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March 20, 2019

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Re: Miller Bridge Piers, Horseshoe Bend National Military Park
Documentation for stabilization and repair scenarios
WJE No. 2018.4595

Dear Jessica and Stacy:

This letter report and the accompanying conceptual drawings and cost estimate provide documentation of the stabilization and repair scenarios for the Miller Bridge Piers identified by the National Park Service for further evaluation.

Findings of the condition assessment of the Miller Bridge Piers conducted in September 2018, together with initial documentation and outline stabilization/repair scenarios for review, were presented in our memo of October 1, 2018, for consideration by the National Park Service. The following narrative with attached documentation and cost estimate comprise the final submittal for this project. This final project submittal addresses comments received on draft documentation submitted on December 3, 2018, and also reflects discussion during a conference call with NPS primarily focused on environmental issues on February 5, 2019, as further described below.

Conceptual drawings illustrating the repair scenarios are provided with this memo (refer to Appendix B), and the scenarios are described in further detail below. In addition, findings of our condition assessment are briefly summarized below, together with a summary of the findings of materials studies completed as part of this assessment by the WJE in-house laboratory. The complete materials studies report is attached as Appendix A of this report. The conceptual cost estimate is attached as Appendix C. (Refer to our memo of October 1, 2018, for further discussion of conditions observed, as well as photographs illustrating conditions at each pier at the time of the site visit in September 2018.)

Architectural and engineering services for this project are being provided by Wiss, Janney, Elstner Associates, Inc. (WJE) as sub-consultant to Panamerican Consultants, Inc. (Panamerican) under NPS SERO IDIQ Contract No. P16PC00097.

Background

As noted in our memo of October 1, 2018, the scope of services is limited to assessment of the four mid-river piers of Miller Bridge; the concrete abutments are not included in this project. The purpose of this project is to identify conceptual treatments for the piers so that they can be safely preserved and will not pose harm to visitors who are using the river for recreational purposes.

The Miller Bridge piers are components of a covered bridge built in 1907, which spanned 858 feet and connected the opposing banks of the Tallapoosa River at the site of the Miller ferry. The bridge was set on stone masonry and concrete piers and had a wood covered span. The bridge piers were reportedly constructed utilizing stones from the riverbank. The bridge collapsed on June 23, 1963, after which the wood portions were removed. The four stone piers and two concrete abutments survived. The concrete bridge carrying US Highway 49 was completed to the east (upstream) of Miller Bridge in 1955.

Historic resources of Horseshoe Bend National Military Park were administratively listed in the National Register of Historic Places in 1966, and the park was documented for the National Register as a historic district in 1976. The documentation identifies the Miller Bridge piers and abutments as contributing resources.¹ The List of Classified Structures states that the bridge piers and abutments (LCS No. 005003, Structure No. HS-3) are locally significant under National Register Criteria A and C in the areas of transportation history and engineering, noting that they are the remains of one of the longest American covered bridges.²

The site visit for this study was conducted on September 5 and 6, 2018, to assess the condition of the masonry piers. Consistent with prior assessments, the piers were numbered 1 through 4, from the southwest pier to the northeast pier, for purposes of the assessment and documentation. Also for purposes of this documentation, project north has been identified as northeast, slightly east of true north. The longer plan dimension of each pier is oriented east–west. Refer to the attached drawings for additional documentation of dimensions of each pier.

The following notable conditions were observed at the four piers during the site work conducted for this project, and are summarized herein from our previous memo for reference in review of the repair scenarios discussed below. (Refer to the attached drawings for approximate dimensions of each pier and additional information.)

- Pier 1 is constructed of coursed rubble stone with mortar, and is mostly intact. It is topped with a concrete parge coating and has a transverse concrete cap beam, extending the length of the pier.
- Pier 2 is constructed of coursed rubble stone with mortar and is partially collapsed. The lower portion of the west side (downstream) portion of the pier remains intact.

¹ Billy D. Stout, Historian, and James F. Kretschmann, Superintendent, Horseshoe Bend Military Park, Daviston, Alabama, *National Register nomination documentation for Horseshoe Bend National Military Park*, August 28, 1975.

² National Park Service, *List of Classified Structures*, “Miller Bridge Piers and Abutments,” LCS No. 005003.

- Pier 3 is a coursed rubble stone structure, and is mostly intact. It is topped with a concrete parge coating.
- Pier 4 is largely collapsed. A remaining intact portion of the coursed rubble stone pier exists, with fallen stones comprising the remnants of the pier.
- At the bottom 6 feet of the standing or partially standing piers (Piers 1, 2, and 3), mortar is severely eroded in the joints between stone units, and at many locations the mortar has been washed out.
- Stone units are missing at the base of the upstream northeast corner of Piers 1 and 3, and displaced stone units were observed at the base of the southeast (upstream) and southwest (downstream) corners of Pier 3.
- Vegetation is growing on all four piers. Trees of some size are growing out of Piers 2 and 4, and a smaller tree is growing out of Pier 1.
- Some vertical cracking was observed through mortar joints and through some stone units above areas of missing mortar. Cracks appeared to emanate at open joints and at plant and tree growth in the stone masonry.
- The tops of Piers 1 and 3 have a parge coat that may offer some protection to the tops of the piers. These areas of the piers could not be safely accessed for close-up evaluation during this site visit.

Refer to our memo of October 1, 2018, for additional documentation of existing conditions observed during site work completed for this study.

Materials Studies

Refer to Appendix A for the materials studies report. Findings are summarized below.

Petrographic studies were conducted to assess the general composition and condition of four mortar samples removed from the piers. The mortar samples were removed from each of the four piers during WJE's September 2018 site visit. The samples are numbered consistently with the pier from which each sample was removed. Two stone samples were also obtained to identify the composition of the stone.

The four mortar samples appear compositionally similar, with varying levels of deterioration observed. The samples appear either grey (Sample 1 and 3) or beige (Samples 2 and 4) on freshly fractured surfaces, varying due to the extent of the deterioration of the paste. Each sample exhibits some form of organic growth, biological growth, or dirt on their exterior surfaces. Abundant particles of residual unhydrated and partially hydrated portland cement, along with underburned cement particles, are present in each sample. The residual cement particles are large (some as large as small sand grains) and exhibit characteristics consistent with portland cement produced in the early 1900s. Sample 1 contains cement lumps, up to 7 mm in diameter; however, these cement lumps are not observed in the other samples.

In each sample, the sand volume appears normal to slightly undersanded, compared to modern requirements. The sand is subangular in shape, and is composed of primarily quartz, with lesser amounts of quartzite and biotite mica. Trace amounts of burnt wood and other rock particles are observed within the samples. The mortars contain entrapped air voids, but do not exhibit spherical air voids such as would result from the use of a chemical air entraining agent.

