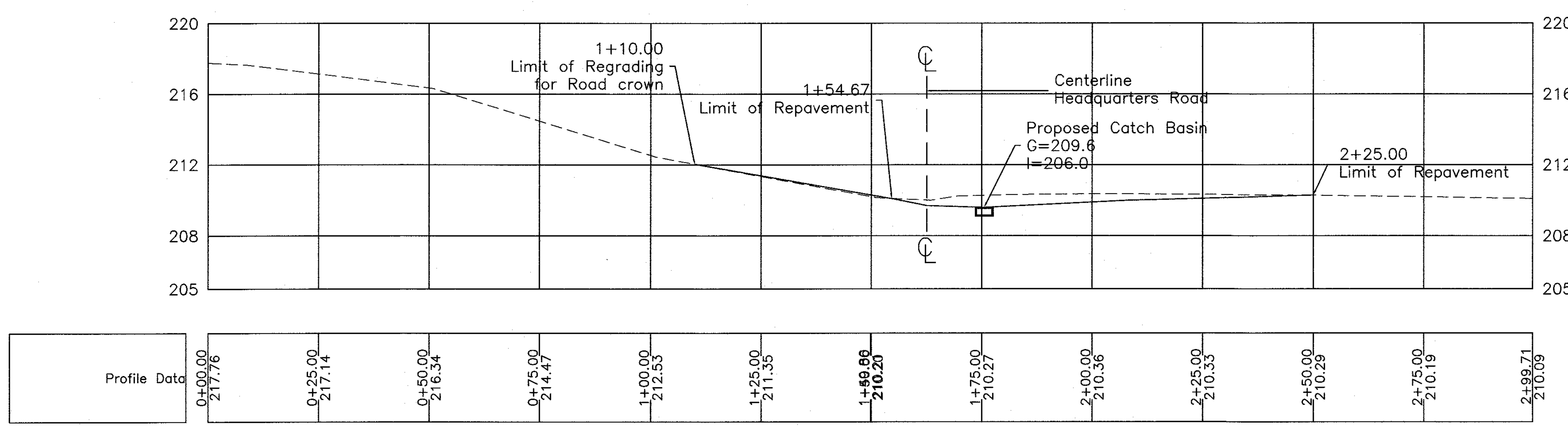
DES: GMG | DWG: AED/CNK | CKD: MPG/GMG

Profile View of Headquarters Bridge Road



HEADQUARTERS ROAD PROFILE

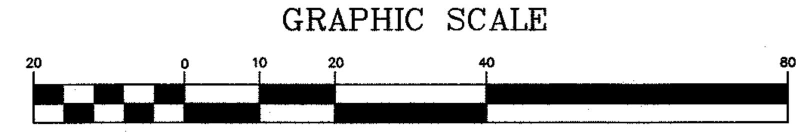
SCALE HOR: 1"=20'
SCALE VERT: 1"=2'



SHEEPHOLE ROAD PROFILE

SCALE HOR: 1"=20'
SCALE VERT: 1"=2'

GRAPHIC SCALE



(IN FEET)
1 inch = 20 ft.

DES: GMG	DWG: AED/CNK	CKD: MPG/GMG

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD

ROAD PROFILES

RECOMMENDED ____________________

SHEET 3 OF 3

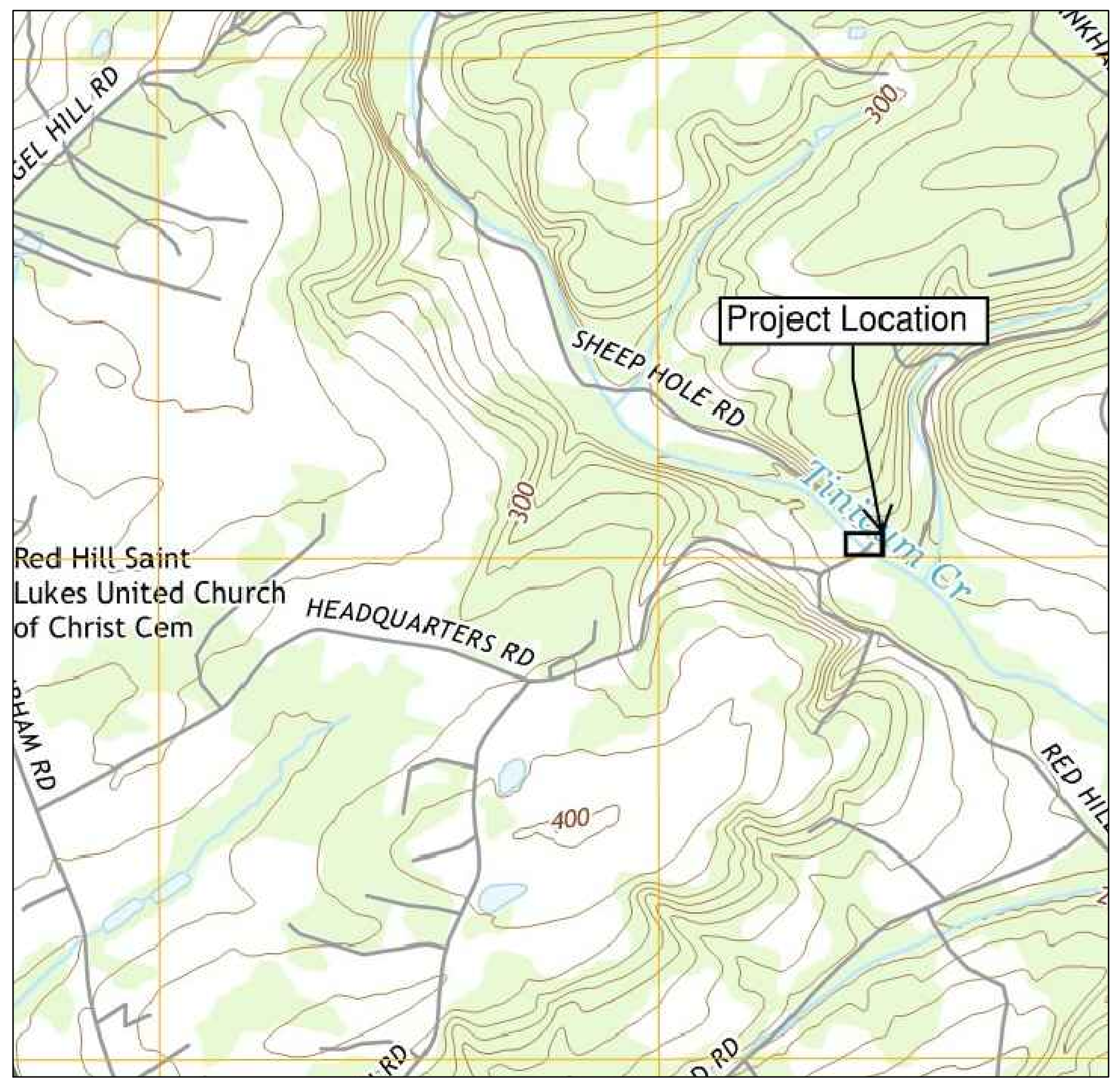
P1611

PROJECT NOTES

1. THESE PRELIMINARY PLANS FOR THE REHABILITATION OF HEADQUARTERS ROAD BRIDGE HAVE BEEN PREPARED FOR THE DELAWARE RIVER KEEPER NETWORK AND ARE NOT FOR CONSTRUCTION NOR HAVE THEY BEEN APPROVED BY THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION. THESE PLANS CALL FOR THE REHABILITATION OF THE EXISTING STONE MASONRY PIERS, ABUTMENTS AND WINGWALLS; AND, THE REMOVAL AND REPLACEMENT OF THE EXISTING SUPERSTRUCTURE.
2. DESIGN EXCEPTIONS TO THE PENNDOT STANDARDS ARE NEEDED PRIOR TO THE DEVELOPMENT OF THESE PRELIMINARY PLANS INTO CONSTRUCTION DOCUMENTS. THESE INCLUDE BUT ARE NOT LIMITED TO:
    A. THE REQUIREMENTS FOR ONE LANE BRIDGES AS SHOWN IN TABLE 1.11 COLLECTOR AND LOCAL ROAD FACILITIES, NEW AND RECONSTRUCTED BRIDGES (PAGE 1-36) AS MODIFIED BY "BRIDGE WIDTH NOTES" PAGE 1-37 ITEM (E), ONE-LANE BRIDGE, THIRD BULLET SHALL APPLY (SEE STRIKE OFF LETTER (SOL) 482-13-34 DATED DECEMBER 20, 2013 WHICH REVISES PUBLICATION 13M, DESIGN MANUAL PART 2.
    B. AN EXCEPTION IS REQUESTED FOR THE TRUCK TURNING MANEUVER TRAVELING SOUTHEAST ON SHEEPHOLE ROAD, TURNING RIGHT ONTO THE BRIDGE OVER TINICUM CREAK AND HEADQUARTERS ROAD.
3. ADDITIONAL INVESTIGATIONS OF EXISTING CONDITIONS ARE NEEDED FOR THE DEVELOPMENT OF CONSTRUCTION DOCUMENTS.
4. TINICUM TOWNSHIP SHALL HAVE THE RIGHT TO ACCESS AND OBSERVE ALL CONSTRUCTION.
5. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH PENNDOT SPECIFICATIONS.
6. ALL WORK PERFORMED WITHIN THE RIGHT OF WAY SHALL BE IN ACCORDANCE WITH PENNDOT STANDARDS FOR ROADWAY CONSTRUCTION.

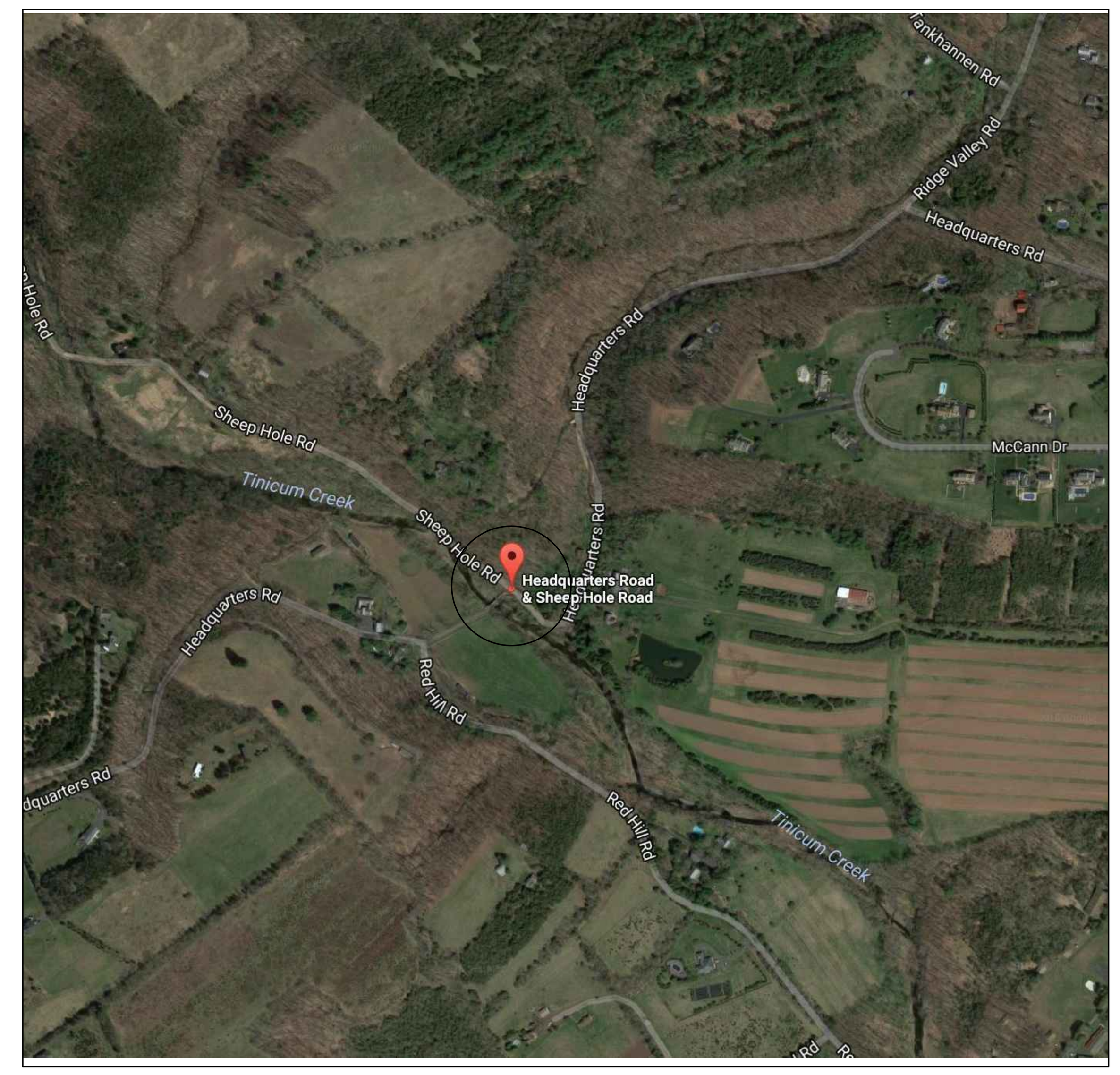
STATE ROUTE 1012 (HEADQUARTERS ROAD)
HEADQUARTERS ROAD BRIDGE REHABILITATION

PRELIMINARY PLANS
PREPARED FOR
THE DELAWARE RIVERKEEPER NETWORK



1 USGS TOPOGRAPHIC CONTOUR MAP

PORTION OF THE WEST CHESTER QUADRANGLE
WEST CHESTER, PENNSYLVANIA
SCALE: 1" = 2000'



2 ORTHOPHOTOGRAPHY - SITE LOCATION

INDEX OF DRAWINGS

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	GENERAL PLAN AND ELEVATION
3	EXISTING PLAN AND ELEVATION
4	EAST ABUTMENT DETAILS AND NOTES
5	WEST ABUTMENT DETAILS
6	EAST PIER DETAILS
7	WEST PIER DETAILS
8	MASONRY DETAILS
9	TRUCK TURNING PLAN
10	SECTIONS AND DETAILS
11	ROAD PROFILES
12	SCOUR COUNTERMEASURE PLAN

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
DOUGLAS EDWARD BOND
ENGINEER
No. PE079367

DATE

PREPARED BY:

McMULLAN & ASSOCIATES, INC.

CONSULTING STRUCTURAL ENGINEERS
1861 WIEHLE AVE. STE 125
RESTON, VA 20190
PH. 703-556-0651

DESCRIPTION	DWG. NO.	APP. DATE
THRIE-BEAM DETAILS	BC-703M	9/30/2016
BEARINGS	BC-755M	9/30/2016
REINFORCEMENT BAR DETAILS	BC-736M	9/30/2016
DOWEL AND DIAPHRAGM DETAILS	BD-651M	4/29/2016
PRESTRESSED BEAM DETAILS	BD-652M	4/29/2016
TYPICAL SPREAD BOX FRAMING DETAILS	BD-653M	4/29/2016
TYPICAL LONGITUDINAL SECTIONS	BD-656M	4/29/2016

SUPPLEMENTAL DRAWINGS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUCKS COUNTY
STATE ROUTE 1012 (HEADQUARTERS ROAD)
HEADQUARTERS ROAD BRIDGE REHABILITATION

TITLE SHEET

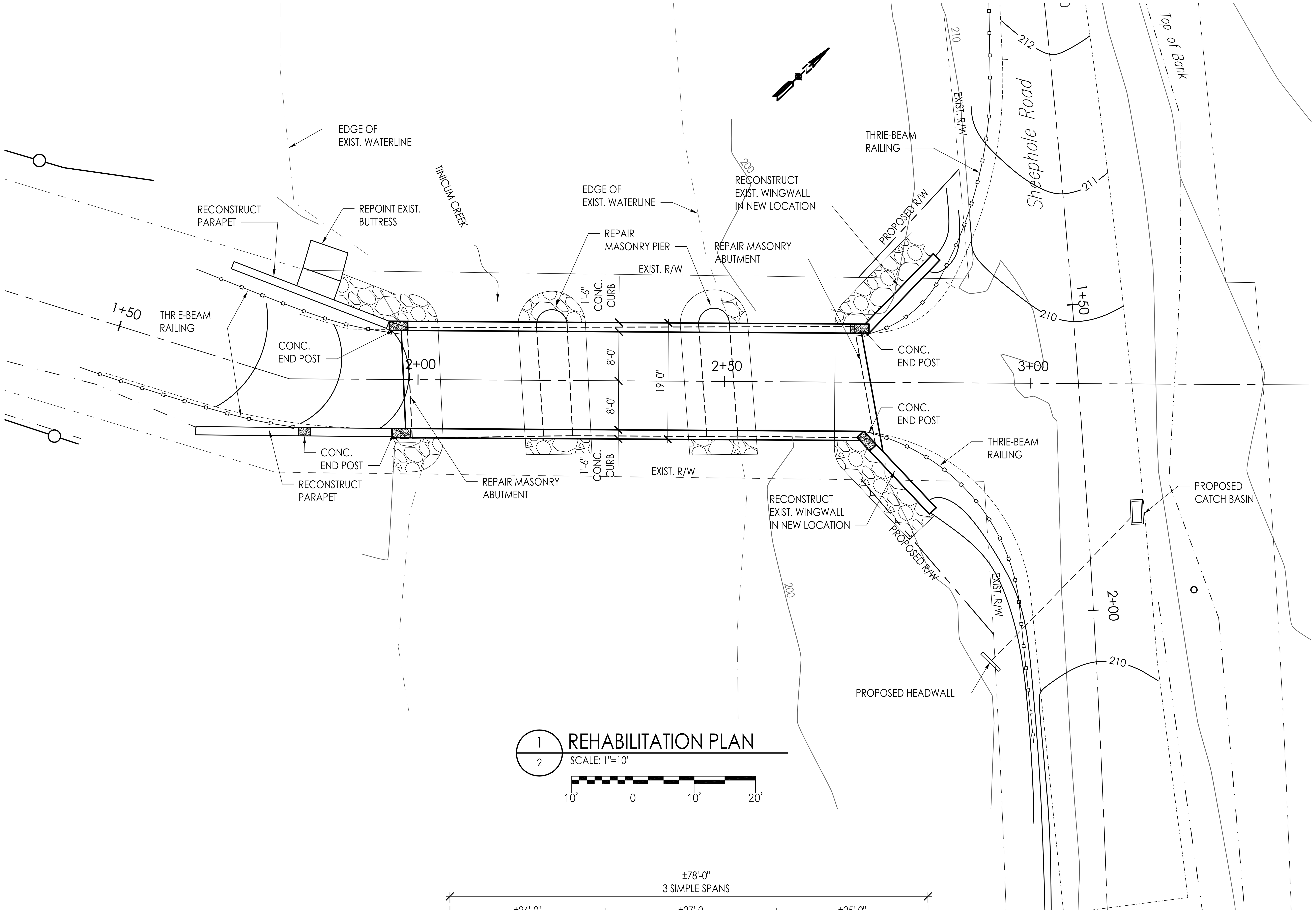
RECOMMENDED ____________________

DISTRICT BRIDGE ENGINEER

SHEET 1 OF 12
+ SUPPLEMENTAL DRAWINGS

NOTES:

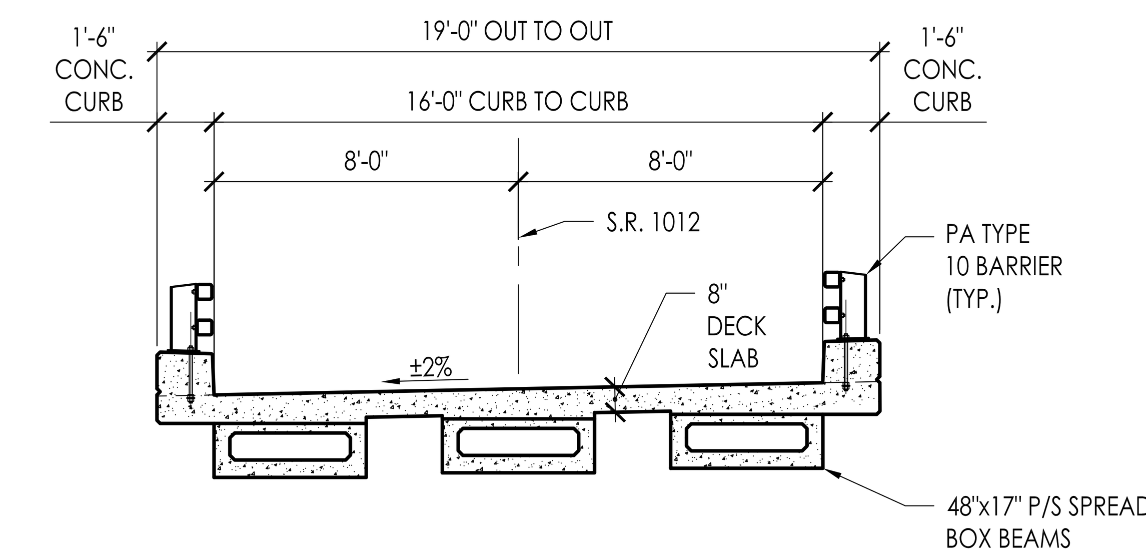
1. DESIGN SPECIFICATIONS: AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 7TH EDITION 2014, AND AS SUPPLEMENTED BY DESIGN MANUAL PART 4, APRIL 2015.
   1.1. LIVE LOAD DISTRIBUTION TO GIRDERS IS BASED ON DM-4 DISTRIBUTION FACTORS
   1.2. DESIGN IS IN ACCORDANCE WITH THE LRFD METHOD
2. DESIGN LIVE LOAD: PHL-93
3. DEAD LOADS: INCLUDES A SURFACE AREA DENSITY OF 0.030 KSF FOR FUTURE WEARING SURFACE ON THE DECK SLAB
4. PROVIDE MATERIALS AND PERFORM WORK IN ACCORDANCE WITH SPECIFICATIONS PUBLICATION 408
5. COORDINATE, LOCATE, AND CONDUCT ALL WORK RELATED TO PUBLIC AND PRIVATE UTILITIES IN ACCORDANCE WITH PUBLICATION 408, SECTIONS 105.06 AND 107.12



1 / 2 REHABILITATION PLAN

SCALE: 1"=10'