Sample 2 exhibits deterioration in the form of increased paste porosity and a loss of paste-aggregate bond strength. The paste is soft and highly absorptive of water, compared to harder and less absorptive paste in Samples 1 and 3. Cracking is rare in each sample, and when observed, is along the exposed surfaces of the samples. Each sample exhibits fully carbonated paste, with secondary calcite deposits observed in void spaces due to dissolution of calcium in the paste that has redeposited within the matrix.

The two examined stone samples removed from the piers represent a quartz monzonite in composition and texture, with gneissic foliation. The most likely source of the stone used in the construction of the Miller Bridge Piers is the Kowaliga gneiss of the Blue Ridge physiographic province (which is a regional geomorphological classification). The USGS classifies the Kowaliga gneiss as a coarse-grained granodiorite to quartz monzonite.³

Findings of the materials studies were referenced in development of the repair scenarios outlined below.

Stabilization/Repair Scenarios

NPS Selection of Scenarios for Consideration

Our memo of October 1, 2018, identified four stabilization/repair scenarios for the four mid-river piers:

- Scenario 1 – Accept the deteriorated condition of the piers and allow them to continue to deteriorate
- Scenario 2 – Stabilize/repair the piers using in-kind materials
- Scenario 3 – Stabilize/repair the piers using other than in-kind materials
- Scenario 4 – Add contemporary features to deflect or reduce the impact of water flow and river debris

Comments received from National Park Service reviewers of the above-mentioned memo requested that all four scenarios be developed, as follows:

- Scenario 1 was designated by NPS reviewers for consideration for Pier 4.
- Scenario 2 was designated by NPS reviewers for consideration for Piers 1 and 2; and Scenario 3 was designated for consideration for Piers 2 and 3. In response to other NPS comments requesting comparison of repair in-kind (as outlined in Scenario 2) and repair with other materials (as outlined in Scenario 3), Scenarios 2 and 3 have been evaluated for Piers 1, 2, and 3.
- Scenario 4 was designated by NPS reviewers for consideration for Piers 1, 2, and 3; however, based on further consultation with NPS Aquatic Ecologist Jeffrey R. Duncan, PhD, this scenario has not been further developed. (See further discussion of environmental considerations as well as discussion of Scenario 4, below.)
- Removal of vegetation was designated for all four piers under all scenarios.

³ U.S. Department of the Interior, National Park Service, Natural Resource Stewardship and Science Directorate, Geologic Resources Division, *Horseshoe Bend National Military Park: GFI Ancillary Map Information Document*, May 7, 2013.

Based on further discussion with National Park Service project team members, including a discussion of environmental issues (see below), Scenario 1 is recommended for Pier 4, and Scenario 2 (in-kind materials) is recommended for Piers 1, 2, and 3. Issues associated with each scenario are discussed below.

Preservation Standards

The overarching treatment for the piers is *Preservation*, as characterized in the Secretary of the Interior's Standards for Treatment of Historic Properties. The overarching treatment *Preservation* will involve stabilization, retaining, and repairing historic fabric. Selective replacement—in-kind or with another material—is included where individual stone units are missing, but without rebuilding of the piers as would be considered under the treatment Restoration. Stabilization/repair scenarios for the piers have been developed based on the Secretary of the Interior's Standards for Preservation, especially standards 5 and 6:

5. Distinctive materials, features, finishes and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new materials will match the old in composition, design, color and texture.⁴

The Secretary of the Interior's Standards were the primary reference used to guide development of the conceptual repair scenarios. Other relevant standards and codes should be referenced in design development and preparation of construction documents for stabilization and repair.

Environmental Issues

In addition to guidance afforded by the Secretary of the Interior's Standards pertaining to the piers themselves, all work undertaken for stabilization/repairs and maintenance of the piers should take into consideration natural resources, including but not limited to the water and riverbanks, as well as wildlife such as turtles, birds, and snakes that interact with the piers.

The WJE project team consulted throughout the project with Jeffrey R. Duncan, PhD, Aquatic Ecologist with the NPS Southeast Region, Science and Natural Resources Division. Dr. Duncan, who was identified by the NPS as a subject matter expert available as a resource to the project team, provided extremely helpful guidance in assessing environmental issues related to the various stabilization and repair scenarios. Following submittal of the draft conceptual stabilization and repair documentation, a conference call was convened on February 5, 2019, to afford an opportunity for Dr. Duncan to comment on environmental issues associated with potential work on the piers, and for other NPS project team members to discuss these issues with him. In addition to Dr. Duncan, participants in the teleconference included Barbara Judy, Chief, Cultural Resources Planning and Stewardship, and Jessica Kelly, Historical Architect and Contracting Officer's Technical Representative, of the NPS Southeast Regional Office; Stacy Speas, Lead Park Ranger, and Steve Crowder, Acting Superintendent and Facility Manager, of Horseshoe Bend National Military Park; and Deborah Slaton of WJE.

⁴ Anne E. Grimmer, *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings* (Washington, D.C.: U.S. Department of the Interior, National Park Service, Technical Preservation Services, 2017).

The Miller Bridge piers are located in the Tallapoosa River, and part of the waterway the flows through the park is classified as a riverine wetland. The area is listed in the Nationwide Rivers Inventory (NRI), “. . . a listing of more than 3,200 free-flowing river segments in the United States that are believed to possess one or more ‘outstandingly remarkable’ natural or cultural values judged to be at least regionally significant.”⁵ River segments listed in the NRI are potential candidates for inclusion in the National Wild and Scenic River System. The NPS and other federal and state agencies would be involved in permitting and compliance review of proposed projects in this area.

The possible effects of upstream operations of the R. L. Harris Dam on the piers are discussed in our memo of October 1, 2018.

During the February 2019 conference call, Dr. Duncan noted that as a matter of policy, the NPS seeks to avoid putting non-native materials into stream systems. As discussed, this approach further supports selection of Scenario 2 (in-kind materials) rather than Scenario 3 (not in-kind materials) for repair of the three piers that remain partially or largely intact. In addition, previous discussion by WJE with Dr. Duncan led to elimination of Scenario 4 from consideration, given that gabion baskets or revetments would likely include some non-native materials and could potentially be dislodged during flood events. Dr. Duncan noted that any new features or modifications to existing construction that could interfere with geomorphology of stream systems, even in a very minor way, can have unintended consequences and impacts—either upstream or downstream—such as bank erosion. Stabilization at the base of the piers as outlined in Scenario 2 is unlikely to have an adverse effect on the hydrology of the river, but further study during design development of repairs would be needed to confirm that this is the case. Other issues for further evaluation during design development would include impacts of repairs on habitat, such as for mussels, on water quality, fluvial studies pertaining to water flow and potential for scour, etc.

All parties agreed that above-water work, especially as articulated in Scenario 2 (in-kind materials) involve non-controversial stabilization and repair actions that are unlikely to be problematic in terms of impacts on natural resources, although care would need to be taken in planning and implementing the work to avoid such effects.

Discussion of each scenario and the associated scope of work follows.

Scenario 1 – Accept the deteriorated condition of the piers and allow them to continue to deteriorate

This scenario is essentially a “No Action Alternative,” in which the piers would continue to be interpreted as remnants of the historic Miller Bridge, but would be allowed to deteriorate. Removal of vegetation would be performed as part of cyclical maintenance. With this approach, the piers would not be stabilized and repaired, and would be allowed to deteriorate into a ruinous condition in which collapse is likely. Ongoing monitoring and minimal intervention (such as removal of loose stones if noted during monitoring) would be needed to protect visitors. Eventual loss of the piers would result in further diminishment of integrity of the piers as contributing features to the Horseshoe Bend Military Park Historic District. This scenario involves the minimal intervention possible; however, other than retaining the piers as ruins in the future, it would not result in their preservation.

⁵ Nationwide Rivers Inventory, <https://www.nps.gov/subjects/rivers/nationwide-rivers-inventory.htm>, accessed November 2018.

Based on guidance provided by the NPS, this scenario has been considered for application to Pier 4, which has previously collapsed and is generally in a ruinous condition.

Scenario 2 – Stabilize/repair the piers using in-kind materials

Based on discussion with the NPS, this scenario has been considered for Piers 1, 2, and 3.

Following the overarching *Preservation* treatment approach, repairs for Piers 1 and 3, which are primarily intact, would involve stabilization and replacement of missing units, without further rebuilding. For Pier 2, which is partially intact, repairs would involve stabilization and replacement of missing units sufficient to create a stable structure, without rebuilding missing and collapsed portions of the pier. The extent of rebuilding is therefore localized and as needed to retain current form and scale, and not to restore or reconstruct the pier to its original height and configuration.

Scenario 2 involves the use of in-kind materials (stone and mortar/grout) for repairs. Refer to Scenario 3, below, for discussion of repairs using concrete. The use of in-kind materials is recommended as more appropriate in terms of the Preservation standards, and avoids the introduction of non-native materials into the riverine environment. Repair using stone and mortar/grout is practical and feasible. Using in-kind materials would also render repairs to the shafts of the piers (above water level) visually compatible with existing original construction. In addition, as water levels fluctuate, the use of in-kind materials at the base of the piers (at and sometimes below water level) is preferable, as these repairs would be visible at low water. Further, in-kind repairs with stone and mortar/grout are considered durable with periodic inspection and maintenance. The stone would be obtained locally (e.g., near the river banks) to match that used in construction of the piers. Mortar/grout materials would be selected to be similar to the original materials.

The work of Scenario 2 includes the following:

1. Carefully remove vegetation from piers. For larger growth (e.g., small trees) that are present, cut off trunk as closely as possible to the stonework of the piers, taking care not to damage the stone. If loose stones are identified, remove and retain for reinstallation. Remove exposed roots; leave embedded roots in place to avoid damaging stone. For smaller growth, remove plant materials in their entirety. Consideration can be given to treatment of the tree roots to prevent regrowth; however, the use of chemicals in removal of plant materials should be avoided, except as treatment to prevent regrowth. During design development conduct research to determine what treatment products can be used that do not present a hazard to wildlife or to the river, and are not deleterious to the historic materials.
2. Shore the piers as needed.
3. Carefully examine stone. Remove loose stone and retain for reinstallation prior to proceeding with further repairs.
4. At the base of the pier, install stone set in cementitious grout at the perimeter of the pier. Use stone obtained locally, in units similar in size to larger units present on pier. Slope stone down to bedrock. Work at the base of the pier would preferably be conducted in a dry environment. This could be achieved in several ways. For example, if work at the base of the pier is conducted at the time of year when water levels are lowest, the base of the piers may be exposed at some or all of the piers. In addition, if operations at the dam can be adjusted to delay water released for the period in which the work occurs, this could help maintain water levels at a point that work could be conducted in a dry

environment. Alternately, a cofferdam (a water-tight enclosure that is pumped dry to conduct construction work below the waterline) could be constructed, and/or hydraulic cement-based materials designed for placement in water could be used. Conditions also vary at the different piers; for example, each pier is typically surrounded by rock, and the water level is therefore typically relatively low, except at the outer corners of Pier 1, where the river bed is lower and water is typically deeper. Thus, a different approach may be needed for repairs at that location than at the other piers. The different possible approaches to providing this environment for repairs have different environmental implications, and some approaches (e.g., construction of a cofferdam) may not be acceptable for this reason. Depending upon the scenario selected for implementation, further consideration of this issue would be anticipated during design development. (See further discussion under Scenario 3, below.)

5. Where stone is missing within the existing configuration of the pier, install replacement stone obtained locally from the vicinity of the piers in the river or onshore near the banks. Refer to archival photographs to understand the historic configuration of the piers prior to stone loss. Install stone in a full mortar bed, following the overall battered profile of the original pier and integrating new stone with existing coursing.
6. If loose stone units are identified, remove and reset in mortar.
7. During design development, conduct further structural review to determine whether concealed anchors (i.e., stainless steel pins) would be needed to supplement setting mortar used to hold the individual stones in place, or to otherwise stabilize the pier structurally.
8. Wash stone with low-pressure water to remove mud and debris.
9. Prepare and repoint eroded mortar joints (assume 100 percent of mortar joints require repointing). Cut out mortar to a depth equal to twice the joint width, minimum 3/4 inch and maximum 2 inches deep. For repointing, use Type N mortar (1 part cement to 1 part lime to 6 parts sand). Remove loose material by hand to allow for deep pointing. Fill deep voids with mortar up to twice the joint width, 3/4 inch minimum. Install one layer of mortar, 1/4 inch deep or one-third of remaining joint depth, and compact into joint. Apply second layer of mortar of similar depth, and compact into joint. Allow to dry as needed to prevent joint cracking. Apply third and final layer of mortar of similar depth. After mortar becomes thumbprint hard, tool to a slight concave profile; hold mortar slightly back from the face of the stone to avoid creating a widened joint appearance. Protect mortar during cure to prevent joint cracking.
10. Install cementitious parging on the top surface of the pier only. During design development, laboratory studies should be considered to help determine the composition of the existing parge coat, techniques utilized, and potentially its date of installation.