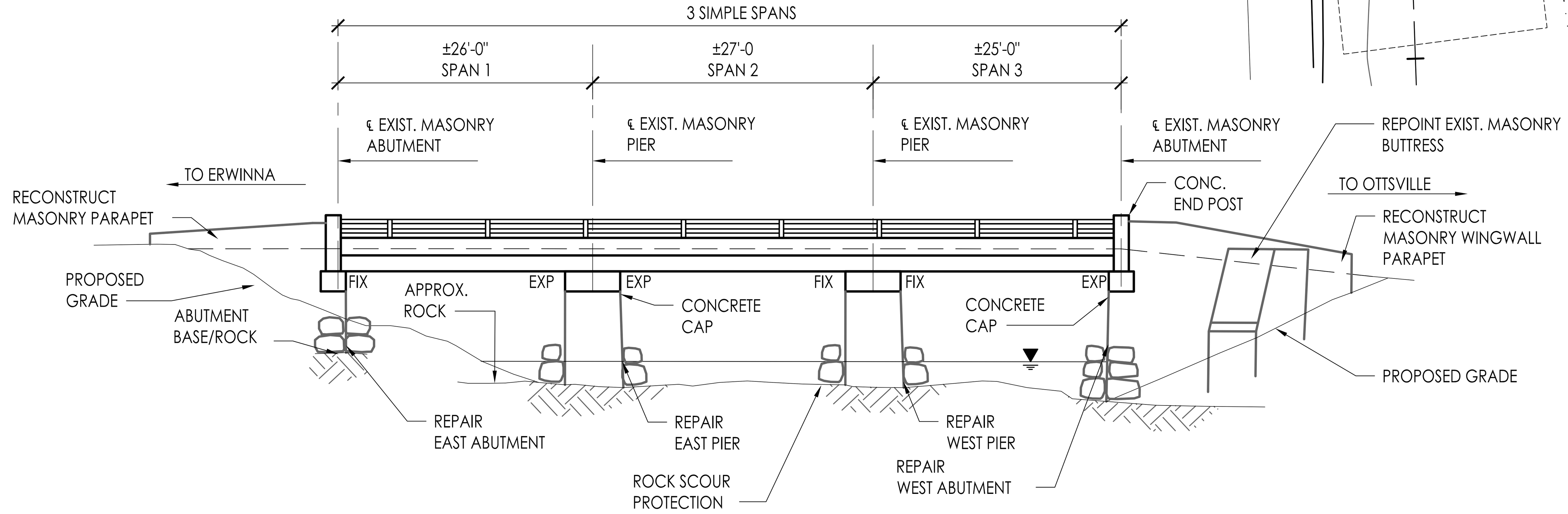
10' 0 10' 20'



3 / 2 TYPICAL SECTION - PROPOSED

SCALE: ¼"=1'-0"

4' 0 4' 8'



2 / 2 NORTH ELEVATION

SCALE: 1"=10'

10' 0 10' 20'

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY

STATE ROUTE 1012 (HEADQUARTERS ROAD)

HEADQUARTERS ROAD BRIDGE REHABILITATION

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL DOUGLAS EDWARD BOND ENGINEER No. PE079067

GENERAL PLAN AND ELEVATION

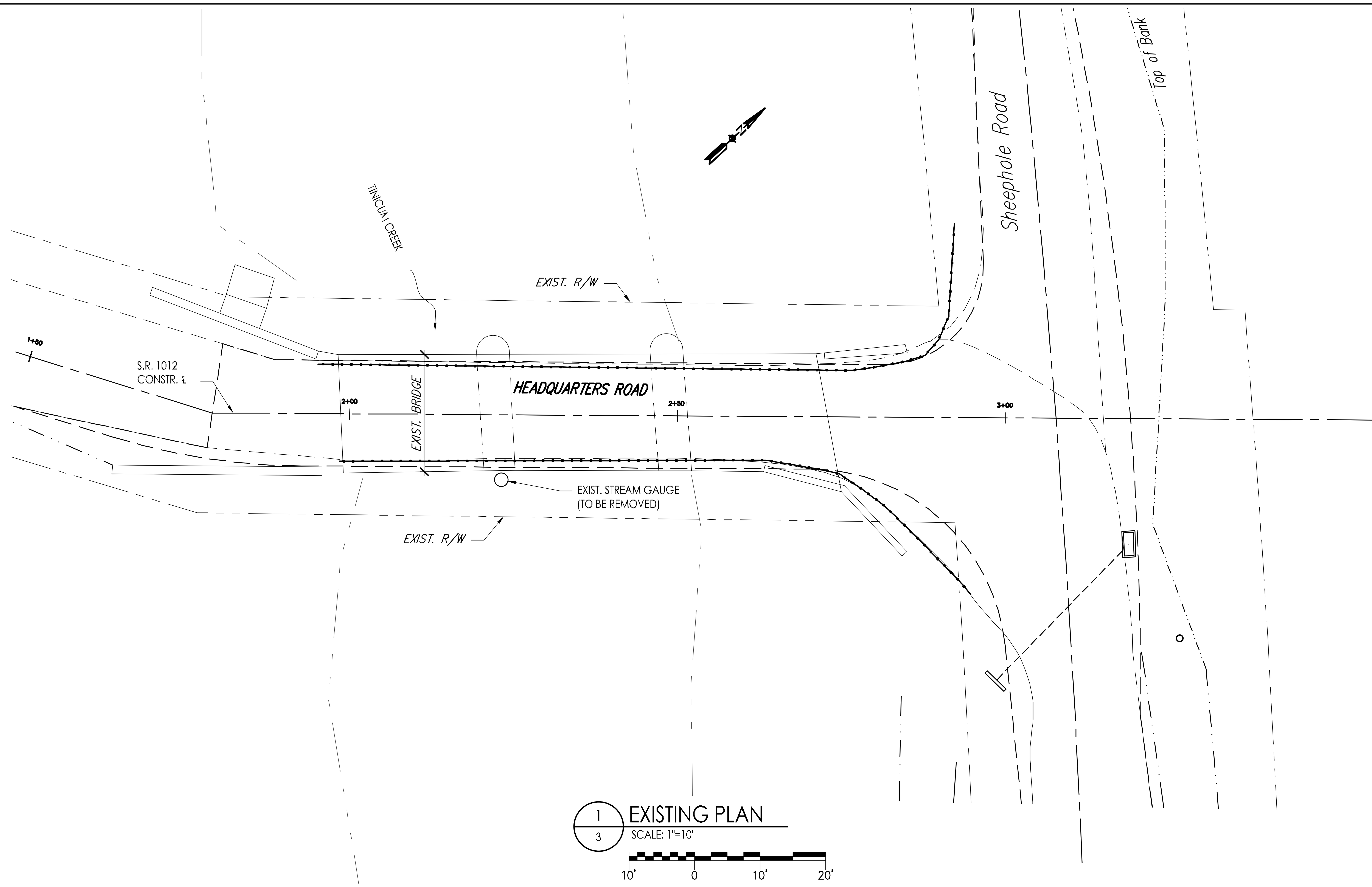
RECOMMENDED ____________________

SHEET 2 OF 12

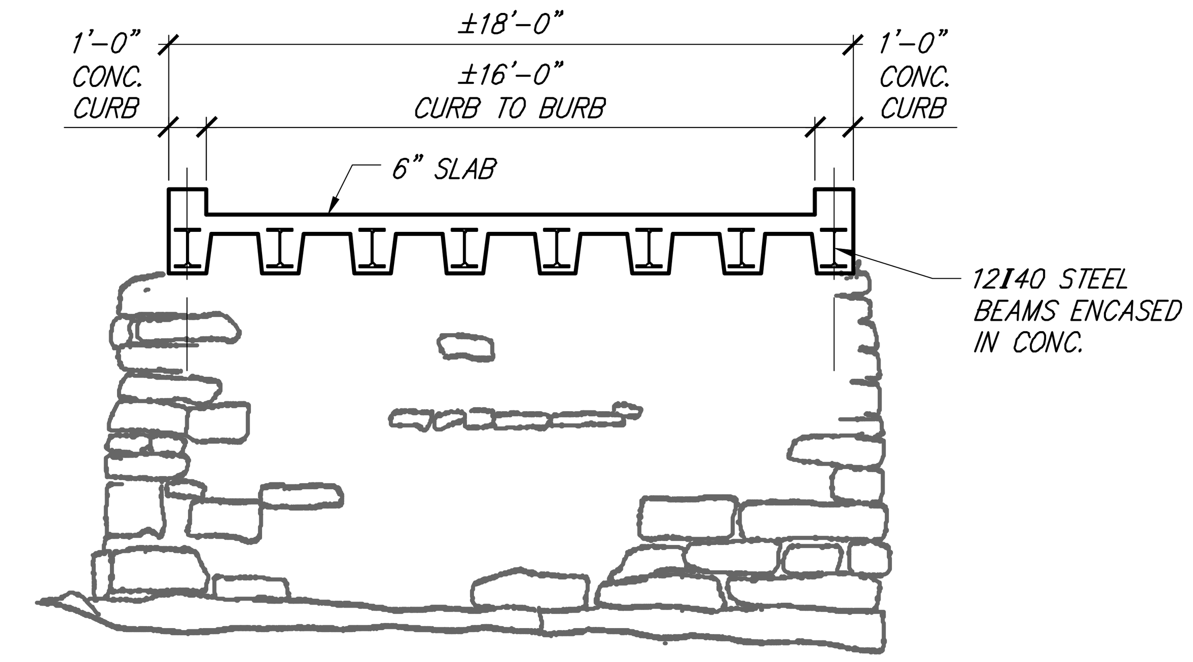
S-101

DES: GMG | DWG: AED/CNK | CKD: MPG/GMG

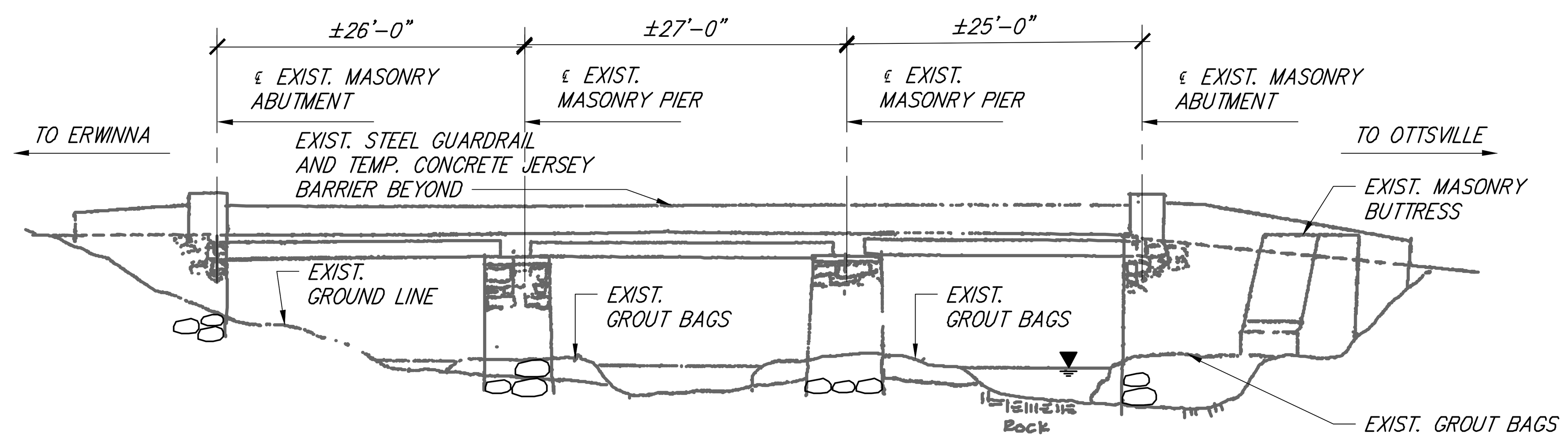
PRELIMINARY DRAWING



1 / 3 EXISTING PLAN
SCALE: 1"=10'
10' 0 10' 20'



3 / 3 EXISTING SECTION
SCALE: ¼" = 1'-0"
4' 0 4' 8'



EXISTING
2 / 3 NORTH ELEVATION
SCALE: 1"=10'
10' 0 10' 20'

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUCKS COUNTY
STATE ROUTE 1012 (HEADQUARTERS ROAD)
HEADQUARTERS ROAD BRIDGE REHABILITATION

EXISTING PLAN AND ELEVATION

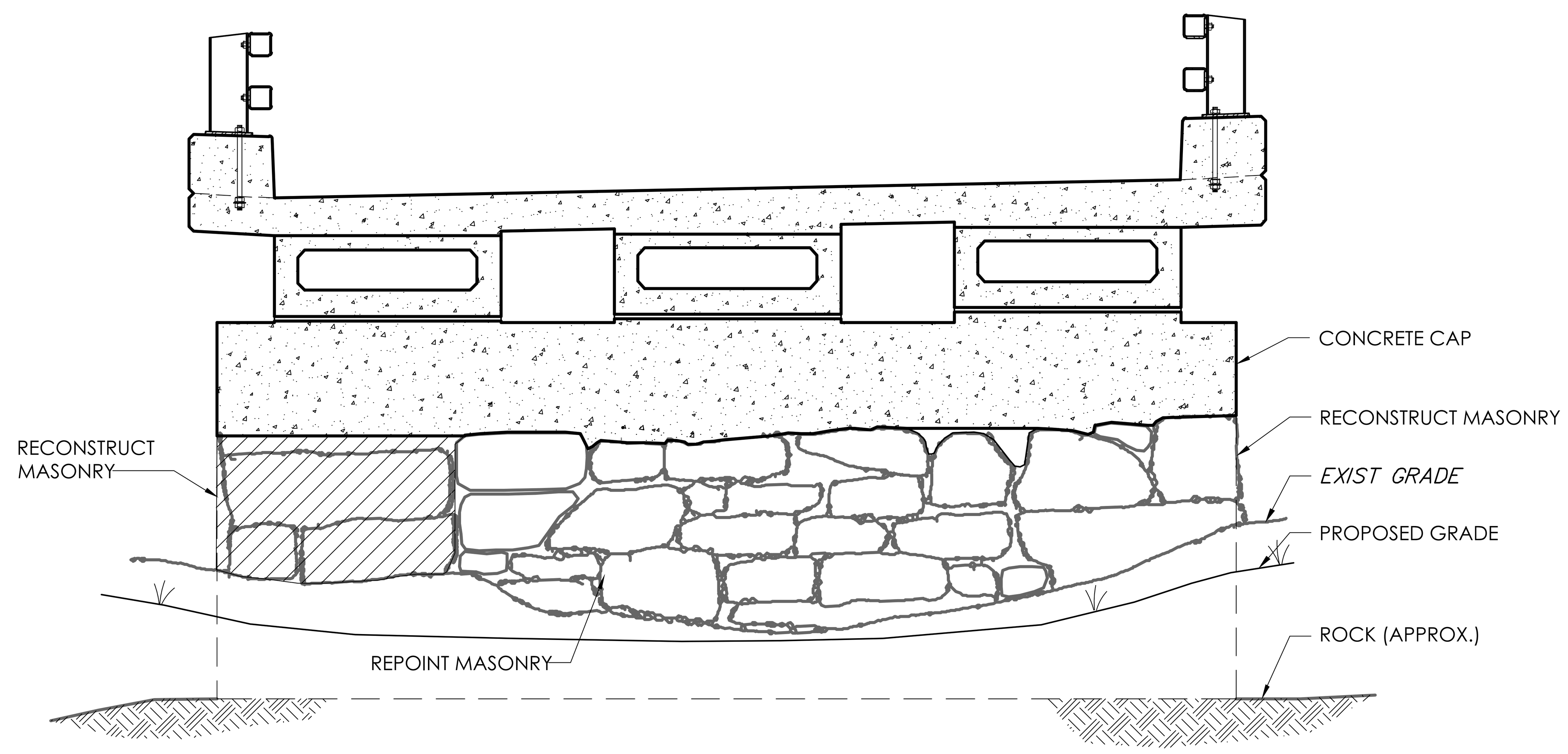
COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL DOUGLAS EDWARD BOND ENGINEER No. PE079367

RECOMMENDED ____________________

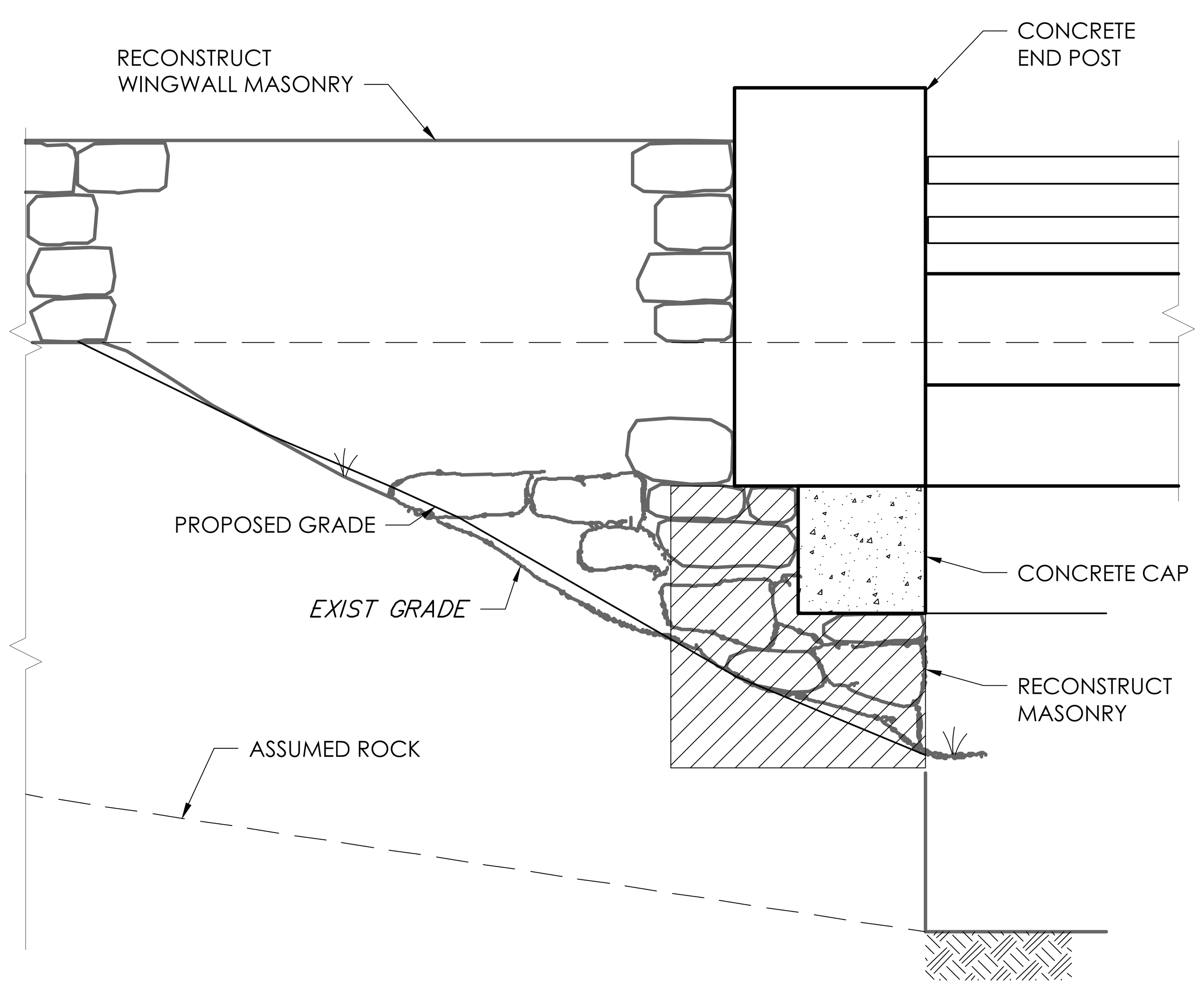
SHEET 3 OF 12
S–102

DES: GMG	DWG: AED/CNK	CKD: MPG/GMG

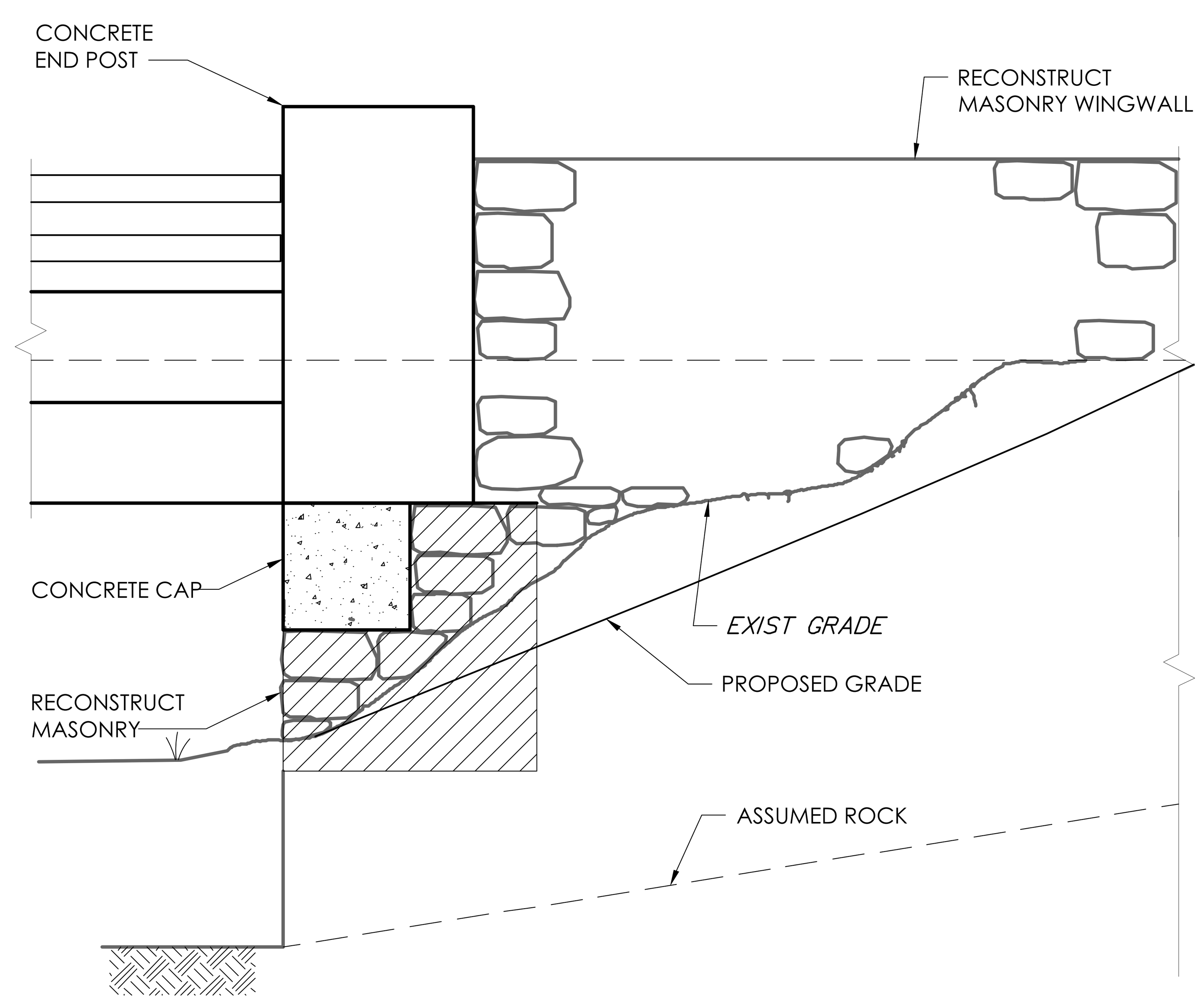
PRELIMINARY DRAWING



1/4 EAST ABUTMENT (EAST ELEVATION)
SCALE: ½"=1'-0"
2' 0 2' 4'