Scenario 3 – Stabilize/repair the piers using other than in-kind materials

Based on discussion with the NPS, this scenario has been considered for Pier 3, and as requested, is also illustrated for Piers 1 and 2 for comparison with Scenario 2.

For Scenario 3, repairs for Piers 1 and 3, which are primarily intact, are similar to those outlined for Scenario 2, and would involve stabilization and replacement of missing units, without further rebuilding. Also similar to Scenario 2, for Pier 2, which is partially intact, repairs would involve stabilization and replacement of missing units sufficient to create a stable structure, without rebuilding missing and collapsed portions of

the pier. The extent of rebuilding is therefore localized and as needed to retain current form and scale, and not to restore or reconstruct the pier to its original configuration.

Scenario 3 involves the use of concrete for repairs, rather than the stone and mortar used in original construction of the piers. Although repairs using concrete would be durable and expected to require very limited maintenance, the use of not in-kind materials is less appropriate in terms of guidance afforded by the Preservation Standards, especially given that repair using stone and mortar/grout is practical and feasible. Further, repairs using concrete would require introducing non-native materials into the riverine environment. Also, such repairs would be visually noticeable and potentially intrusive to the shaft of the piers, and also to the base of the piers when visible at low water. Finally, since the concrete would only be present at a limited portion of the pier where repair is needed, the need to monitor and cyclically maintain the remaining stone masonry construction of the pier would be unchanged.

As noted above under Scenario 2, based on discussion with NPS reviewers the use of in-kind materials is preferred for preservation and environmental reasons. Scenario 2 is therefore recommended for Piers 1, 2, and 3. The work of Scenario 3 is outlined below for reference.

The work of this scenario includes the following:

1. Carefully remove vegetation from piers, as described for Scenario 2, above.
2. Shore the piers as needed.
3. Carefully examine stone. Remove loose stone and retain for reinstallation prior to proceeding with further repairs.
4. At the base of the pier, install new cast-in-place concrete at the perimeter of the pier.

Alternately, install a stone revetment outboard of the base of the pier, with stone units obtained locally, set in mortar. Install concrete between the revetment and the base of the pier. On top of the concrete, install stone set in cementitious grout at the perimeter of the pier. Use stone obtained locally, in units similar in size to larger units present on pier. Slope stone down to bedrock.

In addition to the approaches for implementation outlined above, consideration should be given as to whether these repairs will require a cofferdam or will be performed using tremie concrete designed for placement in water (e.g., concrete incorporating anti-washout admixtures). Tremie concrete is placed below the water level using a pipe or hose. The lower end of the pipe/hose is kept immersed in fresh concrete so that the rising concrete from the bottom displaces the water at the top with minimal washout and segregation of the concrete. Tremie concrete using a stay-in-place fiberglass jacket around each pier could be used. If the water level of the river could be lowered during tremie filling of the jackets, it would be possible for the finished jackets to remain submerged and less visible when the water was at normal levels.

5. Where stone is missing within the existing configuration of the pier, install new cast-in-place concrete following the irregular battered profile of the original stone pier. Refer to archival photographs to understand the historic configuration of the piers prior to stone loss.

6. Carefully examine remaining extant stone. If loose stone units are identified, remove and reset in mortar.
7. During design development, conduct further structural review to determine whether concealed anchors (i.e., stainless steel pins) would be needed to supplement setting mortar used to hold the individual stones in place, and/or to provide mechanical anchorage for concrete repairs, or to otherwise stabilize the pier structurally.
8. Wash stone with low-pressure water to remove mud and debris.
9. Prepare and repoint eroded mortar joints, as described for Scenario 2, above.
10. Install cementitious parging on top surface of the pier only, as described for Scenario 2, above.

Scenario 4 – Add contemporary features to deflect or reduce the impact of water flow and river debris

Based on NPS comments received on the four scenarios developed, we initially began to prepare documentation for Scenario 4, the addition of contemporary features to mitigate effects of water movement and protect the piers from waterborne debris, and potentially to prevent visitors from approaching the piers. We researched several options, including new steel structures and gabions consisting of rock in steel cages. Criteria considered in evaluation options for this scenario included environmental impacts on water and wildlife, visitor safety, visibility, and maintenance.

In following up with Dr. Jeffrey Duncan regarding these criteria, Dr. Duncan noted significant concerns with this scenario, particularly in terms of environmental impacts. He also noted that the addition of such features to the river is unlikely to be acceptable for a number of regulatory reasons, including NPS regulations related to the protection of the river, wetlands, and floodplains.

Although the goal of the repair scenarios is to preserve the Miller Bridge Piers, measures to enhance preservation of the piers are not appropriate if they may adversely affect the surrounding natural environment. Based on the above and as discussed with the NPS project team, we have excluded Scenario 4 from further development.

Other Repair Approaches

Several other repair approaches or measures were initially discussed as part of development of these scenarios but not pursued as part of the above scenarios. These measures are described here for informational purposes, and are not a part of the scenarios discussed above.

To address the safety of recreational visitors to the river in the vicinity of the piers, the project team had considered inclusion of barriers in the river adjacent the piers, or on shore for the near-shore pier, to prevent visitors from accessing the piers or their immediate vicinity and to protect visitors from hazards due to falling stone from the piers. However, given the concerns associated with Scenario 4 described above, these measures were not pursued further for purposes of the conceptual documentation of scenarios.

In addition, several alternative approaches were considered for stabilizing the piers to mitigate potential collapse, but without further repair (e.g., replacement of missing stone, repointing of stonework, etc.) as articulated in Scenarios 2 and 3. Although historic fabric would be retained, stabilization without repair was

not further considered because this approach would have a significant impact on the existing masonry, diminishing the integrity of the piers, without providing for their long-term preservation. (Approaches identified but not further considered included a steel frame constructed around each pier to support it in its current configuration, with support to bedrock provided to prevent the piers from being displaced by water flow or continued erosion, or wrapping of the piers in a structural fiber-reinforced jacket. Both of these approaches were not pursued because they are considered overly intrusive to the historic resources, problematic from an environmental perspective, and not appropriate to the overall preservation approach, as well as visually intrusive and diminishing of the integrity of the structures.)

Further, consideration was given to adding reinforcement to the existing piers, such as could theoretically be implemented by coring vertically through the center of the pier into bedrock and installing a reinforcing bar, grouted in place, into the core. Although the repair would add strength to the piers and be essentially invisible, this approach is considered intrusive to the historic fabric, and the necessity for this type of strengthening is not indicated by the currently observed condition of the piers or likely causes of observed distress. Deterioration has most likely been caused by water movement and possibly debris striking the base of the piers, as well as erosion of mortar between the stone units over time (especially at water level), rather than lack of stability of the overall pier structure. In addition, the condition of the piers—especially the concealed structure of the interior—is unknown and may be too fragile to withstand the intervention of installing vertical rods. Repairs to the piers and repointing of mortar joints are considered a more appropriate approach.

Future Maintenance Needs

As noted in our previous memo, each of the alternatives outlined above has maintenance implications for future stewardship of the piers.

In Scenario 1, considered for Pier 4, the pier would be allowed to fall further into ruin and would not receive further maintenance, other than periodic removal of vegetation. Periodic monitoring would be required to ensure that loose stones do not present a hazard to recreational kayakers.

For Scenarios 2 and 3, the following maintenance would be needed:

- Vegetative growth would need to be removed on a regular basis.
- The piers would need to be assessed close-up (e.g., from a small boat) on a regular basis, including the full height of the piers with particular attention to the area near the water line affected by water flow and movement. In addition, the below-water base of the piers would need to be assessed periodically to ensure that the masonry (original and any repairs implemented) remains intact.
- Any stones that become loose or displaced would need to be reset.
- Mortar joints would need to be prepared and repointed on a cyclical basis, especially at the approximately lower 6 feet (at and near typical water levels), where joints are most vulnerable to erosion.
- The parge coat present on top of several of the piers, if retained or added to other piers, would need to be renewed periodically.

All work undertaken for maintenance should take into consideration historic natural resources, including but not limited to the water and riverbanks, as well as wildlife such as turtles, birds, and snakes that interact with the piers.

The stone piers of Miller Bridge, constructed in 1907, have been present for more than 100 years, and reportedly have not been maintained for at least the last several decades. With respect to the repairs outlined in Scenarios 2 and 3, stone repairs to the piers above water would be expected to have an extended service life of several decades, with periodic inspection and repointing as needed (together with localized repairs if the piers are damaged during a flood event). Concrete repairs to replace missing stone, as included in Scenario 3, would also be expected to have a similar service life of several decades, but are not considered as appropriate as replacement in-kind with respect to the overarching preservation treatment approach. The grouted stone (Scenario 2) and concrete (Scenario 3) repairs below water would be expected to have similar extended service lives, with limited inspection and maintenance/repair if damaged during a flood event. Further evaluation of below-water repair approaches under both scenarios in consultation with NPS is recommended to evaluate the environmental issues associated with these repairs, to assist in selection and refinement of the repair scenarios.

Cost Estimate

The conceptual cost estimate for the work included in Scenarios 1, 2, and 3 is provided in Appendix C.

The estimated total cost of a repair approach consisting of Scenario 1 for Pier 4 (including periodic monitoring and vegetation removal), and Scenario 2 (including periodic monitoring and vegetation removal, as well as the stabilization and repair work outlined above) for Piers 1, 2, and 3, is \$1,218,555.

Note that this cost estimate is an opinion of probable costs based on the conceptual repair scenarios illustrated in the attached drawings. Once the repair approach is confirmed and repairs further developed through design development, a more refined cost estimate can be developed.

Also, note that the cost of construction mobilization and general conditions will vary significantly depending on the method used for implementation of the work, especially at the base of the piers (e.g., working at low water with adjustments to dam operations, versus use of a cofferdam, etc.).

Sincerely,

WISS, JANNEY, ELSTNER ASSOCIATES, INC.



Deborah Slaton
Principal

cc: Barbara Tagger, NPS HOBE
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Mark Steinback, Panamerican
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APPENDIX A: MATERIALS STUDIES REPORT

APPENDIX A

Miller Bridge Piers, Horseshoe Bend National Military Park Laboratory Studies of Mortar and Stone Samples

Petrographic studies have been conducted to assess the general composition and condition of four mortar samples removed from the Miller Bridge piers in Horseshoe Bend National Military Park. The samples were removed from each of the four mid-river piers during WJE's site visit to conduct documentation and condition assessment of the piers in September 2018. Two stone samples removed from the piers were also submitted to identify the composition of the stone. Studies were conducted by the in-house materials scientists at the WJE Janney Technical Center in Northbrook, Illinois.

Samples

Mortar sample identifications and brief descriptions are given in Table 1. The appearance of each of the as-received samples is shown in Figure 1 through Figure 4.

Table 1. Notes on the as-received samples

Sample ID	Nominal Dimensions	Notes
Mortar Sample 1 (Pier 1)	2-1/2 inches x 1-1/2 inches x 3/4 inch	Removed from pier 1, which was mostly intact Medium grey mortar, moderately hard paste, somewhat absorbent of water Mortar contains biological and plant growth on exterior
Mortar Sample 2 (Pier 2 - South Elevation)	3-3/4 inches x 2-1/2 inches x 1-1/2 inches	Removed from pier 2, which is partially collapsed Beige mortar, soft paste, highly absorbent of water Exterior of sample contains exposed sand (primarily quartz grains), and some dark beige/orange discoloration
Mortar Sample 3 (Pier 3 - South Side)	1-3/4 inches x 1-3/4 inches x 1 inch	Removed from pier 3, which is mostly intact Medium grey mortar, moderately hard paste, somewhat absorbent of water Mortar is discolored beige on exterior, with black and brown areas of organic growth Green and black organic growth on exterior surfaces Inclusions of rock particles and wood within mortar
Mortar Sample 4 (Pier 4 - Top)	Multiple pieces of mortar measuring up to 2-1/2 inches x 1-1/4 inches x 1 inch	Removed from pier 4, which is largely collapsed Medium grey mortar, moderately hard paste, somewhat absorbent of water Mortar is discolored beige on its exterior, with darker deposits of debris and/or biological growth

The appearance of the two submitted stone samples is shown in Figure 5 and Figure 6. The stone samples appeared black on their exterior surfaces, due to biological growth and dirt accumulation.

Petrographic Studies

Methods

Petrographic studies were conducted in accordance with the petrographic examination portion of ASTM C1324, *Standard Test Method for Examination and Analysis of Hardened Masonry Mortar* using the appropriate methods and procedures outlined in ASTM C856, *Standard Practice for Petrographic Examination of Hardened Concrete*, which also applies to mortar. Each sample was examined visually and detailed studies of the as-received surfaces were conducted at magnifications up to 40X using a stereomicroscope. Mortar samples 1, 2, and 3 were selected for detailed studies and thin sections were prepared from the mortar specimens to assess paste and aggregate constituents. Mortar sample 4, removed from pier 4 was not subjected to thin section preparation due to the more weathered and collapsed characteristic of the pier. The thin sections were examined at magnifications ranging from 50X to 500X using a petrographic (polarized-light) microscope.