2/4 EAST ABUTMENT (NORTH ELEVATION)
SCALE: ½"=1'-0"
2' 0 2' 4'



3/4 EAST ABUTMENT (SOUTH ELEVATION)
SCALE: ½"=1'-0"
2' 0 2' 4'

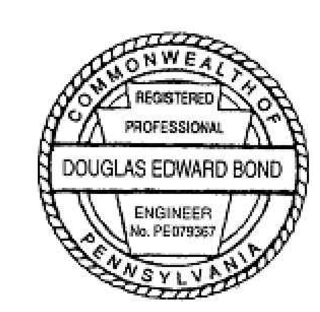
MASONRY NOTES

1. ALL MASONRY WORK SHALL BE ACCOMPLISHED BY QUALIFIED STONE MASONS THAT ARE APPROVED BY THE ENGINEER.
2. MASONRY RECONSTRUCTION SHALL UTILIZE EXISTING STONES FIRST AND THEN THE REMAINDER WITH NEW STONES AS NEEDED. PARTS OF WALLS THAT ARE RECONSTRUCTED SHALL MATCH THE CHARACTER OF THE COURSING IN ADJACENT PARTS OF THE WALL.
3. NEW STONES USED FOR RECONSTRUCTION SHALL MATCH THE EXISTING STONES IN TYPE, SIZE, COLOR, AND FINISH.
4. EXISTING MASONRY THAT IS TO BE RECONSTRUCTED SHALL FIRST BE DISMANTLED AND THE EXISTING STONES SALVAGED, CLEANED, AND TEMPORARILY STORED.
5. PRIOR TO THE PARTIAL RECONSTRUCTION OF MASONRY, IN AN AREA APPROVED BY THE ENGINEER, CONSTRUCT A SAMPLE OF RECONSTRUCTED MASONRY THAT IS AT LEAST 9 FEET SQUARE IN SURFACE AREA. ONCE APPROVED, ALL RECONSTRUCTED MASONRY SHALL MATCH THE CHARACTER OF THE SAMPLE AS DETERMINED BY THE ENGINEER.
6. MORTAR USED IN REPOINTED SHALL BE BASED ON NATURAL CEMENT ASTM C10 WITH A (PRELIMINARY DESIGN) PROPORTION OF 1 PART CEMENT TO 2 PARTS HYDRATED LIME. 28 DAY CURED SAMPLES OF MORTAR MIXES SHALL BE APPROVED BY THE ENGINEER PRIOR TO MASONRY REPOINTING OR RECONSTRUCTION.
7. EXTERIOR EXCESS MORTAR COATINGS ARE TO BE REMOVED USING HAND TOOLS AND SMALL PNEUMATIC POWERED CHIPPING HAMMERS WHEN APPROVED BY THE ENGINEER TO EXPOSE THE NATURAL STONE FACES. AVOID DAMAGING, LOOSENING, OR WORKING LOOSE THE UNDERLYING STONES. WHERE REMOVAL OF EXCESS MORTAR WOULD RESULT IN THE DAMAGE TO THE STONE, THE ENGINEER MAY APPROVE LEAVING THE EXISTING MORTAR COATING IN PLACE.
8. GROUTING OF EXISTING MASONRY SHALL BE ACCOMPLISHED USING A NATURAL CEMENT BASED GROUT. INSERT GROUT INJECTION AND EXIT PORT TUBES INTO MORTAR JOINTS. SEAL MASONRY JOINTS AND CRACKS PRIOR TO GROUTING. INJECT WATER INTO MASONRY TO BE GROUTED PRIOR TO GROUTING. GROUTING SHALL BE DONE IN LIFTS FROM THE LOWER INJECTION TUBE UNTIL IT EXITS THE UPPER TUBE. CAPTURE ALL WASTE GROUT.
9. REPOINT ALL DETERIORATED AND LOOSE MORTAR JOINTS. JOINTS THAT CONTAIN SOLID MORTAR ARE TO REMAIN. RAKE LOOSE MATERIAL IN JOINTS TO BE REPOINTED TO A MINIMUM DEPTH OF 2 TO 2.5 TIMES THE WIDTH OF THE JOINT USING HAND TOOLS, BRUSHES, AND LOW PRESSURE WATER (40-60 PSI). PLACE MORTAR BY HAND OR USING A PRESSURE GUN WHEN APPROVED BY THE ENGINEER.
10. CLEAN MASONRY IMMEDIATELY AFTER REPOINTING OR GROUTING WITH WATER AND NYLON BRUSHES TO REMOVE EXCESS MATERIAL AND PREVENT STAINING.
11. STONES SEPARATED INTO LARGE PIECES BY HAIRLINE CRACK TO REMAIN UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
12. STONE FACE TREATMENT WILL BE CONSIDERED AT CONCRETE CAPS.

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUCKS COUNTY
STATE ROUTE 1012 (HEADQUARTERS ROAD)
HEADQUARTERS ROAD BRIDGE REHABILITATION



EAST ABUTMENT DETAILS AND NOTES

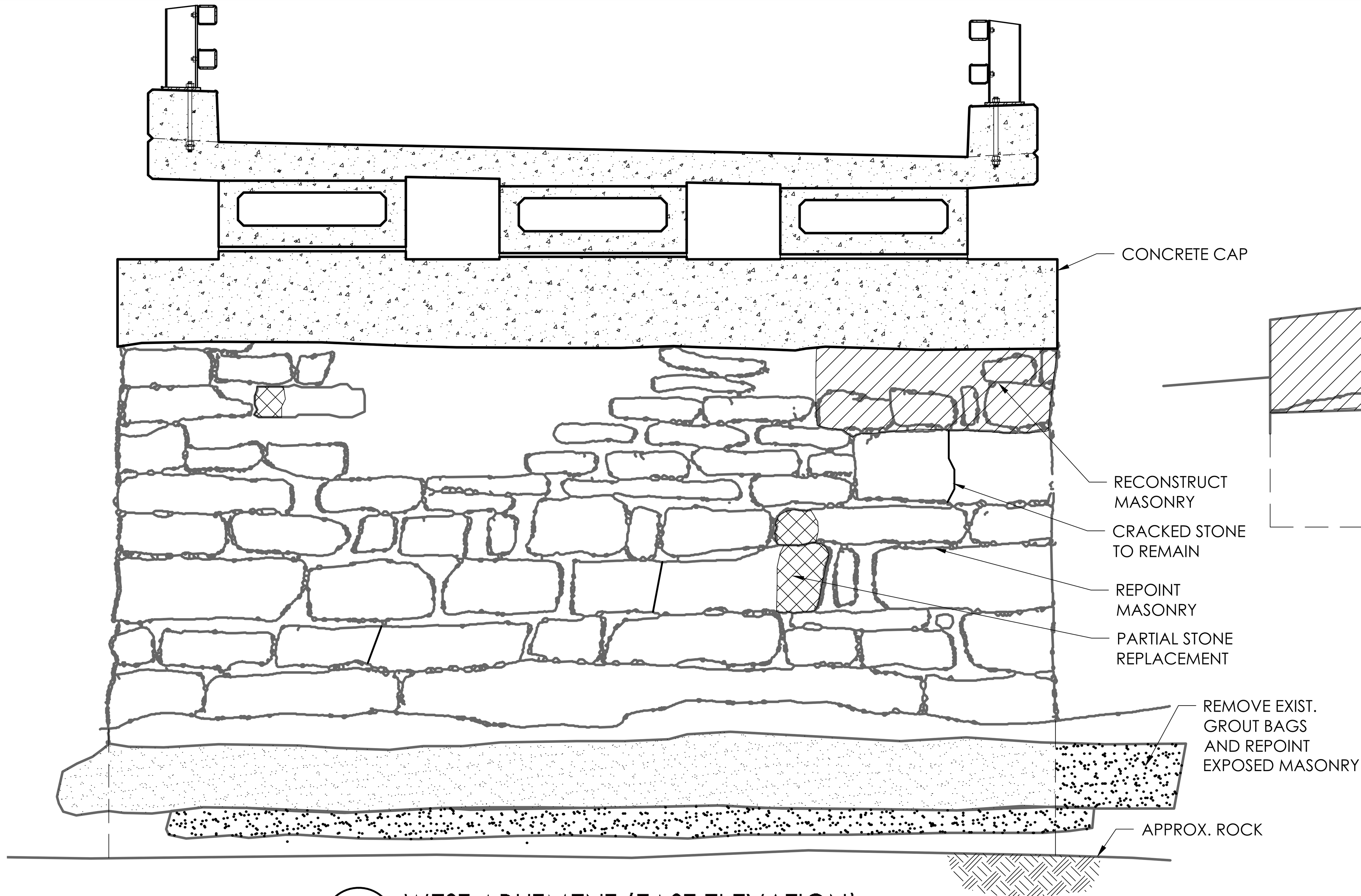
RECOMMENDED ____________________

SHEET 4 OF 12

S-401

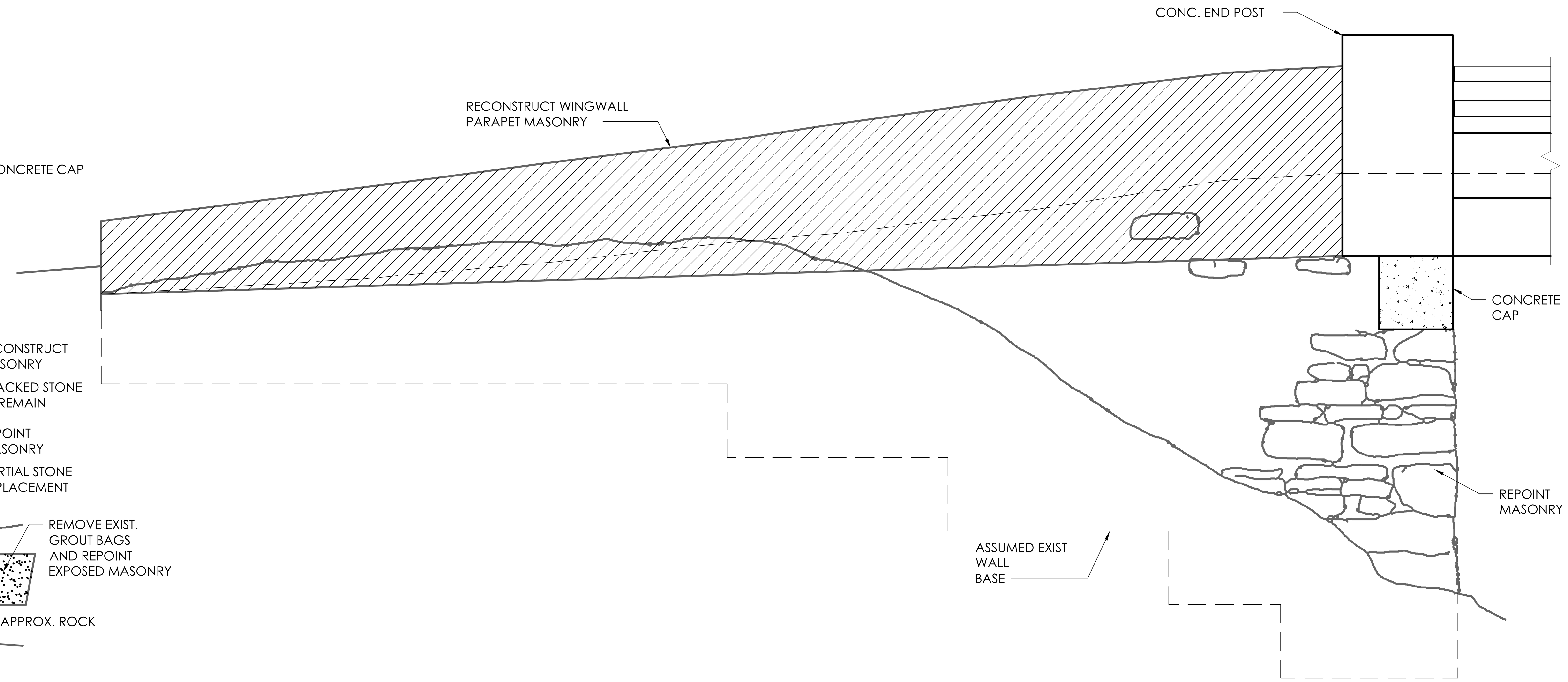
PRELIMINARY DRAWING

DES: GMG | DWG: AED/CNK | CKD: MPG/GMG



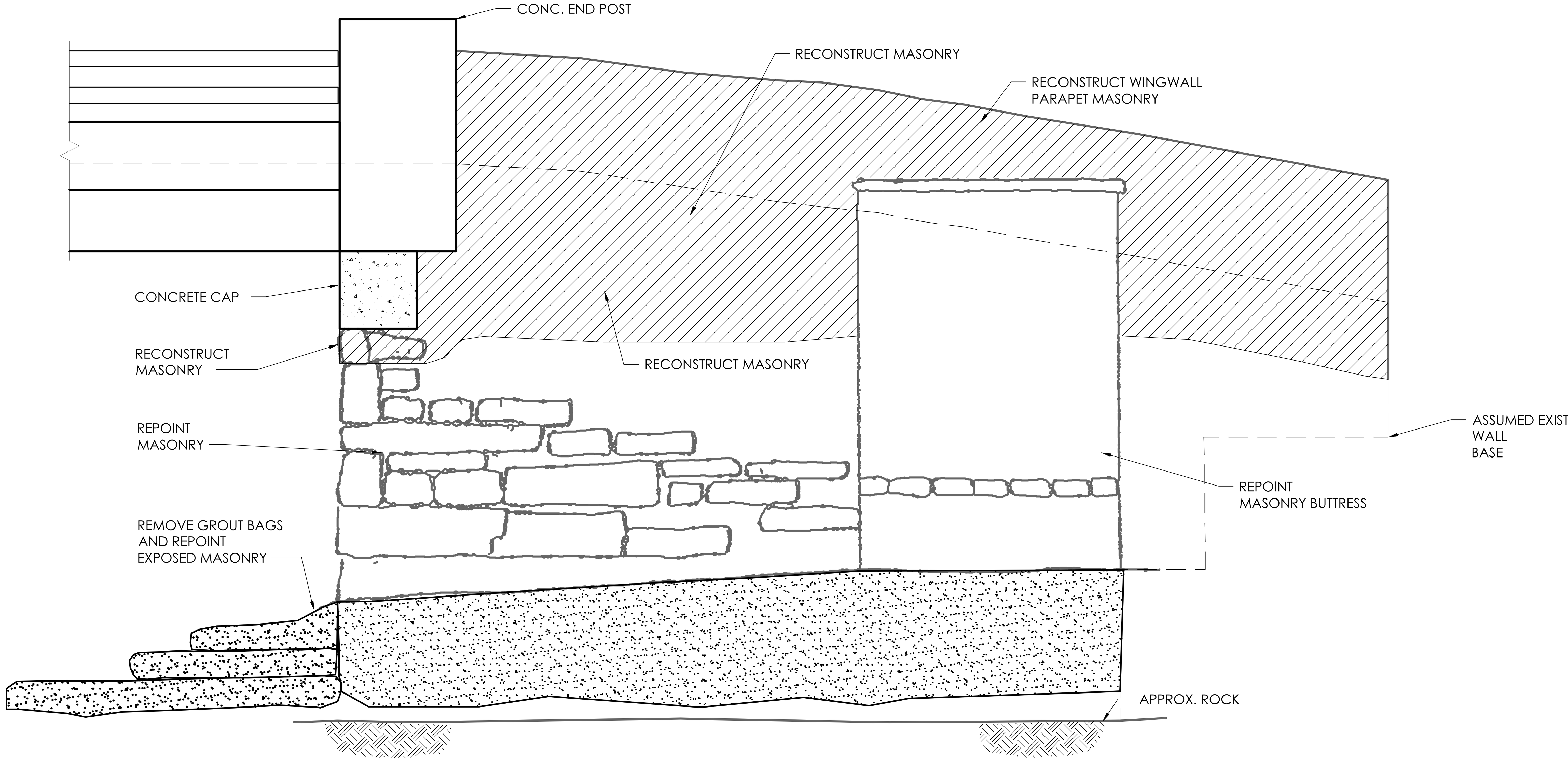
1/5 WEST ABUTMENT (EAST ELEVATION)
SCALE: 1/2"=1'-0"

2' 0 2' 4'



3/5 WEST ABUTMENT (SOUTH ELEVATION)
SCALE: 1/2"=1'-0"

2' 0 2' 4'



2/5 WEST ABUTMENT (NORTH ELEVATION)
SCALE: 1/2"=1'-0"

2' 0 2' 4'

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUCKS COUNTY
STATE ROUTE 1012 (HEADQUARTERS ROAD)
HEADQUARTERS ROAD BRIDGE REHABILITATION

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
DOUGLAS EDWARD BOND
ENGINEER
No. PE079367