The two stone samples were cut and lapped, using progressively finer abrasives in order to create a surface suitable for examination. The lapped sections were examined using a stereomicroscope in order to identify the rock type.

Mortar Findings

General Observations

The four mortar samples appear to be similar in composition, with varying levels of deterioration. The samples contain biological growth, plant growth, and/or dirt accumulation on exposed surfaces, as well as some discoloration due to weathering of the mortar constituents. Initial examination of the microstructure of mortar samples removed from piers 1, 2 and 3 reveals the presence of abundant particles of residual unhydrated and partially hydrated portland cement (Figure 7), with underburned cement particles present that exhibit the structure of the parent limestone rock used to produce the cement (Figure 8). The residual cement particles are large (some as large as small sand grains) and exhibit characteristics consistent with portland cement produced in the early 1900s.

In each examined sample, the sand volume in the examined mortar samples appears normal to slightly undersanded, compared to modern requirements. Major constituents of the sand, which is subangular in shape, are quartz, quartzite, and biotite mica minerals (Figure 9). Trace amounts of burnt wood and other rock particles are observed. The mortars contain entrapped air voids, but do not exhibit spherical air voids due to the use of a chemical air entraining agent.

Observations pertaining to the individual samples are summarized below:

Mortar Sample 1

Mortar sample 1 exhibits a medium grey color on a freshly fractured surface. The sample is moderately hard and somewhat absorbent of water. The sample contains biological and plant growth on its exterior. The sample represents mortar removed a mostly intact pier, and exhibits some localized evidence of leaching of cementitious products within the paste, but no severe deterioration.

Sample 1 contains abundant cement lumps, measuring up to 7 mm in diameter. The cement lumps are large collections of portland cement and hydration products and do not contain sand grains (Figure 10). No hydrated lime lumps were detected. The matrix is fully carbonated, and secondary deposits of calcite are

observed filling voids in the paste, due to dissolution and reprecipitation of calcium-based products in the matrix (Figure 11).

Mortar Sample 2

Mortar sample 2 exhibits an overall beige color, due to deterioration. The sample is moderately hard and somewhat absorbent of water. The sample contains biological and plant growth on its exterior. The sample represents mortar removed from a partially collapsed pier, and exhibits deterioration.

Sample 2 exhibits a higher paste porosity compared to samples 1 and 3, which results in a poor paste-to-aggregate bond strength, and an overall weaker paste structure (Figure 12). Sample 2 is more absorbent of water, due to the increased paste porosity. Cement lumps are not observed, and large cement grains are somewhat uniformly distributed throughout the sample. No hydrated lime lumps were detected, however secondary deposits of calcite are observed within voids. Cracking is observed, however the cracking is limited, and loss of bond between the paste and aggregate and a softer paste structure is evidence of more severe deterioration than any cracking observed.

Mortar Sample 3

Mortar sample 3 exhibits a medium grey color on a freshly fractured surface. The sample is moderately hard and somewhat absorbent of water. The mortar is discolored beige on its exterior, with dark areas of organic and/or biological growth. Inclusions of rock particles and wood are observed within the mortar. The sample represents mortar removed a mostly intact pier, and exhibits little to no deterioration in the form of leached paste, or loss of bond strength between the aggregates and the paste.

No lumps of cement or hydrated lime lumps were detected. The matrix is fully carbonated, and secondary deposits of calcite are observed filling voids in the paste, due to dissolution and reprecipitation of calcium-based products in the matrix. Cracking is rare, and limited to the exposed surfaces of the sample. The paste appears similar to mortar sample 1, but with no observed localized leaching of the paste in the examined sample.

Stone Findings

The stone samples examined are classified as quartz monzonite in composition and texture, with gneissic foliation. The particles show distinct foliation (banding, Figure 13 and Figure 14). The stones are composed mainly of light colored quartz and feldspar (albite and microcline) minerals, with foliation highlighted by the dark brown to black banding of biotite mica. Orange coloration within the lapped cross sections and coating the samples is due in part to iron bound within minerals, as well as oxidation of iron minerals within the stone. The exterior surfaces of the stones contains a combination of oxidation products, biological growth, and dirt accumulation.

Summary

Petrographic studies to assess the general composition and condition of four mortar samples removed from the Miller Bridge piers in Horseshoe Bend National Military Park were completed, as well as studies of two stone samples removed from the piers that were submitted to identify the composition of the stone. The four mortar samples were removed from the mid-river piers. Piers 1 and 3 were mostly intact, pier 2 was mostly intact, and pier 4 was largely collapsed. The stone samples were removed from the piers and represent the general character and condition of existing construction.

The four mortar samples appear compositionally similar, with varying levels of deterioration observed. The samples appear either grey (Sample 1 and 3) or beige (Samples 2 and 4) on freshly fractured surfaces, due to the extent of the deterioration of the paste. Each sample exhibits some form of organic growth, biological growth, or dirt on their exterior surfaces. Abundant particles of residual unhydrated and partially hydrated portland cement, with underburned cement particles are present in each sample. The residual cement particles are large (some as large as small sand grains) and exhibit characteristics consistent with portland cement produced in the early 1900s. Sample 1 contains cement lumps, up to 7 mm in diameter, however these cement lumps are not observed in the other samples.

In each sample, the sand volume appears normal to slightly undersanded, compared to modern requirements. The sand is subangular in shape, and is composed of primarily quartz, with lesser amounts of quartzite and biotite mica. Trace amounts of burnt wood and other rock particles are observed within the samples. The mortars contain entrapped air voids, but do not exhibit spherical air voids due to the use of a chemical air entraining agent.

Sample 2 exhibits deterioration in the form of increased paste porosity and a loss of paste-aggregate bond strength. The paste is soft and highly absorptive of water, compared to harder and less absorptive paste in Samples 1 and 3. Cracking is rare in each sample, and when observed is along the exposed surfaces of the samples. Each sample exhibits fully carbonated paste, with secondary calcite deposits observed in void spaces due to dissolution of calcium in the paste that has redeposited within the matrix.

The two examined stone samples removed from the piers represent a quartz monzonite in composition and texture, with gneissic foliation. The most likely source of the stone used in the construction of the Miller's Bridge Piers is the Kowaliga Gneiss of the Blue Ridge physiographic province (which is a regional geomorphological classification). The USGS classifies the Kowaliga Gneiss as a coarse-grained granodiorite to quartz monzonite. Granite, granodiorite and quartz monzonite are all made up of the same major minerals: Quartz, plagioclase feldspar (albite), potassium feldspar (microcline) and mica (mainly biotite). Granodiorite generally has more plagioclase feldspar than potassium feldspar. Quartz monzonite has around equal proportions of plagioclase feldspar to potassium feldspar (USGS web site).



Figure 1. Images of Mortar Sample 1, as-received. Note the dark deposits on the surface of the mortar in the right image.



Figure 2. Images of Mortar Sample 2, as-received. Note the dirt deposits on the surface of the mortar in both images and the beige coloration of the samples.



Figure 3. Images of Mortar Sample 3, as-received. Note the dark deposits on the surface of the mortar in the images.



Figure 4. Images of Mortar Sample 4, as-received. Note the dark deposits on the surfaces of the mortar in the images.



Figure 5. Images of Stone Sample 1, as-received. Note the overall dark brown to black appearance of the samples.



Figure 6. Images of Stone Sample 2, as-received. Note the overall dark brown to black appearance of the samples, as well as biological and/or organic growth (red arrows).

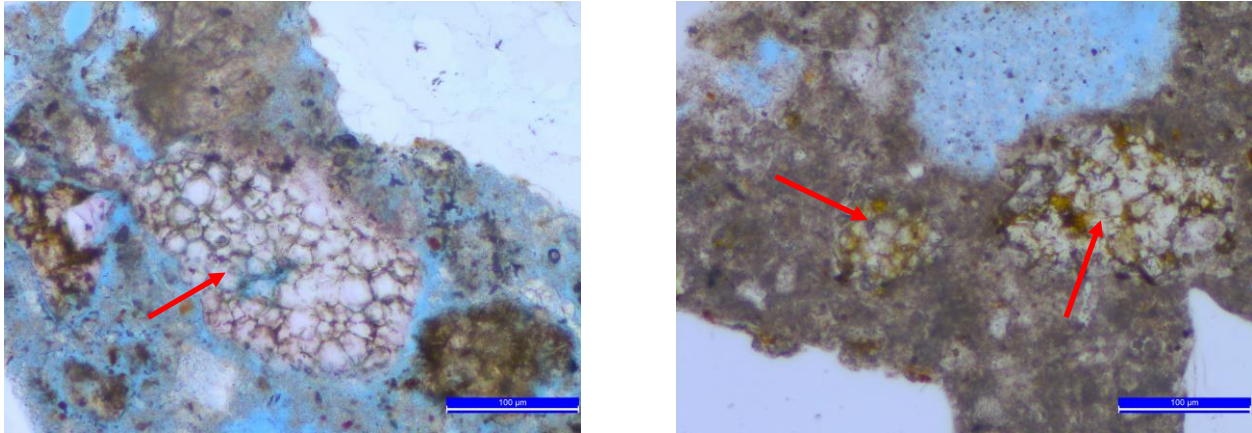


Figure 7. Images of coarse portland cement particles in Mortar Sample 2 (left) and Mortar Sample 3 (right). Also note the presence of a higher amount of blue dyed epoxy in the left image as compared to the right image, indicating a higher paste porosity. PPL images¹.

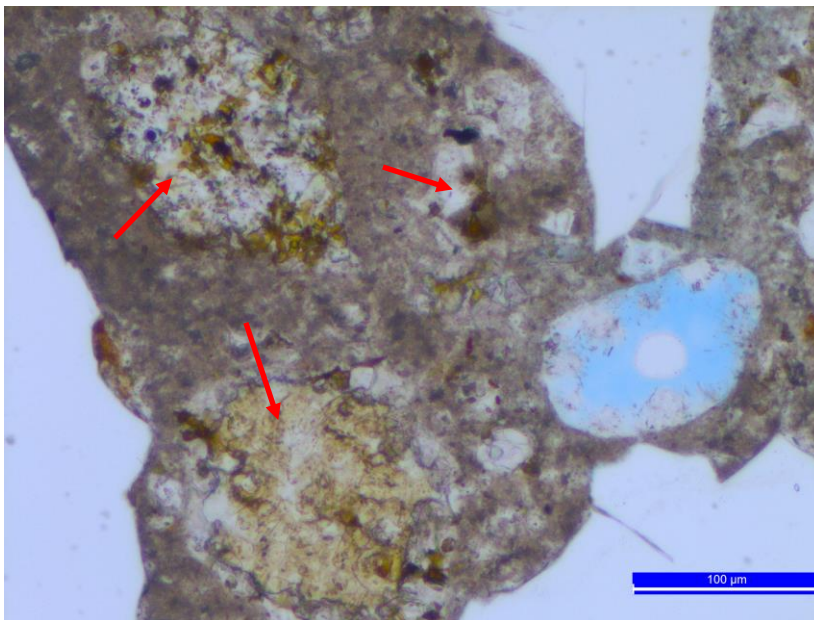


Figure 8. Examples of underburned limestone used in the production of the cement observed in the mortar samples (red arrows). Note the presence of some of the original characteristics of the limestone structure in the particles. PPL image

¹ Abbreviations in the image captions include PPL for plane polarized light and XPL for cross-polarized light. PPL and XPL are illumination techniques used to obtain specific diagnostic optical properties to aid in the identification of materials.

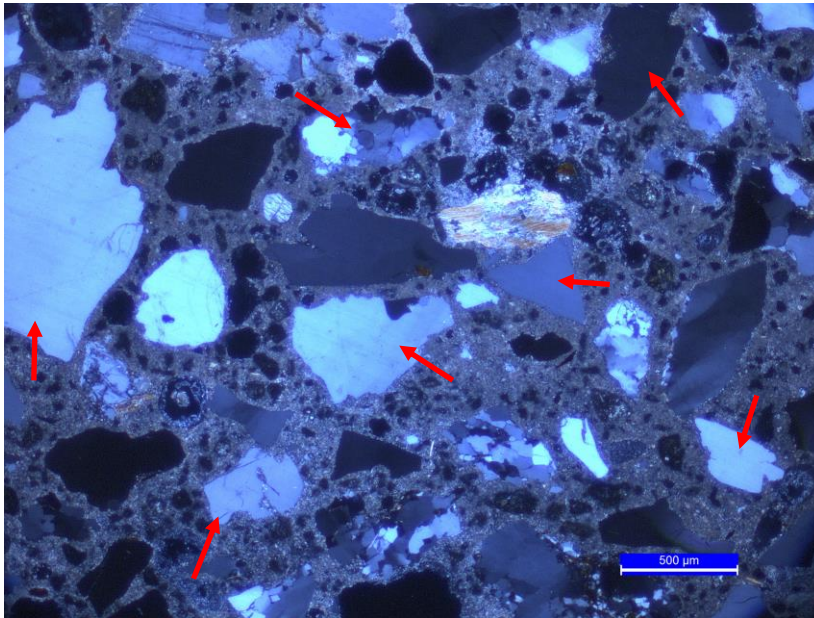


Figure 9. Overview of Mortar Sample 3, showing the distribution of sand grains (red arrows point to some sand grains). XPL image.