WEST ABUTMENT DETAILS

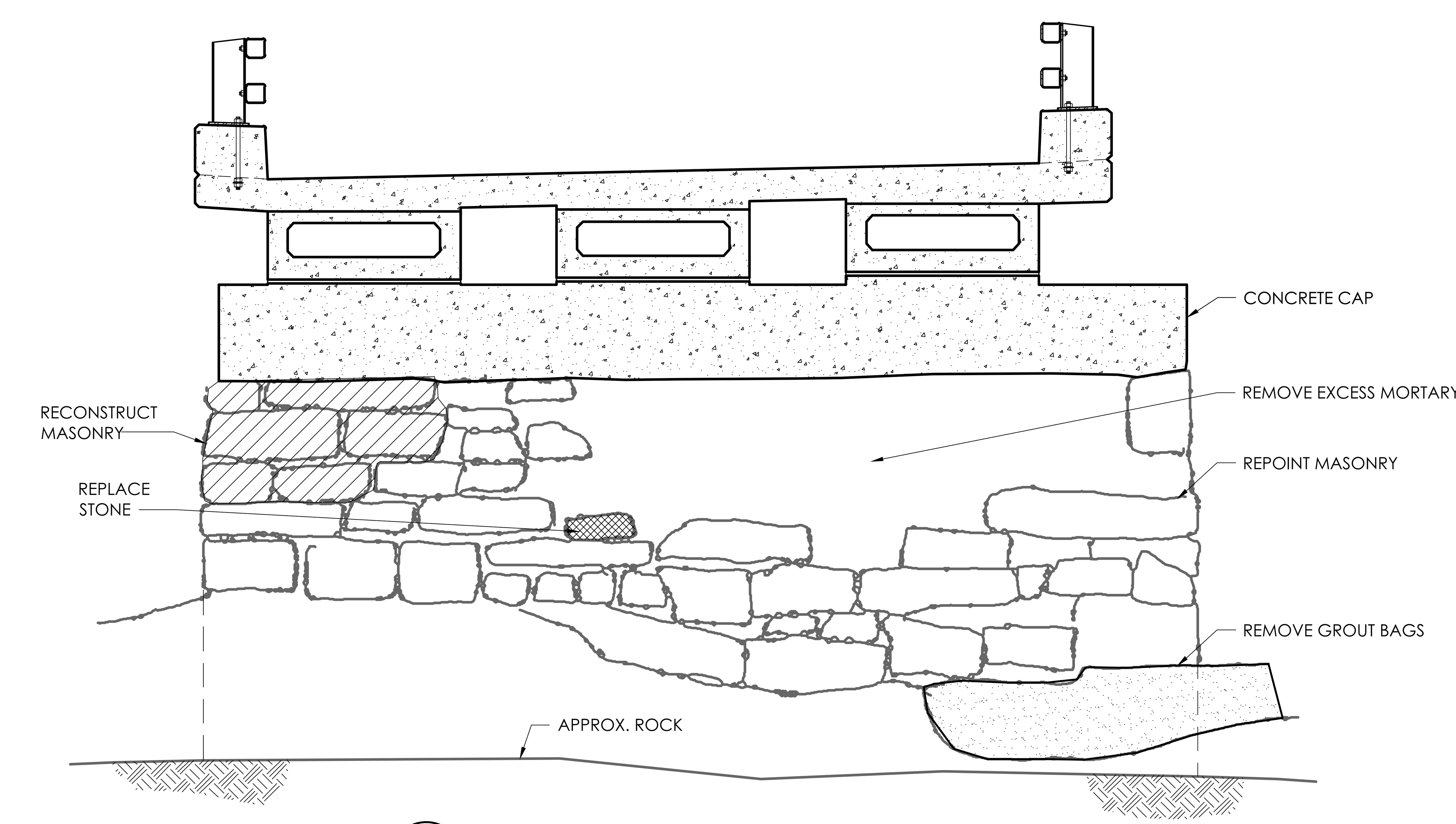
RECOMMENDED ____________________

SHEET 5 OF 12

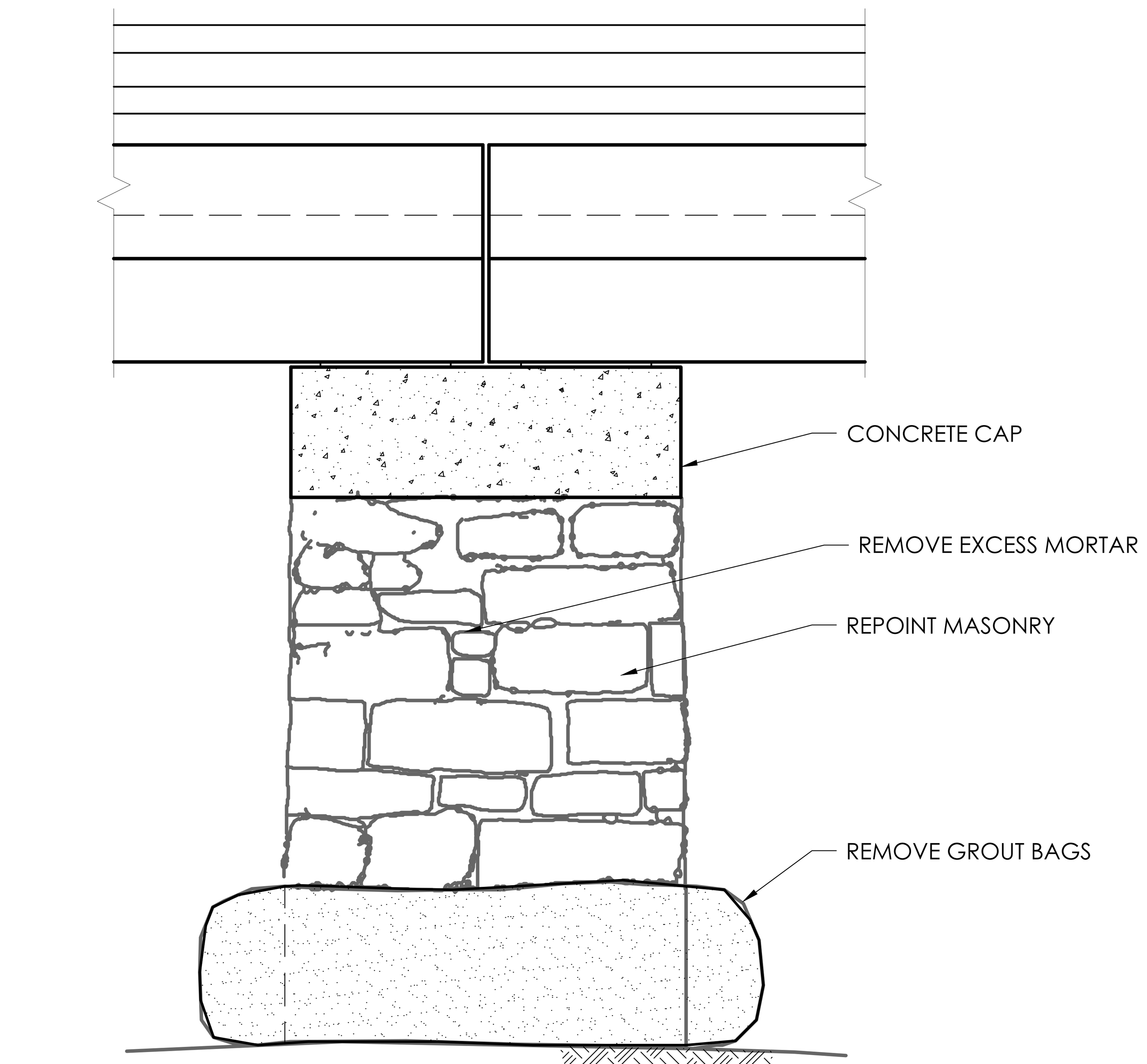
S-402

PRELIMINARY DRAWING

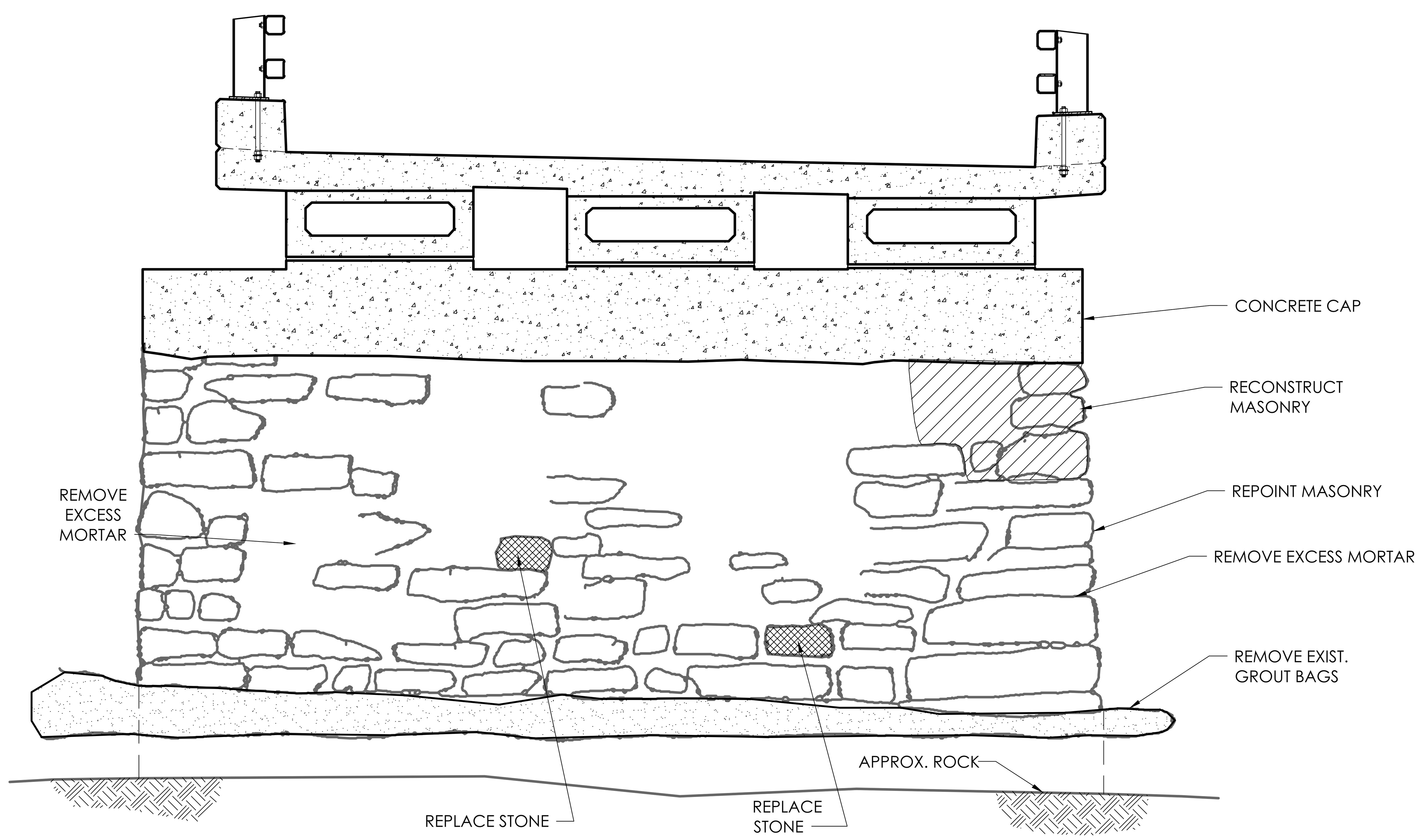
DES: GMG | DWG: AED/CNK | CKD: MPG/GMG



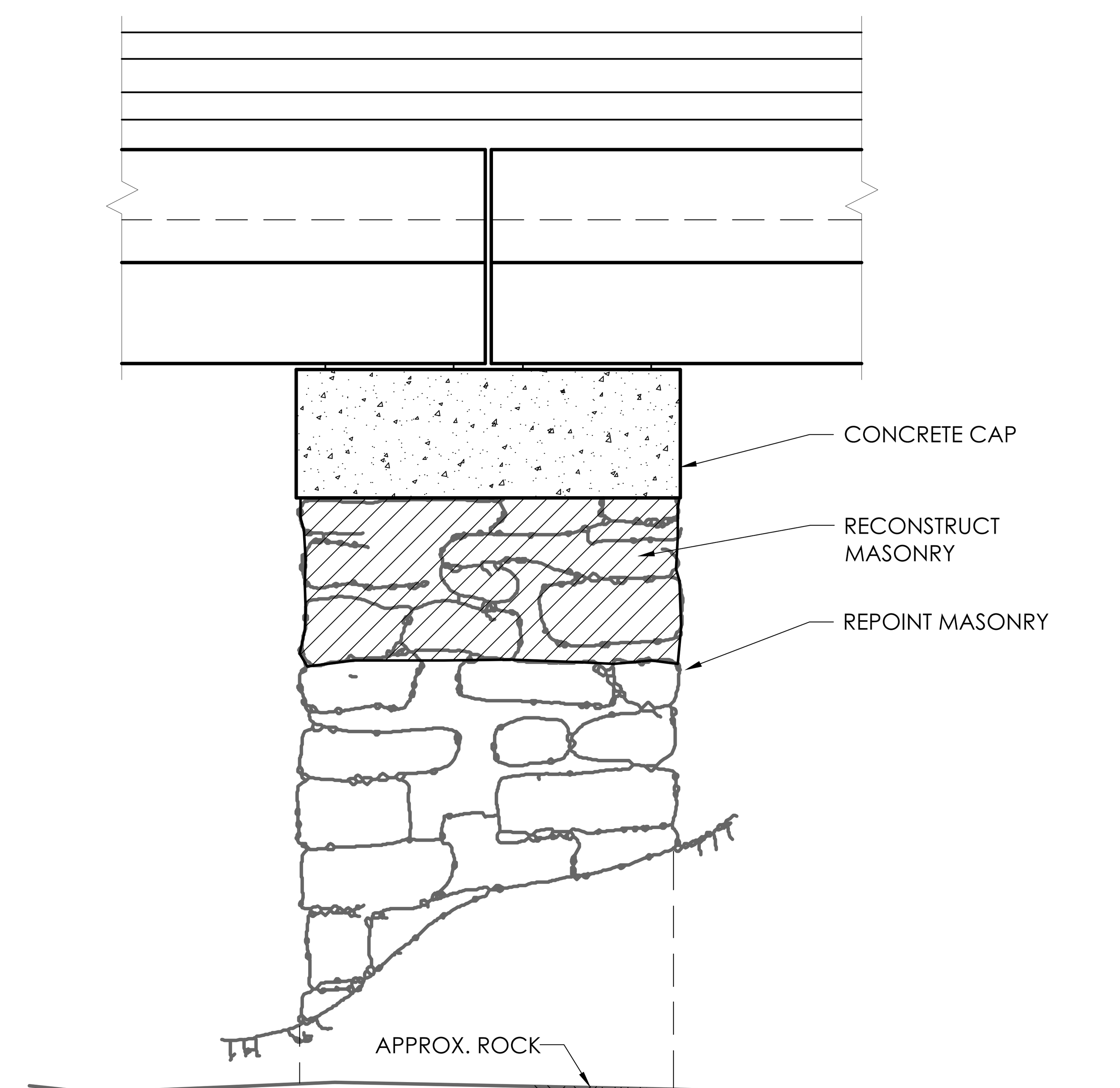
1/6 EAST PIER (EAST ELEVATION)
SCALE: 1/2"=1'-0"
2' 0 2' 4'



3/6 EAST PIER (NORTH ELEVATION)
SCALE: 1/2"=1'-0"
2' 0 2' 4'



2/6 EAST PIER (WEST ELEVATION)
SCALE: 1/2"=1'-0"
2' 0 2' 4'



4/6 EAST PIER (SOUTH ELEVATION)
SCALE: 1/2"=1'-0"
2' 0 2' 4'

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUCKS COUNTY
STATE ROUTE 1012 (HEADQUARTERS ROAD)
HEADQUARTERS ROAD BRIDGE REHABILITATION

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL DOUGLAS EDWARD BOND ENGINEER No. PE079367

EAST PIER DETAILS

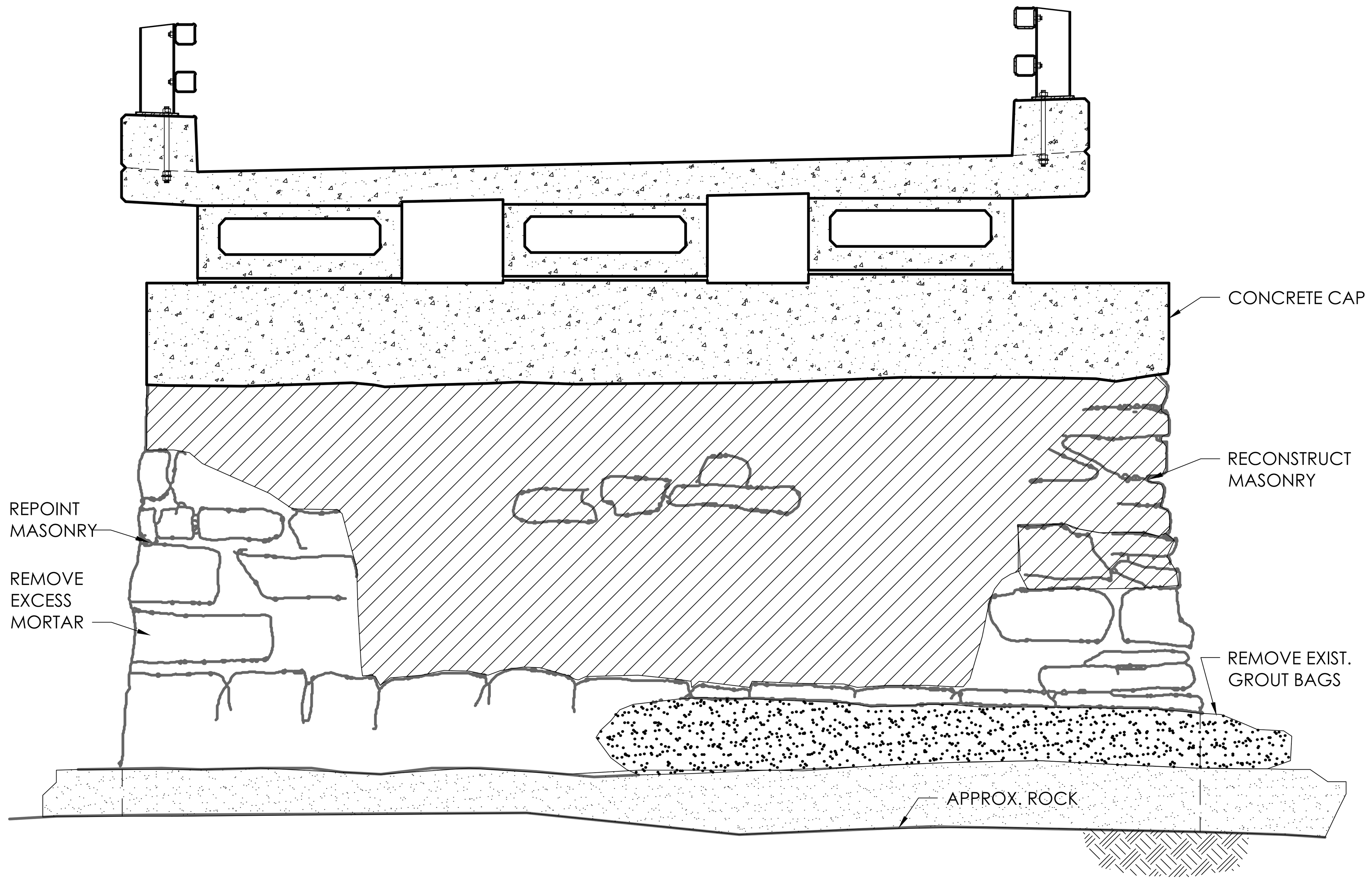
RECOMMENDED ______________________

SHEET 6 OF 12

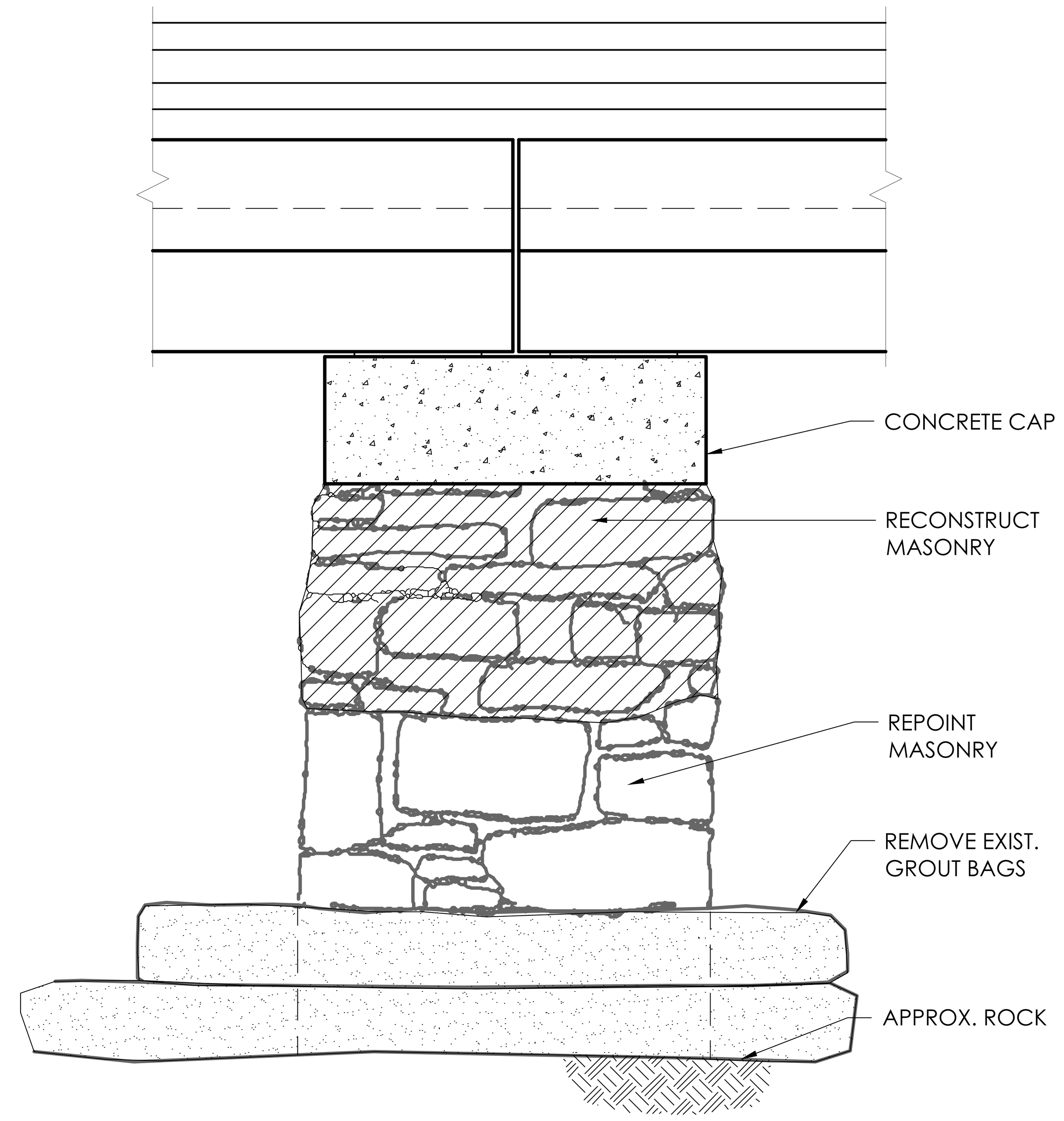
S-403

PRELIMINARY DRAWING

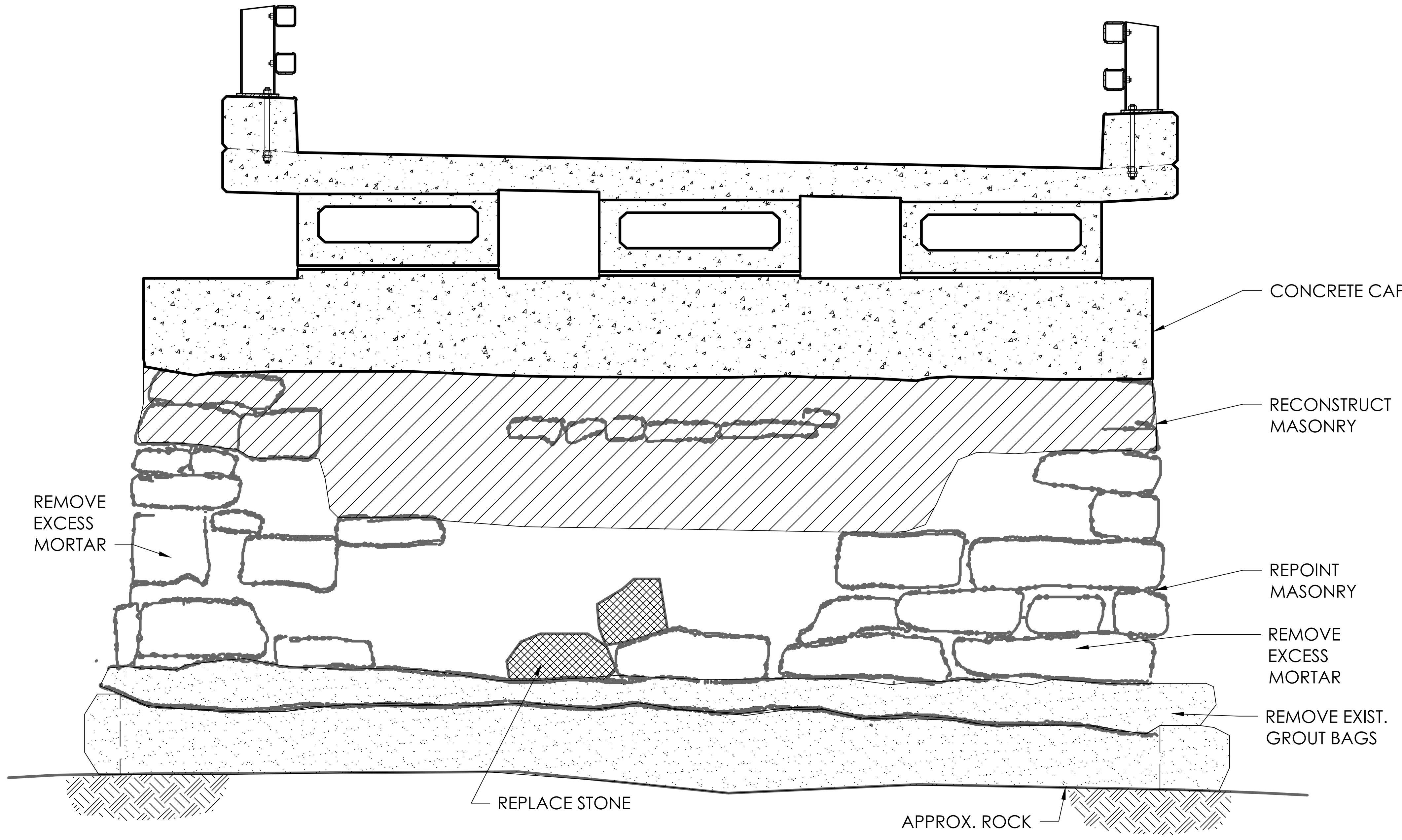
DES: GMG | DWG: AED/CNK | CKD: MPG/GMG



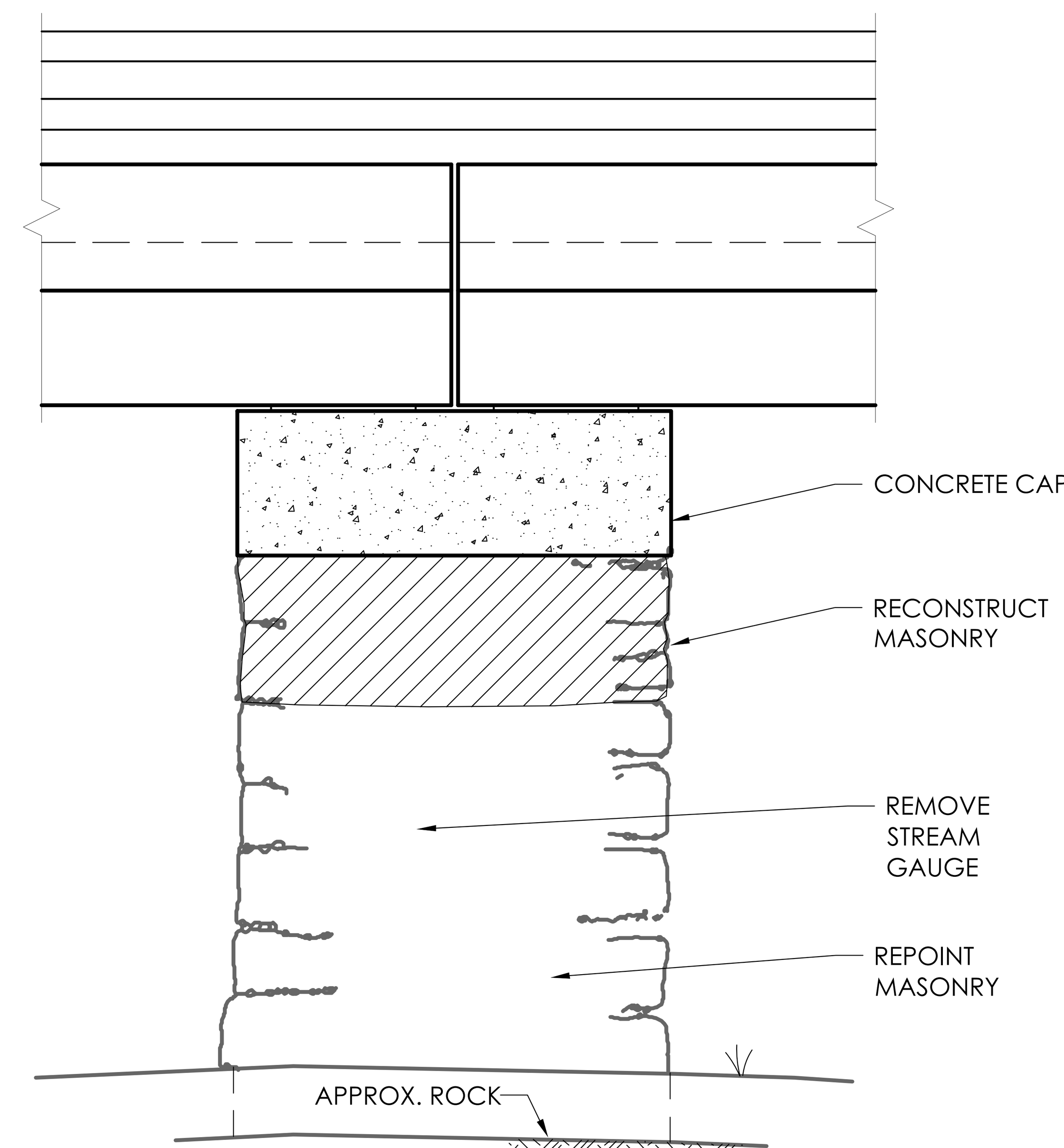
1/7 WEST PIER (EAST ELEVATION)
SCALE: 1/2"=1'-0"
2' 0 2' 4'



2/7 WEST PIER (NORTH ELEVATION)
SCALE: 1/2"=1'-0"
2' 0 2' 4'



3/7 WEST PIER (WEST ELEVATION)
SCALE: 1/2"=1'-0"
2' 0 2' 4'



4/7 WEST PIER (SOUTH ELEVATION)
SCALE: 1/2"=1'-0"
2' 0 2' 4'

PRELIMINARY DRAWING

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUCKS COUNTY
STATE ROUTE 1012 (HEADQUARTERS ROAD)
HEADQUARTERS ROAD BRIDGE REHABILITATION

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL DOUGLAS EDWARD BOND ENGINEER

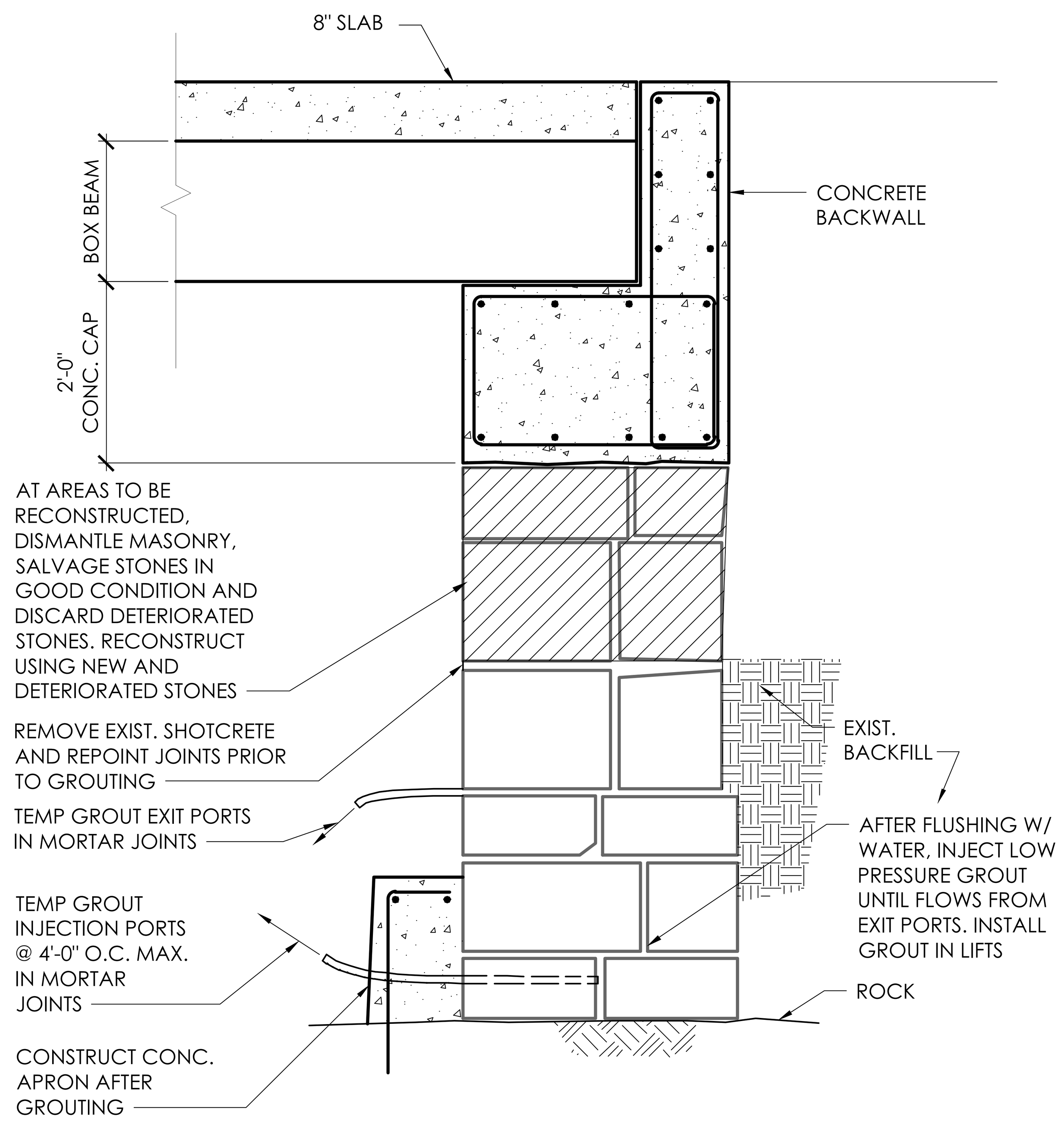
WEST PIER DETAILS

RECOMMENDED ____________________

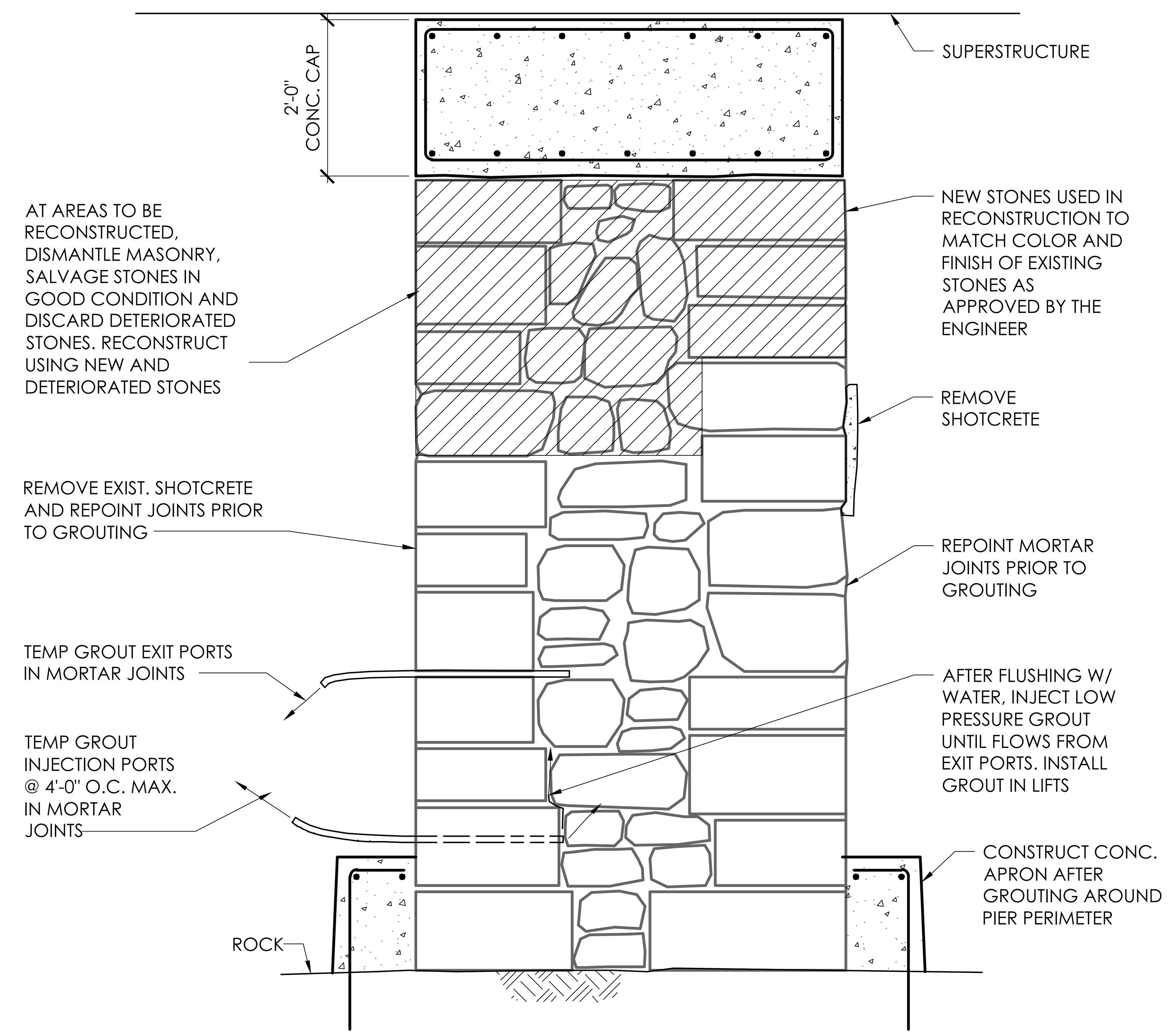
SHEET 7 OF 12

S-404

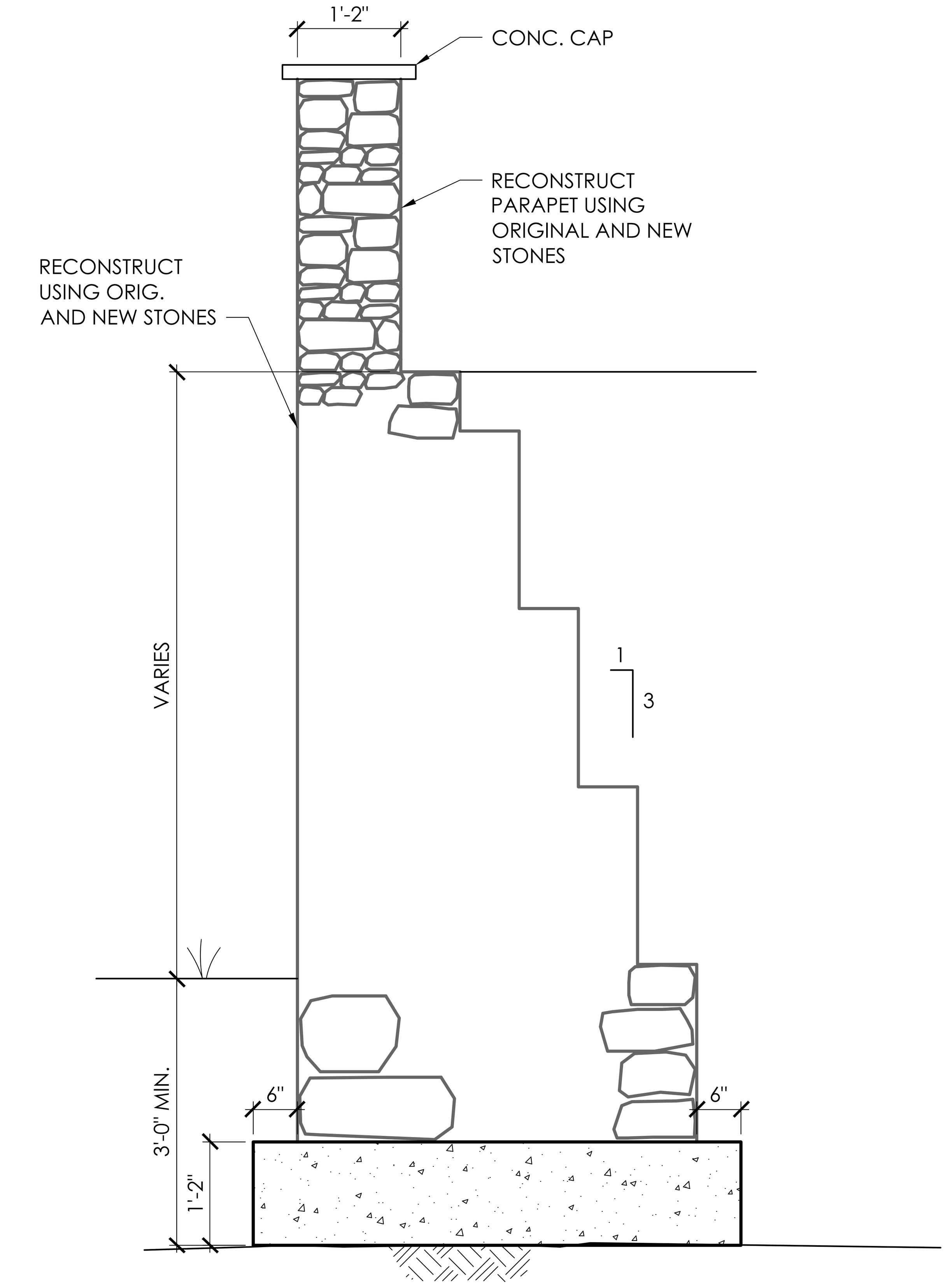
DES: GMG | DWG: AED/CNK | CKD: MPG/GMG



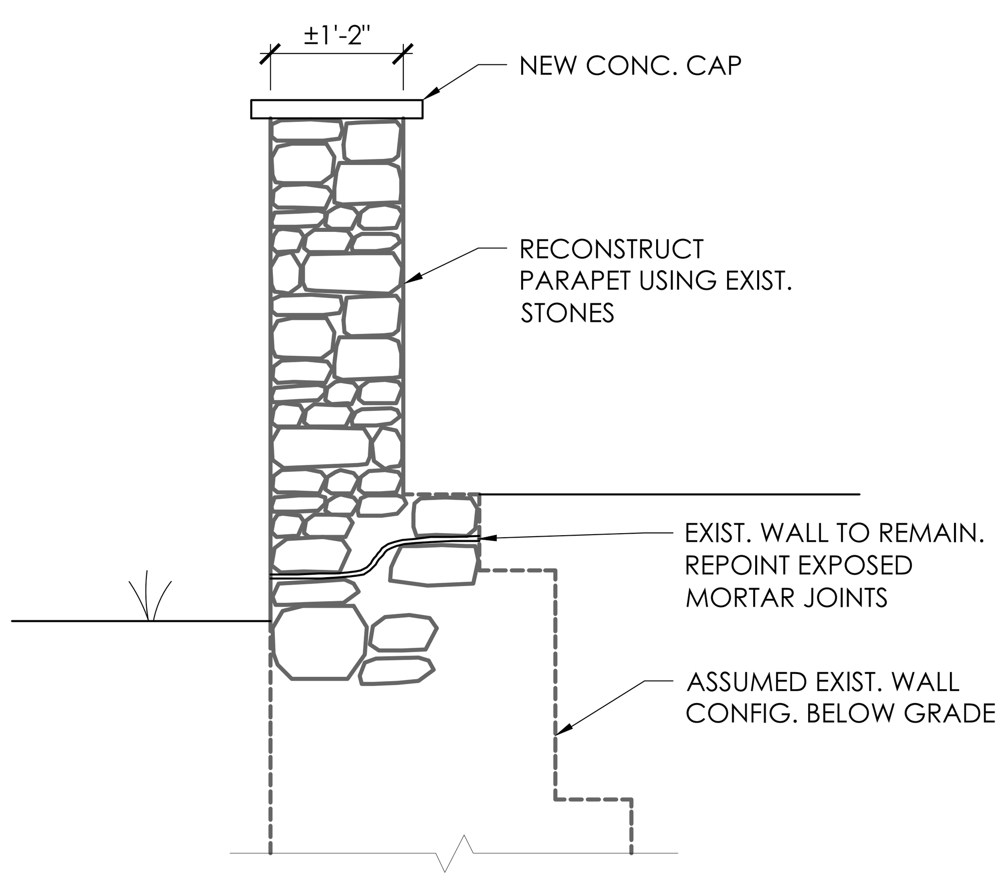
1 / 8 ABUTMENT REHABILITATION DETAIL
SCALE: ¾"=1'-0"
1' 0 1' 2' 3'



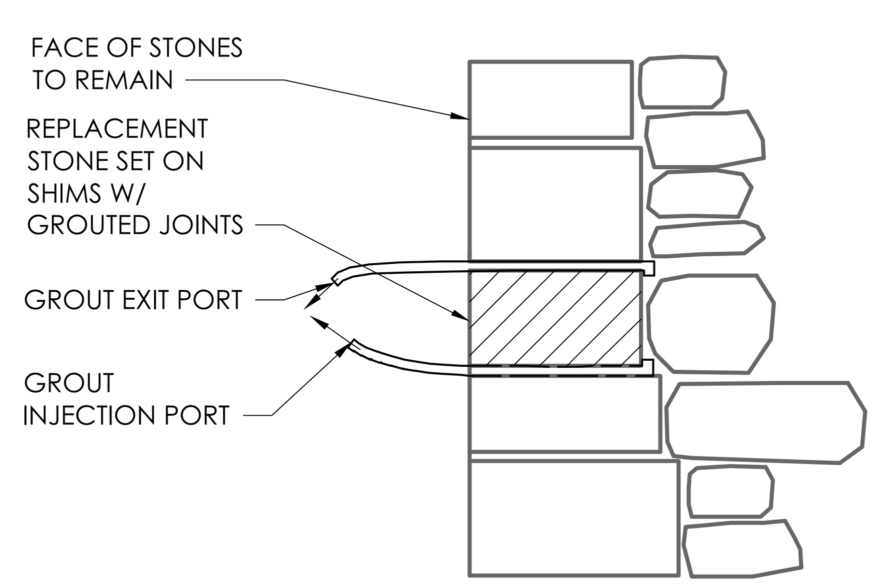
2 / 8 PIER REHABILITATION DETAIL
SCALE: ¾"=1'-0"
1' 0 1' 2' 3'



3 / 8 WINGWALL RECONSTRUCTION DETAIL
SCALE: ¾"=1'-0"
1' 0 1' 2' 3'



4 / 8 WINGWALL PARAPET RECONSTRUCTION
SCALE: ¾"=1'-0"
1' 0 1' 2' 3'



5 / 8 STONE REPLACEMENT DETAIL
SCALE: ¾"=1'-0"

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUCKS COUNTY
STATE ROUTE 1012 (HEADQUARTERS ROAD)
HEADQUARTERS ROAD BRIDGE REHABILITATION

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL DOUGLAS EDWARD BOND ENGINEER No. PE079367

MASONRY DETAILS

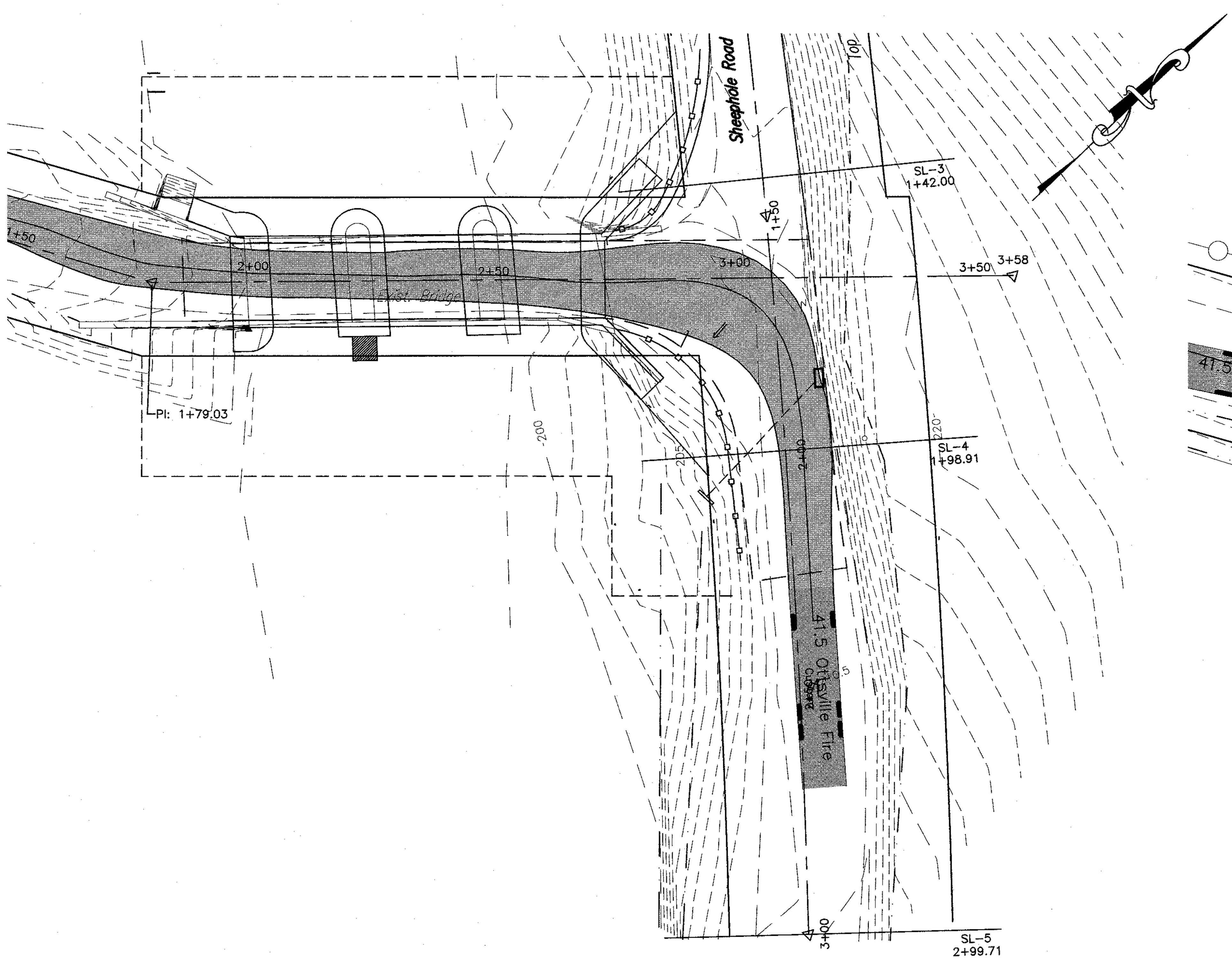
RECOMMENDED ____________________

SHEET 8 OF 12

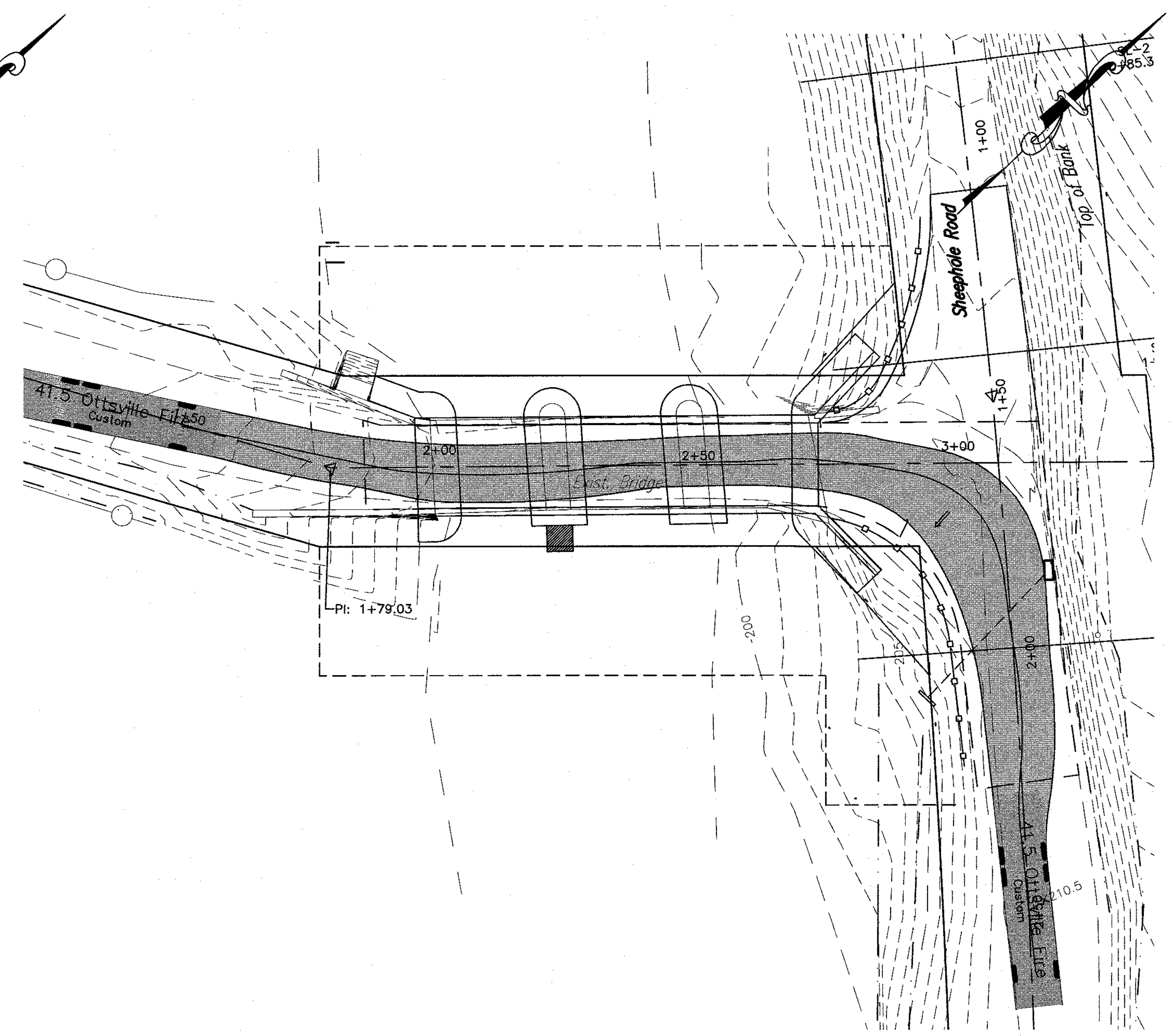
S-501

PRELIMINARY DRAWING

DES: GMG | DWG: AED/CNK | CKD: MPG/GMG



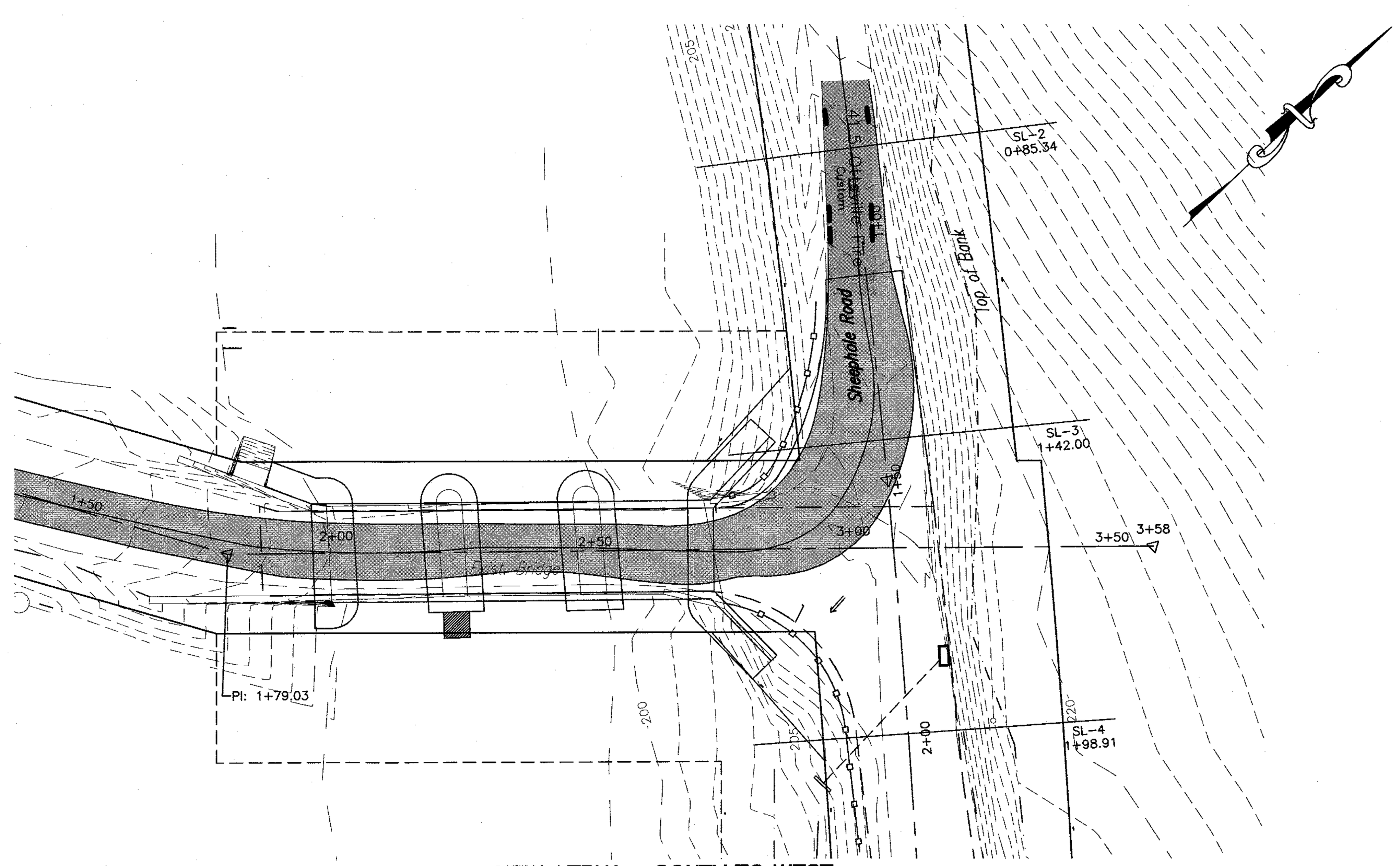
NEW AERIAL - EAST TO SOUTH
SCALE: 1"=20'



NEW AERIAL - SOUTH TO EAST
SCALE: 1"=20'

GENERAL NOTES:

1. THIS PLAN REFLECTS EXISTING SITE CONDITIONS AS THE RESULT OF AERIAL PHOTOS, TAX MAPS, AND A FIELD SURVEY PERFORMED BY ROBERTS ENGINEERING GROUP, LLC. DATED APRIL 21, 2016.
2. THIS PLAN IS NOT INTENDED TO GUARANTEE OWNERSHIP. DOCUMENTS OF RECORD WHICH MAY HAVE BEEN REVIEWED AND CONSIDERED AS PART OF THIS PLAN OF SURVEY ARE NOTED HERON AND HAVE BEEN OBTAINED BY ROBERTS ENGINEERING GROUP, LLC. THERE MAY EXIST OTHER DOCUMENTS OF RECORD WHICH WOULD AFFECT THIS PLAN.
3. THIS PLAN IS SUBJECT TO ANY EASEMENTS OR AGREEMENTS, WHICH MAY OR MAY NOT BE OF THE PUBLIC RECORD AND DISCLOSED AT THE TIME OF AN ABSTRACT OF TITLE OR TITLE SEARCH, WHICH MAY BE LOCATED BELOW THE SURFACE OF THE LANDS AND NOT VISIBLE AT THE TIME OF SURVEY. THE LOCATIONS OF UNDERGROUND UTILITIES AS SHOWN HEREON ARE BASED UPON ABOVE GROUND STRUCTURES VISIBLE AT THE TIME OF THE FIELD SURVEY AND RECORD OR AS-BUILT DRAWINGS PROVIDED TO ROBERTS ENGINEERING GROUP, LLC.
4. LOCATIONS OF UNDERGROUND UTILITIES/STRUCTURES MAY VARY FROM LOCATIONS SHOWN HEREON; WHEREAS ADDITIONAL BURIED UTILITIES/STRUCTURES MAY BE ENCOUNTERED. NO EXCAVATIONS WERE MADE DURING THE PREPARATION OF THIS SURVEY TO LOCATE BURIED UTILITIES OR STRUCTURES. BEFORE EXCAVATIONS ARE BEGUN, THE UNDERGROUND UTILITIES LOCATION SERVICE AT 1-800-242-1776 SHALL BE CONTACTED AT LEAST 72 HOURS PRIOR TO COMMENCEMENT OF ANY DEMOLITION OR EXCAVATION ACTIVITIES, IN APPLICABLE LAWS, RULES, AND REGULATIONS.
5. ALL BUILDINGS, SURFACE AND SUBSURFACE IMPROVEMENTS, ON OR ADJACENT TO THE SITE ARE NOT NECESSARILY SHOWN.
6. RIGHT-OF-WAY AND PROPERTY LINE INFORMATION ARE APPROXIMATE AND ARE BASED UPON TAX MAP INFORMATION AND LIMITED FIELD SURVEYING, AND HAS BEEN TAKEN FROM VARIOUS SOURCES AND IS NOT GUARANTEED FOR COMPLETENESS OR ACCURACY.
7. BOTH HORIZONTAL AND VERTICAL DATUM ARE ASSUMED SITE SPECIFIC.
8. TRUCK TURNING PLANS ARE BASED ON THE 41.5' FIRE TRUCK AS PER OTTSVILLE.



NEW AERIAL - SOUTH TO WEST
SCALE: 1"=20'

GRAPHIC SCALE

(IN FEET)
1 inch = 20 ft.

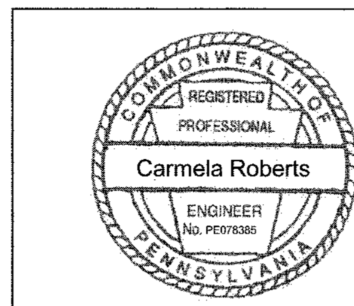
MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD

TRUCK TURNING PLAN



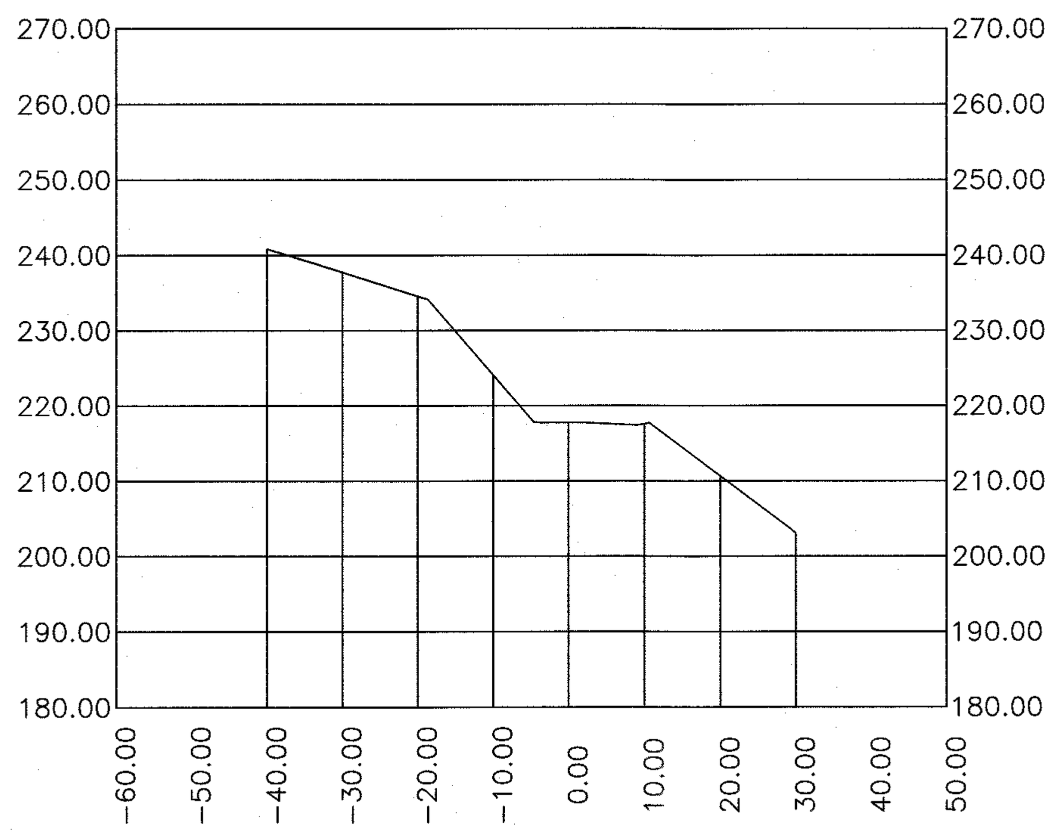
DATE

RECOMMENDED ____________

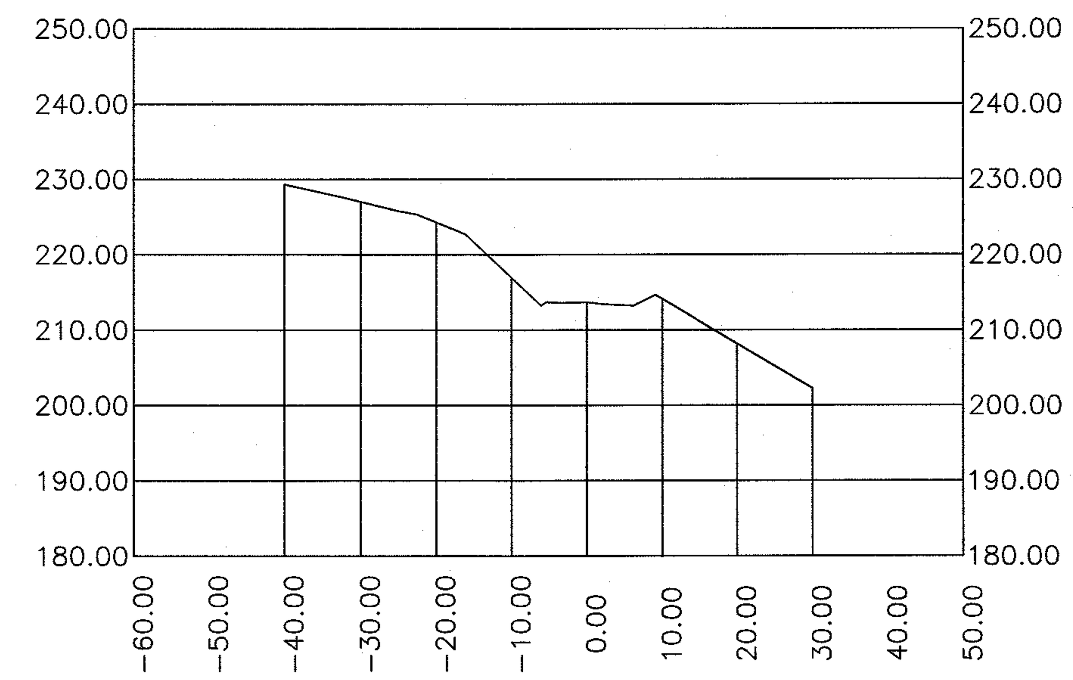
SHEET 9 OF 12

P1611

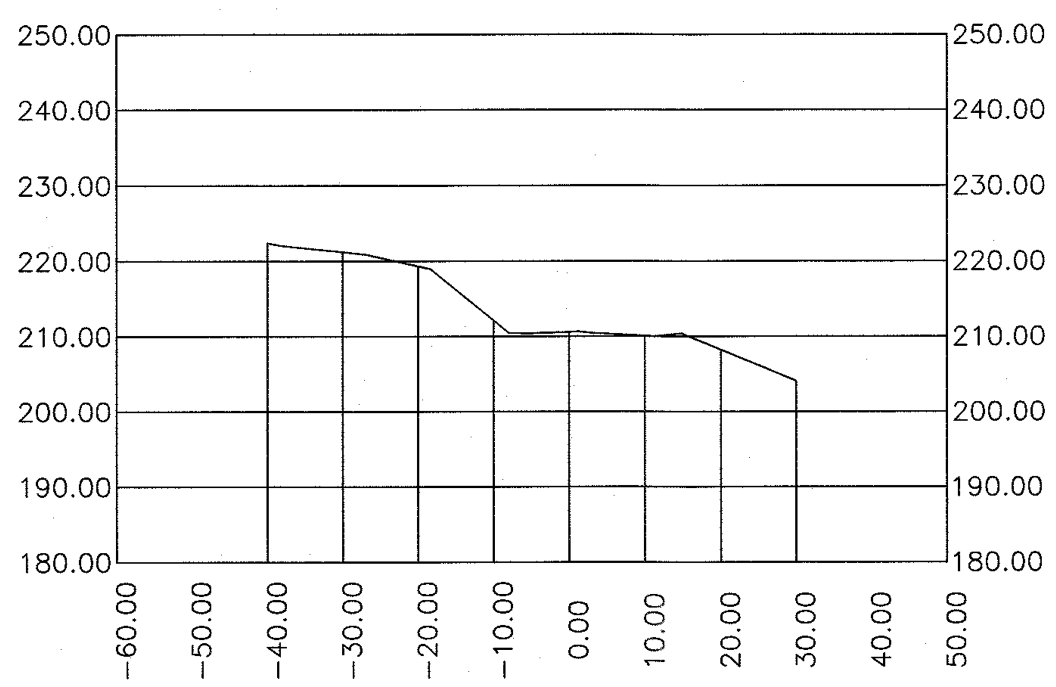
DES: GMG	DWG: AED/CNK	CKD: MPG/GMG



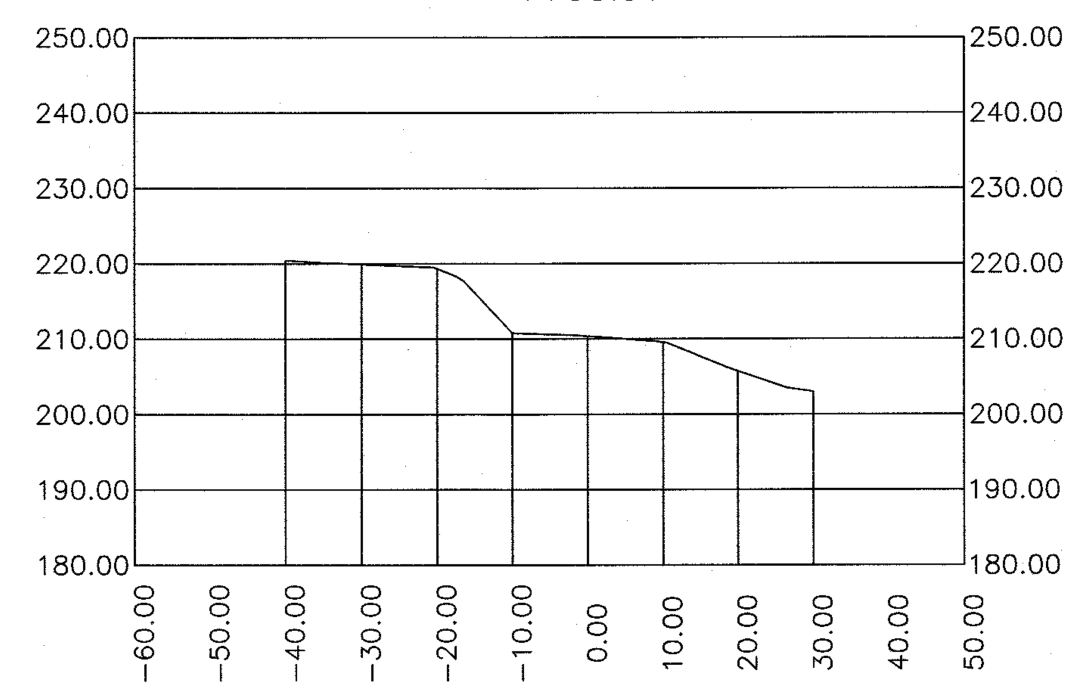
SECTION A-A
SCALE: 1"=20'



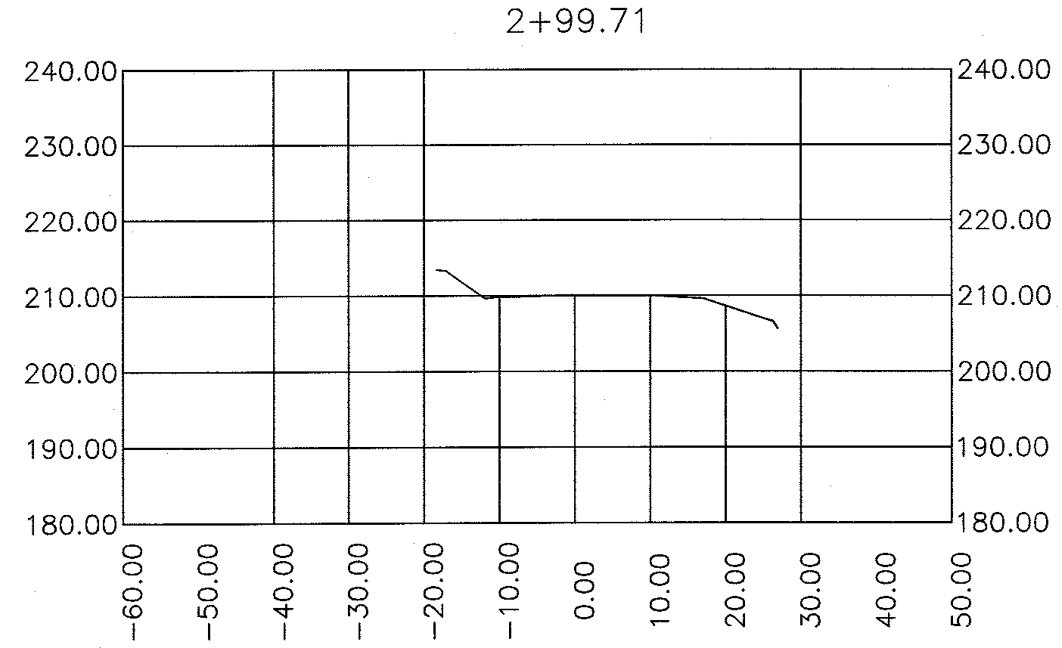
SECTION B-B
SCALE: 1"=20'



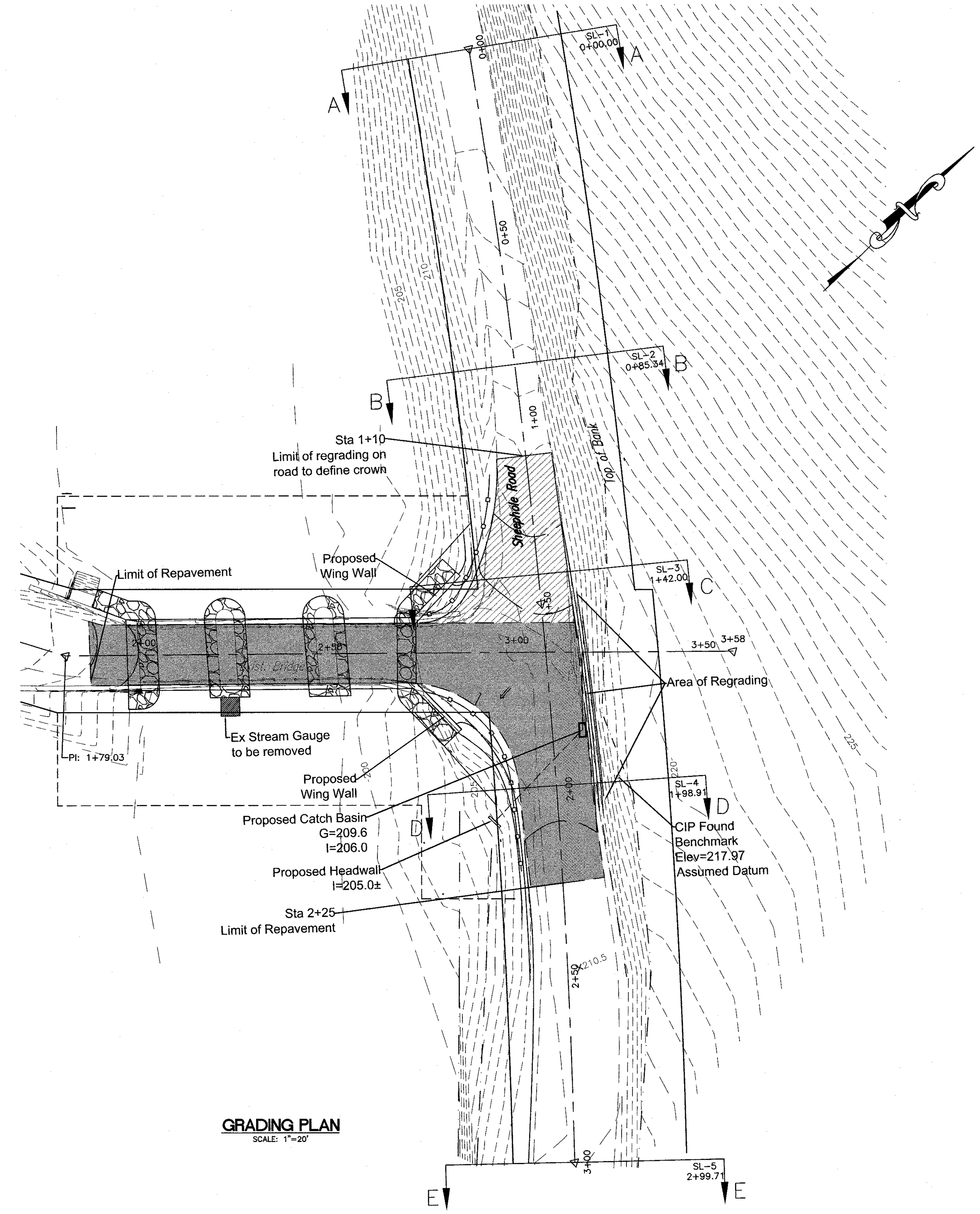
SECTION C-C
SCALE: 1"=20'



SECTION D-D
SCALE: 1"=20'



SECTION E-E
SCALE: 1"=20'



GRADING PLAN
SCALE: 1"=20'

GRAPHIC SCALE

(IN FEET)
1 inch = 20 ft.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD

SECTIONS AND DETAILS

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
Carmela Roberts
ENGINEER

DATE

RECOMMENDED ____________________

SHEET 10 OF 12

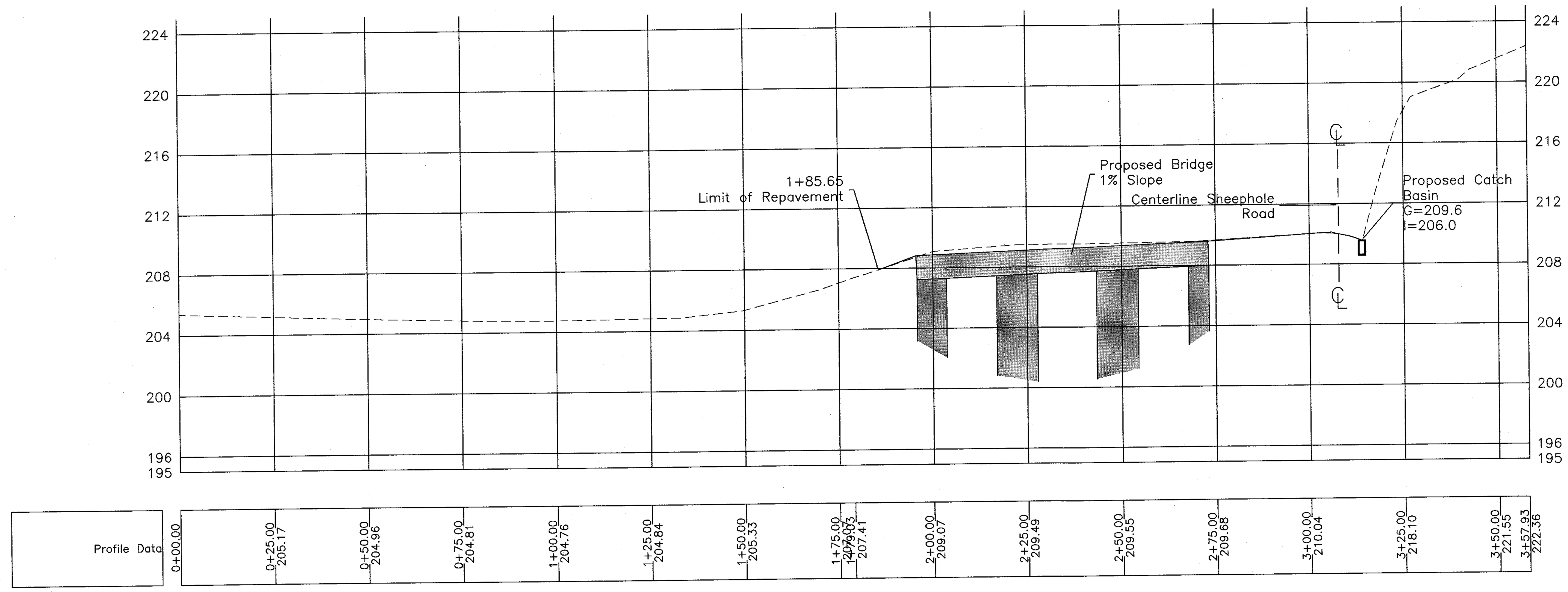
P1611

MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

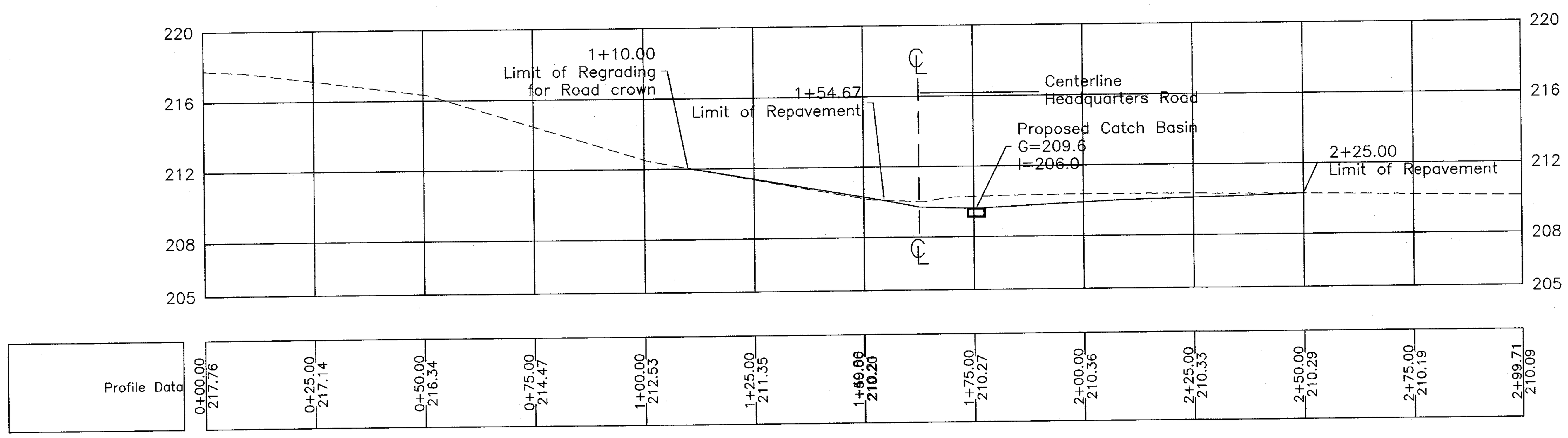
DES: GMG | DWG: AED/CNK | CKD: MPG/GMG

Profile View of Headquarters Bridge Road



HEADQUARTERS ROAD PROFILE

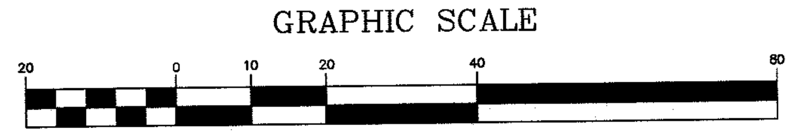
SCALE HOR: 1"=20'
SCALE VERT: 1"=2'



SHEEPHOLE ROAD PROFILE

SCALE HOR: 1"=20'
SCALE VERT: 1"=2'

GRAPHIC SCALE



(IN FEET)
1 inch = 20 ft.

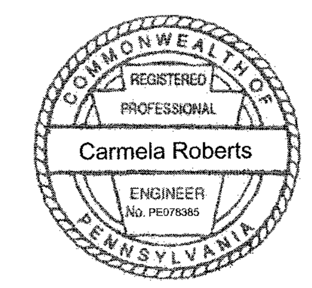
MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD

ROAD PROFILES



DATE

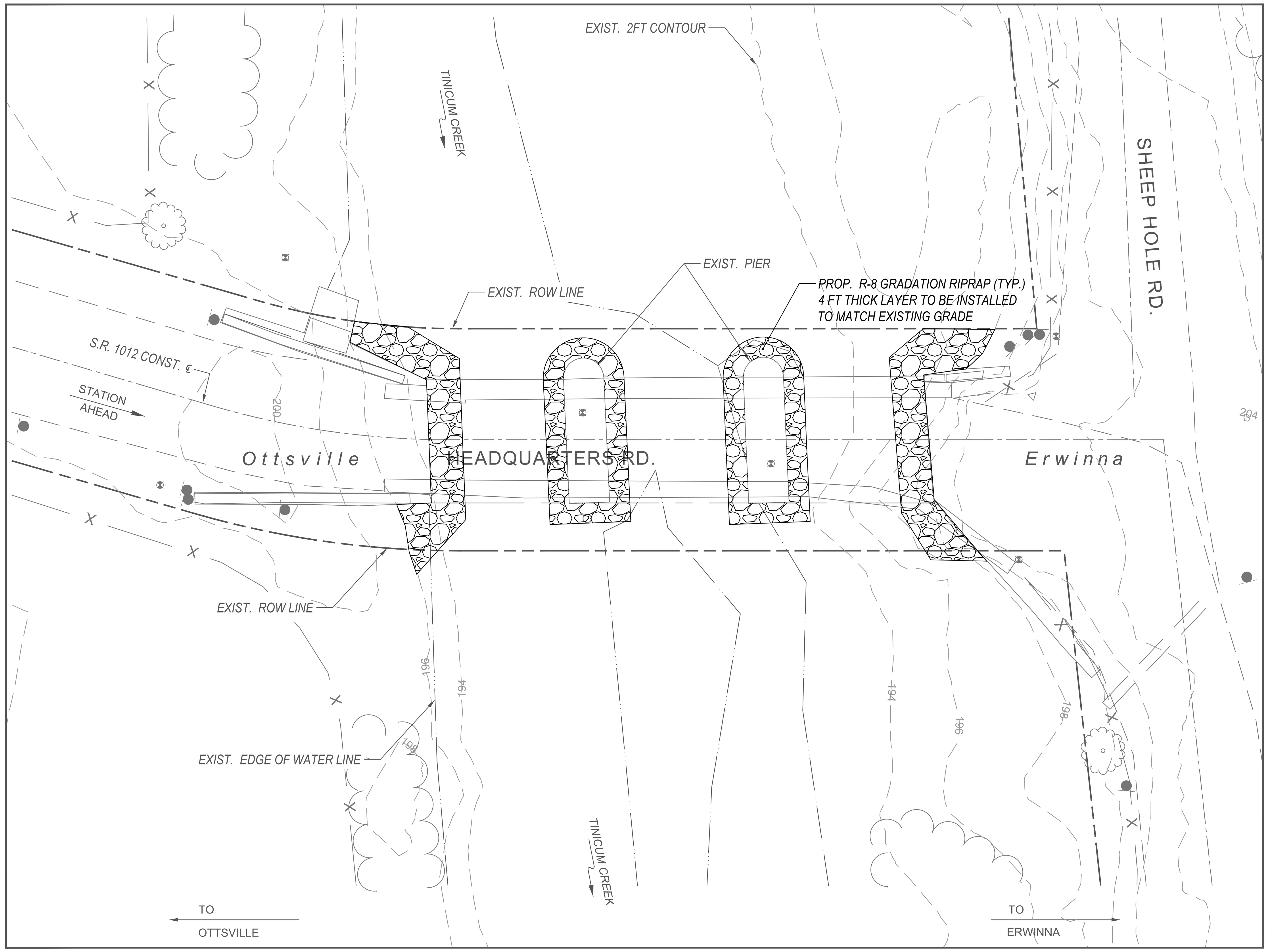
RECOMMENDED ____________

SHEET 11 OF 12

P1611

DES: GMG	DWG: AED/CNK	CKD: MPG/GMG

Drawing name: P:\1020\Projects\1020017\CAD\SHEETS\01 PROPOSED.dwg Plotted on: Jan 11, 2017 - 3:12pm



SCOUR COUNTERMEASURE PLAN
SCALE: 1"=10'

LEGEND

- EXISTING 2FT CONTOUR
- EXISTING RIGHT-OF-WAY LINE
- EXISTING EDGE OF WATER LINE
- EXISTING TREELINE
- ROAD CENTERLINE
- X EXISTING FENCE
- PROPOSED R-8 RIPRAP

GRAPHIC SCALE
0 2 4 6 8 10 20 30 40 FEET
SCALE: 1" = 10'

NOTES:

1. SCOUR COUNTERMEASURES AT BRIDGE OR DOWNSTREAM OF THE BRIDGE WILL BE DEVELOPED DURING FINAL DESIGN PLANS PREPARATION.
2. AS PART OF THE FINAL DESIGN, THE STREAM MAY BE REALIGNED USING NATURAL CHANNEL DESIGN FEATURES UPSTREAM OF THE BRIDGE.

RIPRAP GRADATION TABLE

	PERCENT PASSING (SQUARE OPENINGS)
CLASS SIZE NO. / ROCK SIZE (INCHES)	R-8
42	100
30	
24	15-50
18	
15	0-15
12	
9	
6	
4	
3	
2	

NOTE:
GRADATION OBTAINED FROM NCSA ROCK SIZE AND GRADATIONS INCLUDED IN SECTION 850 OF PENNSYLVANIA DEPARTMENT OF TRANSPORTATION PUBLICATION 408/2016; SPECIFICATIONS.

PREPARED BY:

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MARK	DESCRIPTION	BY	CHK'D	RECM'D	DATE

REVISIONS

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

BUCKS COUNTY
HEADQUARTERS ROAD
AND SHEEPHOLE ROAD

SCOUR COUNTERMEASURE PLAN

RECOMMENDED ____________________

SHEET 12 OF 12

P1611

DES: MPG | DWG: EPD | CKD: MPG

Headquarters Road Bridge
(a.k.a Burnt Mill Bridge)

Preliminary Condition Assessment and Proposed Rehabilitation

Prepared for: the Delaware Riverkeeper

FINAL REPORT March 6, 2012

Prepared by:

McMullan & Associates, Inc.

Background

McMullan & Associates was retained by the Delaware Riverkeeper Alliance in June 2011 to investigate the condition of the Headquarters Road Bridge (aka Burnt Mills Bridge) located in Tinicum Township, Bucks County, Pennsylvania. This included a brief inspection of the bridge, a review of available documentation, and a report of our initial findings and recommendations.

The bridge was originally constructed in 1812 with stone masonry piers and abutments and a wooden beam and deck superstructure. It carries S.R. 1012 (Headquarters Road) across the Tinicum Creek and originally was a principal east-west route to a nearby mill site.

In 1919, the bridge was rehabilitated with the original stone piers and abutments and a steel beam and concrete slab deck. Sixteen feet clear was provided between the curbs. Noted Architect and Engineer Oscar Martin, who served as the County Bridge Engineer, provided a simple bridge design using the original 1812 piers and abutments that was compatible with the surrounding countryside.

Sometime prior to 2001, the original bridge railing was replaced with a new more substantial railing with posts bolted to the edges of the concrete deck. The railing on the south side of the bridge was heavily damaged, reportedly by a truck trailer, and subsequently concrete jersey barriers were placed on the bridge, resulting in a significantly narrowing of the curb to curb width to its present 10'-11".

The bridge was identified as a contributing resource to the Ridge Valley Rural Historic District, listed in the National Register of Historic Places July 24, 1992. On April 28, 2006, the Keeper of the National Register of Historic Places identified the bridge as being "historically significant in the context of the development of the township, regional transportation, and the operation of local mills, and its engineering significance both for its early 19th century construction and its sensitive modernization in 1919".

In August 2006, a consultant to PennDOT performed a thorough inspection of the bridge and detailed several deficiencies in their report. After the report, repairs were made to the bridge. The bridge was closed to traffic in March 2010 due to concerns about deterioration deck.

In April 2011, PennDOT conducted a public meeting and exhibited plans for replacing the bridge with an entirely new structure.

Until its recent closure, the bridge reportedly was used by school buses, fire and rescue vehicles, contractors, trash collection vehicles, and the general public.

Field Investigation and Observations

On June 13, 2011, McMullan & Associates visited the bridge. Present at the bridge were:

- Elizabeth Koniers-Brown, Delaware Riverkeeper Alliance
- Damon Aherne, Woodtiger Fund
- Kathryn Auerbach (and a student), Preservation Consultant
- Abba Lichtenstein, McMullan & Associates

- Douglas Bond, PE, McMullan & Associates

A general discussion ensued of the history of the bridge, its condition, and ideas for saving the bridges historic features. A brief inspection of the bridge was conducted involving observation, photographs, measurements, and some probing. This was followed by further discussion offsite. Photographs taken during the inspection are included as Appendix A.

The bridge is currently closed to traffic. There is a sign for a 10 ton load limit. The bridge crosses Tinicum Creek along an East-West axis. At the time of our visit, water flowed under the center and west spans of the three span bridge. The clear distance between piers and abutments is approximately 21 feet and the piers are about 5'-4" feet wide.

The stone piers and abutments are constructed using a squared rubble coursing with larger stones at the base and smaller stones near the top. It is evident that repairs have been made to the stone piers as evidenced by the variety of mortar color in the joints between the stones. Mortar or shotcrete has been applied to the surface of the stones in many areas. In some cases this layer is very thin, about ¼ inch in thickness. No large open cracks were observed, although there are a number of minor cracks, which have been repaired with mortar. The stone coursing appeared regular and no large displacements or settlements were noted. There is a minor bulge on the west face of the west pier and a few stones that have deteriorated but these conditions appear to be repairable.

The abutments appear to be in good condition, with no large cracks, missing stones, or other signs of significant deterioration. There are some minor cracks that have been repaired with mortar or shotcrete. The stones appear to be a form of silt stone or shale.

No large scour holes were observed at the bottom of the piers and abutments. Remedial grout bags were present around the upstream nose of each pier and the West Abutment, presumably as a scour countermeasure.

The stone masonry wing-walls at each end of the bridge are in fair condition with some minor cracks and displacements and plant growth in mortar joints. Some of the cracks have been repaired with mortar.

Little remains of the 2001 W-Beam railing on the downstream (south) edge of the bridge slab. The exposed edge of the remaining concrete contains large rounded aggregate. The railing post anchor bolts are exposed. There is significant spalling at the bolt locations.

On the underside of the deck, many of the original concrete encased steel beam stringers are exposed and exhibit significant corrosion. The concrete encasement below remaining stringers has delaminated as a result of the corrosion at other stringers. There are several spalls in the concrete slab itself, leaving the original expanded wire reinforcement exposed. There are three significant holes in the slab.

Jersey barriers have been placed inside the railing and allow a 10'-11" curb to curb width. There are three steel plates on the bridge deck that have been placed over holes in the concrete slab.

Documents Reviewed and Comments

The following documents were provided to McMullan for review:

1. Plans for the Bridge Repairs, 1919, by Oscar Martin
2. Presentation Handout by PennDOT, April 27, 2011
3. Engineering Inspection Report, 2006, Urban Engineering Inc.
4. 2008 Guidelines for Stonework, Headquarter Bridge, Kathryn Auerbach
5. Determination of Eligibility Notification, 2 pages, Department of Interior, April 28, 2006.

The 1919 Repair plans (Appendix D) indicate that the bridge, known as "Hockmans Bridge", was to be built on the existing stone masonry substructure. Parapets were added to the original wing walls and concrete posts added as a termination for a 2" diameter galvanized pipe railing. The pipe railing was supported by steel posts set on concrete curbs. The 16 foot wide bridge between curbs was supported by 12 inch deep steel stringers encased in concrete. The concrete deck was a 6" slab reinforced with expanded wire. The slab was crowned with asphalt. A concrete cap was placed on the piers and the abutments.

The PennDOT 2011 preliminary bridge plans indicate removing the original stone masonry piers and abutments and 1919 superstructure with replacing them with a new 24 foot wide 2 lane structure supported by concrete piers faced with the original stones "where possible". It is likely that some of the larger stones at the base of the pier may be thicker than what would be needed for facing a concrete pier. Also, additional right of way may be needed for this design.

The 2006 Urban Engineering Report noted several deficiencies. Many of these had been repaired at the time of our inspection. A list of the defects noted in the report in with a comparison to their present condition is included as Appendix B. The report also made reference to a "Foundation Report" from June 2005 that contains logs of test borings. For the Stone Masonry Properties, the Uniaxial Compressive Strength of the stone is listed as 814.9 TSF (about 11,000 psi) "...per Foundation Report Testing...", and the stone type is identified as Siltstone. Bedrock properties are indicated to have an Average Rock Quality Designation (RQD) of 53%.

The 2008 Guidelines for Stonework contain a detailed description of the stone masonry piers and abutments and recommendations for mortar.

The 2006 Eligibility Notification, from the office of the Secretary of the Interior, indicated that the Headquarters Road Bridge is eligible for the National Register of Historic Places as a contributing property in the National Register listed Ridge Valley Rural Historic District.

Recommendations for Rehabilitation

The condition of the stringers and deck is such that replacement of the superstructure is the logical alternative. The stone piers and abutments, although exhibiting some minor cracks, can be rehabilitated to support a new superstructure. The stresses in the stone masonry are low in comparison to their compression capacity. The piers and abutments should be repaired using historically compatible materials and techniques. Given the historical age and significance of the stone piers and abutments, these are the key features of the structure which should be the focal point of any scheme for rehabilitation.

The new superstructure will be built in a similar configuration as the original using steel beams and concrete.

For the rehabilitation of the bridge, we recommend the following:

- A new 7" concrete slab with epoxy coated reinforcement
- New structural steel wide flange stringers at the same spacing as the original
- The outside stringers will be encased in concrete
- The interior stringers will be painted
- A new concrete curb and bridge railing similar to the original
- Repairing the top of the stone piers and abutment and replacement of the concrete cap
- Repairing the stone masonry piers and abutments by using a suitable mortar and by grouting.
- Reconstructing the stone masonry wing-walls as needed
- Replacing the concrete posts at the ends of the bridge railing
- For scour protection, the bottoms of the piers and abutments may be encased in concrete.

A sketch of a proposed cross section for the rehabilitated bridge is attached as Appendix C.

The bridge railing posts will be anchored to the concrete curb. The exterior stringers would be encased in concrete and support the curb. Encasement would also provide an elevation view of the bridge consistent with its 1919 design. The interior stringers would be painted.

The existing concrete cap on the piers will be replaced with a new concrete cap. Some repair of the stone masonry is anticipated when the cap is removed, and this may involve removing and resetting some stones or grouting. The new concrete cap will be appropriately reinforced to distribute the bearing loads of the stringers.

Local stone masonry repairs of the piers and abutments would include raking mortar joints, pointing with an appropriate mortar, and replacement of damaged stones where needed. Some of the mortar coating on the surface of the stones would be removed where needed in order to lessen the entrapment of water in the masonry. The latter would also improve the historical appearance of the coursed stone. The stone masonry parapets on the wing-walls can be rebuilt using the original stones or repaired in a manner similar to the piers and abutments.

Recommendations for future work

This initial report is based on our preliminary field investigation and review of the documents provided. For a detailed development of rehabilitation method, a more in-depth inspection of the bridge is required, as well as review of other documents such as the 2005 Foundation Report.

A detailed inspection of the bridge would include measuring of cracks in the stonework and measurements and probing around each of the piers and abutments to determine if there is any undermining as a result of scour.

From the information given in PennDOT's April presentation of the bridge replacement scheme, it appears that soil borings were taken, stone compression tests performed, and some preliminary drawings of the existing layout of the site developed. This information would be useful to us in developing the rehabilitation plans.

In addition, any photographs that may have been taken during the repairs of the piers and abutments would be helpful.

Plans for rehabilitation of the bridge should follow the AASHTO Guidelines for Historic Bridge Rehabilitation and Replacement and follow the Secretary of the Interior Standards for Historic Rehabilitation and Restoration. A proposal for Part 2 of our assessment will be submitted.

Respectfully Submitted,

Douglas Bond, PE
Vice President and Consulting Engineer, McMullan & Associates

Abba Lichtenstein
Consulting Engineer, McMullan & Associates

Attachments

Appendix A - Photographs

Appendix B - Comparison of Conditions

Appendix C – Sketch of Proposed Cross Section

Appendix D – Original Oscar Martin 1919 Repair Drawings

Appendix E – Existing Condition Drawings by Katheryn Auerbach

Headquarters Road Bridge – Coring Tests

McMullan & Associates Report

March 18, 2014

Background

McMullan & Associates was retained to observe corings taken from the stone masonry piers and abutments at the Headquarters Road Bridge near Tinicum Pennsylvania. We visited the site on January 24, 2014, February 20, 2014, and March 27, 2014 in order to observe cores taken from the piers and abutments under the supervision of PennDOT consultant, Mike McAtee of Urban Engineering. This report contains a summary of McMullan's observations and findings.

Coring Procedures

Cores were taken with a rotary core barrel by Pennoni Associates under contract with PennDOT consultant, Urban Engineers. An electric rotary drill with a 2.75 inch diameter core barrel was used to horizontally core the East and West Piers and East Abutment. Core material was extracted and saved in a wooden box. A small amount of water was pumped into the barrel for cooling and lubrication. The core barrel extensions were 15 inches long. After drilling the length of one barrel, it was withdrawn and another 15 inch section added to extend the core length. The depth of the cores varied slightly up to about 40 inches. The core barrel machine was fastened to a stone at each location using an expansion type anchor placed into a hole drilled into the stone with a rotary hammer bit.

Figure 1 – North Elevation of the Bridge. The Arrow indicates the East Pier

Figure 2 – Core drill setup on the east face of the East Pier with the drill machine fastened to the stone

After measurements of the core hole were completed, the core holes were patched with high strength mortar flush to the surface of the stone.

Due to snowy weather and high water, a total of 3 days of coring were needed in order to core each of the piers and abutments. A core was not extracted from the face of the West Abutment due to high water, but a core was taken from the adjacent north side wing wall and this core is assumed to be representative of the conditions at the abutment face.

Coring Findings

The cores holes were observed using a flashlight and photographs were taken. Measurements of the widths of the face stone were taken. The widths of the stones beyond could not be accurately measured due to the small diameter of the hole and the angle of the tape. The material inside the core barrel was photographed each time after it was extracted.

Figure 3 - Core hole on the East Pier

Figure 4 – Extracted core material from the East Pier

The table below summarizes what was found at each core location.

Core #	Location	Observations
Core 1	East Pier, about mid height. 43 inches below the bottom of the concrete encasement around the steel beams	Large stone exterior course, 20 inches in width. Exterior course height 13 inches. Smaller stones in interior with apparent random coursing. Fragments of mortar attached to the extracted stone corings. Gap between stones observed at back of core hole. At the back of the 35 inch long hole, the coring bit cut 7 inches into a larger stone at the back of the hole, but not all the way through when coring was terminated.
Core 2	East Pier, near the bottom, 72 inches below the concrete encasement	Large stone exterior course, 17 to 19 inches in width. At the back of the 37 long inch hole, the coring bit cut into a large stone but did not go through the stone. Large stones have small gaps between.
Core 3	East Pier, near the top, 17 inches from the bottom of the concrete encasement	Core taken through smaller stones near the top of the pier. Exterior course of stone 9 inches in width. Grayish sandy mixture observed between stones. Core length 28 inches.
Core 4	West Pier, 60 inches below the cap, roughly mid-height	Core taken in smaller coursing height stones. Stone length was 19 inches. Grayish sand observed between the stones in the core. Smaller width stones near the back of the hole. Core length 36 inches.

Core 5	East pier, near the top, about 7 inches from the bottom of the beam.	Core taken in smaller height stone course. Exterior stone width is 4" wide. Many smaller stones seen throughout the length of the core. Core length 25".
Core 6	East Pier, near the top, 17 inches from bottom of beams.	Exterior stone course 18 inches in width. Total core length 36 inches.
Core 7	East Pier, near the top, 17 inches from the bottom of the beam.	Exterior Stone course 9 inches. Total core length 27 inches. At end of core, the barrel cut into a stone but did not go through it. Stones within the core appeared to be longer in length.
Core 8	East Abutment, about mid-height. 20 inches from the bottom of the beam.	Exterior Stone course 24 inches in width. Core length 36 inches, then into soil, likely clay.
Core 9	West Pier, 15 inches from the bottom of the beam	Width of face stone is about 5inch with a 9 inch stone behind it. Loose material was found from 18 inches onward towards the pier interior.
Core 10	West pier, 12 inches to the bottom of the beam	The width of the first stone was unclear. Small stones were found throughout the core depth of 26 inches.
Core 11	West Pier, north face of bull nose, about mid height	The face stone is about 14 inches in width. Behind the face stone there is loose material with some roots and clay visible.
Core 12	West Pier, about 5’-6” below the beams	The width of the face stone is about 12 inches wide and behind the stone there are voids and loose material.
Core 13	West Abutment, about 3’-9” to the bottom of the beams.	The width of the face stone is about 14 inches and there are smaller stones and loose material to where to the end of the core at about 22 inches.

In general, at the lower part of the piers, the face coursing of stone was found to be 14 to 20 inches wide. The interior of the pier at this location is between 20 to 24 inches wide, and appears to filled with larger stones and mortar.

Near the top of the pier, the width of the face coursing of stone is apparently smaller, and varies between 4 and 18 inches in width. Six of the eleven cores were taken near the top of the piers. The fill behind the face stones near the top is composed of smaller stone, sand, some clay, and remnants of mortar.

Mortar was observed attached to some of the pieces of stone that were extracted from the lower cores. These lower cores also contained a sandy material that could be deteriorated mortar.

Figure 5 - Piece of stone extracted from pier with arrow indicating mortar bonded to the stone

One core was taken in the East Abutment. The face stone is 24 inches thick and the total wall thickness was measured to be 36 inches.

One core was taken from the north wing wall near the West Abutment. The face stone is 14" wide.

Interpretation of Core Test Results

The stone piers are constructed with a Coursed Rubble type of masonry with larger squared stones near the bottom of the piers and smaller stones near the top. Coursed masonry and Squared-stone masonry typically have more compressive strength than Uncoursed or Random. See figure below for a graphic representation of the types of stone masonry.

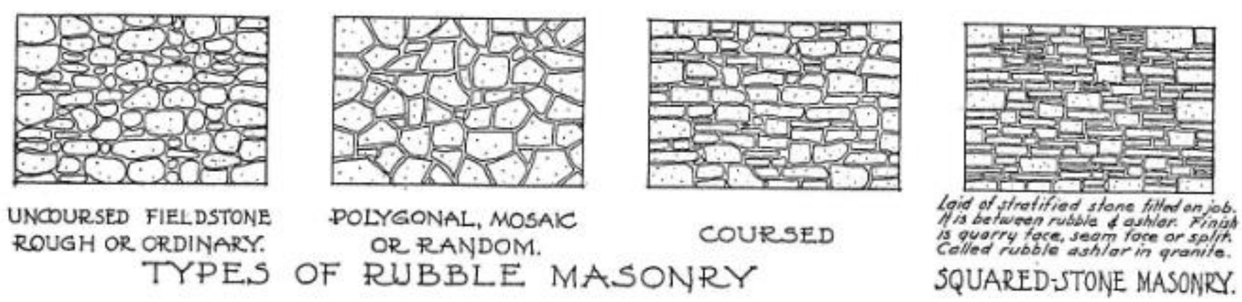

Figure 6 - Graphical representation of the types of rubble stone masonry (AGS, 1932)

The piers are constructed with larger coursed and squared stone near the base and smaller coursed stone near the top. The face stones were measured to be between 18 to 20 inches in width except near the top where they were measured between 4 and 18 inches. The 20 to 24 inch space between the face stones is filled with larger stone and mortar near the base of the piers and filled with smaller stone, deteriorated mortar, and soil near the top. It is unknown if the soil was part of the original fill or the result of creek sediment deposited during high water. A cross section of the pier is indicated below.

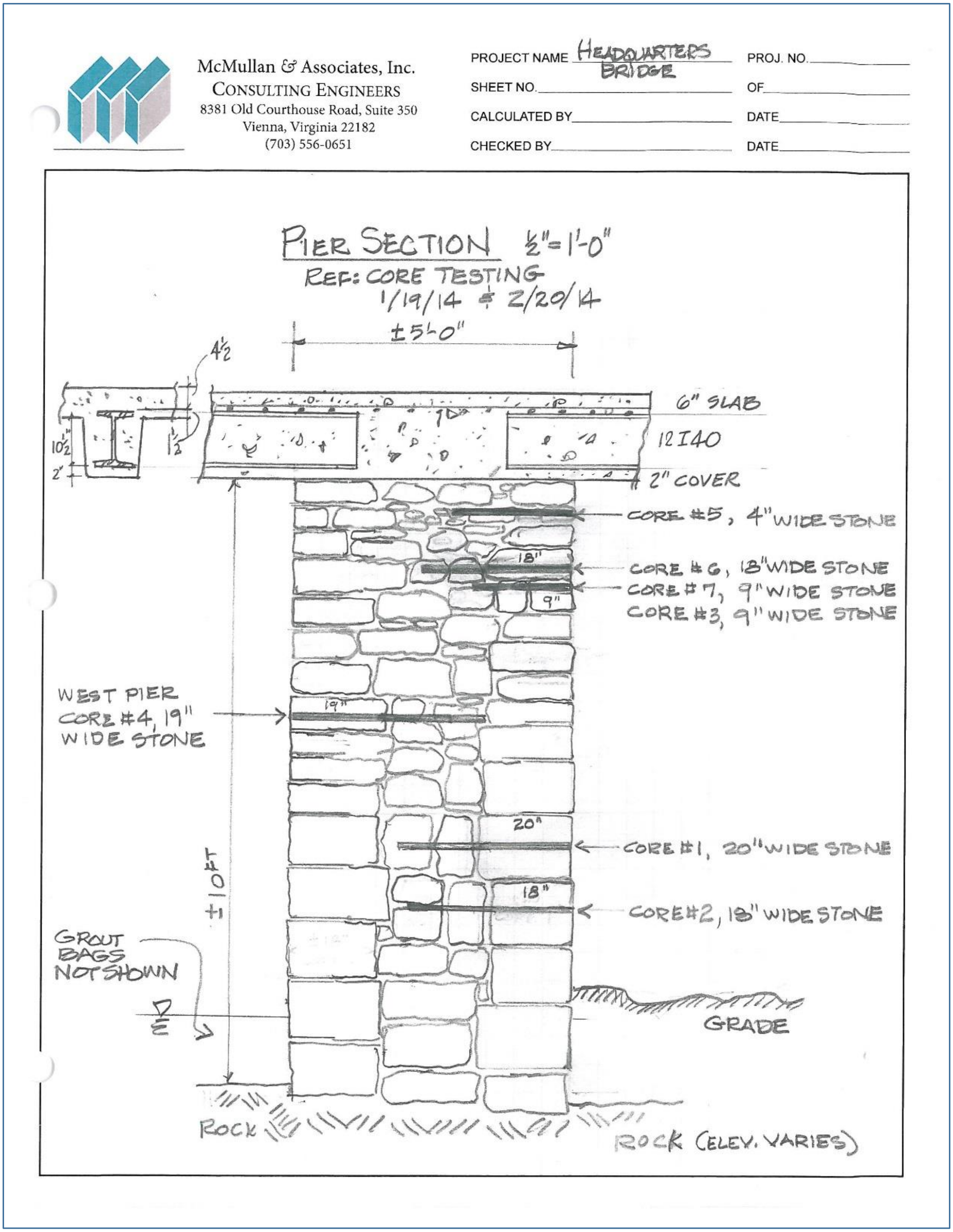

Figure 7 - Cross Section through the pier as interpreted from core results

This type of stone pier can be rehabilitated using stone restoration and repair techniques that have been successfully used on other historic stone projects. There many sources of information that contain descriptions of how stone structures can be rehabilitated such as the PennDOT Stone Arch Maintenance manual. This manual provides guidance on general stone structure repairs that would apply to the Headquarters Bridge as well as guidance specific to arch stone structures.

The abutments are constructed of coursed and squared stone masonry that was measured to be 36 inches in thickness. The abutments can also be rehabilitated using stone restoration and repair techniques similar to the piers.

Respectfully Submitted,

Douglas E. Bond

Douglas E. Bond, PE

Vice President

McMullan & Associates

1861 Wiehle Ave

Reston, VA 20190

McMullan & Associates, Inc.

February 23, 2018

Ms. Kitty Henderson
Historic Bridge Foundation
PO Box 66245

M&A 3575

RE: Headquarters Road Bridge Rehabilitation

Dear Ms Henderson:

As requested by my client, the Delaware Riverkeeper, and after reviewing your memo to Monica Harrower, I am writing to inform you that it is my professional opinion, that the stone masonry substructure for the Headquarters Bridge substructure can be rehabilitated to support vehicular traffic.

Our firm has investigated and designed the rehabilitation of many historic stone structures and bridges. I have personally visited the Headquarters bridge on several occasions, reviewed the PennDOT reports, and stated my opinion at several public meetings.

I agree with PennDOT's assessment that the steel and concrete superstructure has deteriorated beyond repair and requires replacement. I also agree with PennDOT's assessment that the stone masonry piers can be rehabilitated, as they have stated in the Final Individual Section 4(f) Evaluation paper. Furthermore, it is my opinion that the stone masonry abutments can be rehabilitated and do not need replacement. The reasons for PennDOT's recommendation for replacing the historic bridge appear to have more to do with non-structural considerations. I respectfully ask that you to reconsider your position on the Headquarters Road Bridge project and recommend that further investigation of the rehabilitation option for the 1812 substructure be implemented before it is replaced with modern materials.

Sincerely,

c AN A C AT , NC.

Douglas E. Bond

Douglas E. Bond, PE
Vice President

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