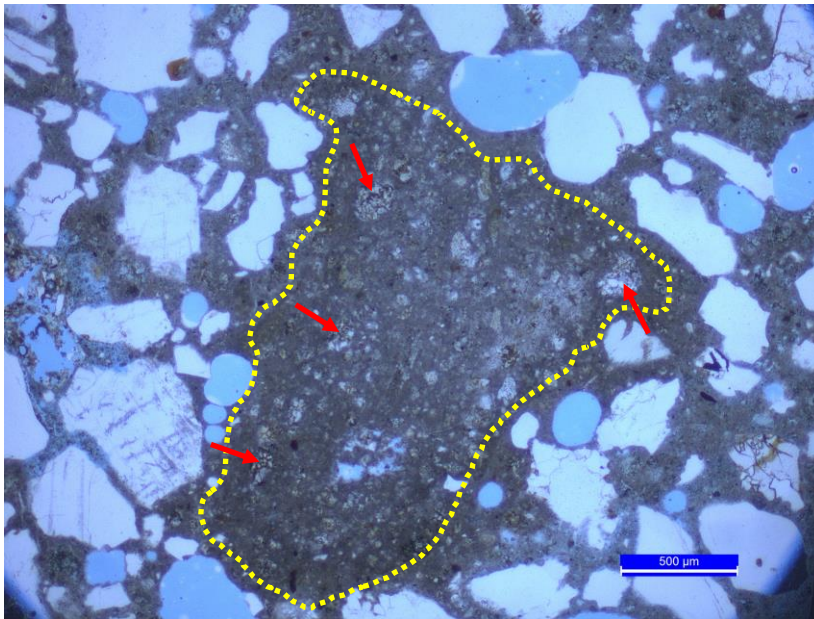


Figure 10. PPL image of Mortar Sample 1, showing one of the smaller cement lumps observed in the matrix (outlined with yellow dotted line, red arrows point to some of the coarser cement particles in the lump).

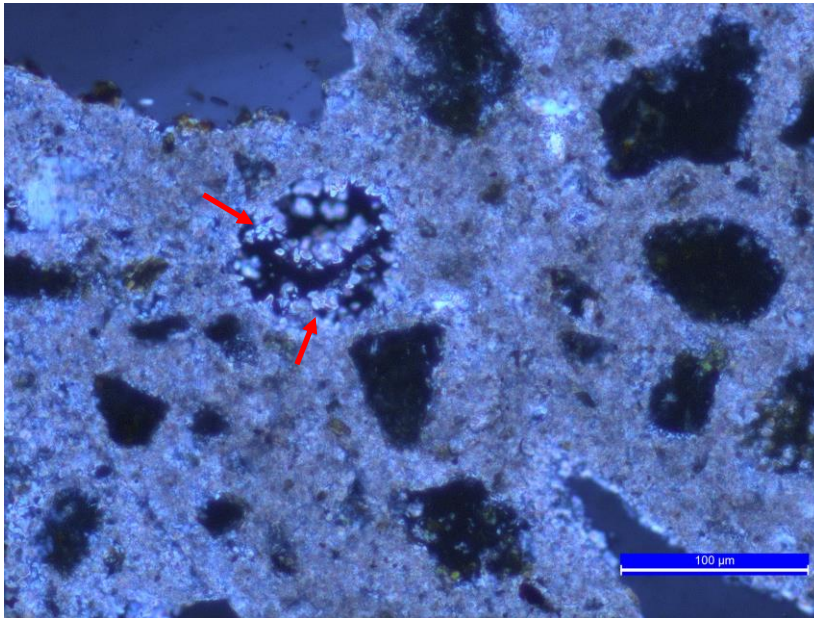


Figure 11. XPL image of Mortar Sample 1, showing the fully carbonated matrix and secondary deposits of calcite in an air void (red arrows).



Figure 12. Mortar Sample 2 exhibits a porous paste structure, as shown by the absorption of a large amount of blue dyed epoxy (the overall blue coloration of the image). Red arrow points to biotite mica, part of the sand within the mortar.

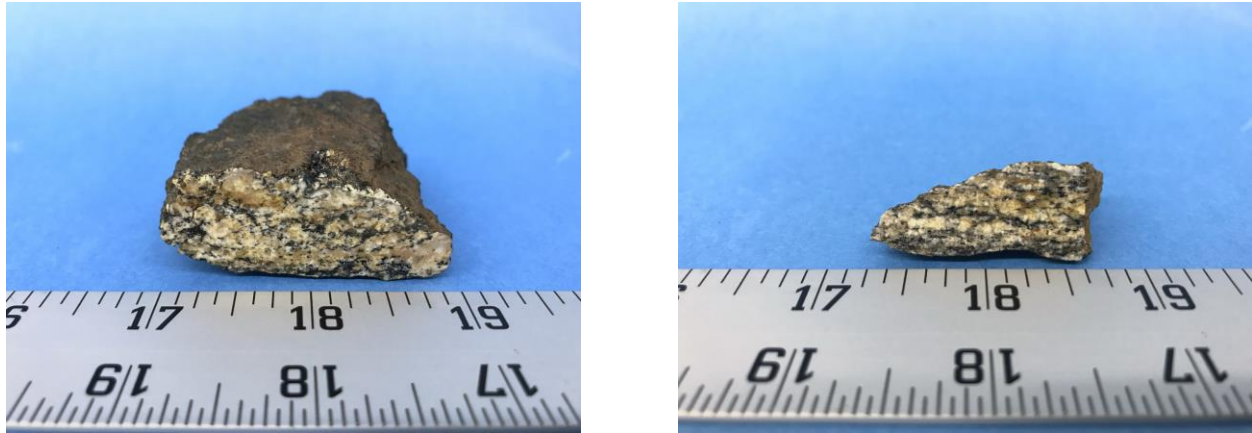


Figure 13. Lapped cross sections of Stone Sample 1 (left) and Stone Sample 2 (right) showing the distinct foliation of the stone. Note the discolored exterior surfaces of the stone.



Figure 14. Magnified image of Stone Sample 2 showing the foliation highlighted by black biotite.

APPENDIX B: CONCEPTUAL REPAIR DRAWINGS

3/21/2019 - AUTOCAD 2014 - GO HOBECOV.DWG - XREFS: XG-PEVIBASE.dwg



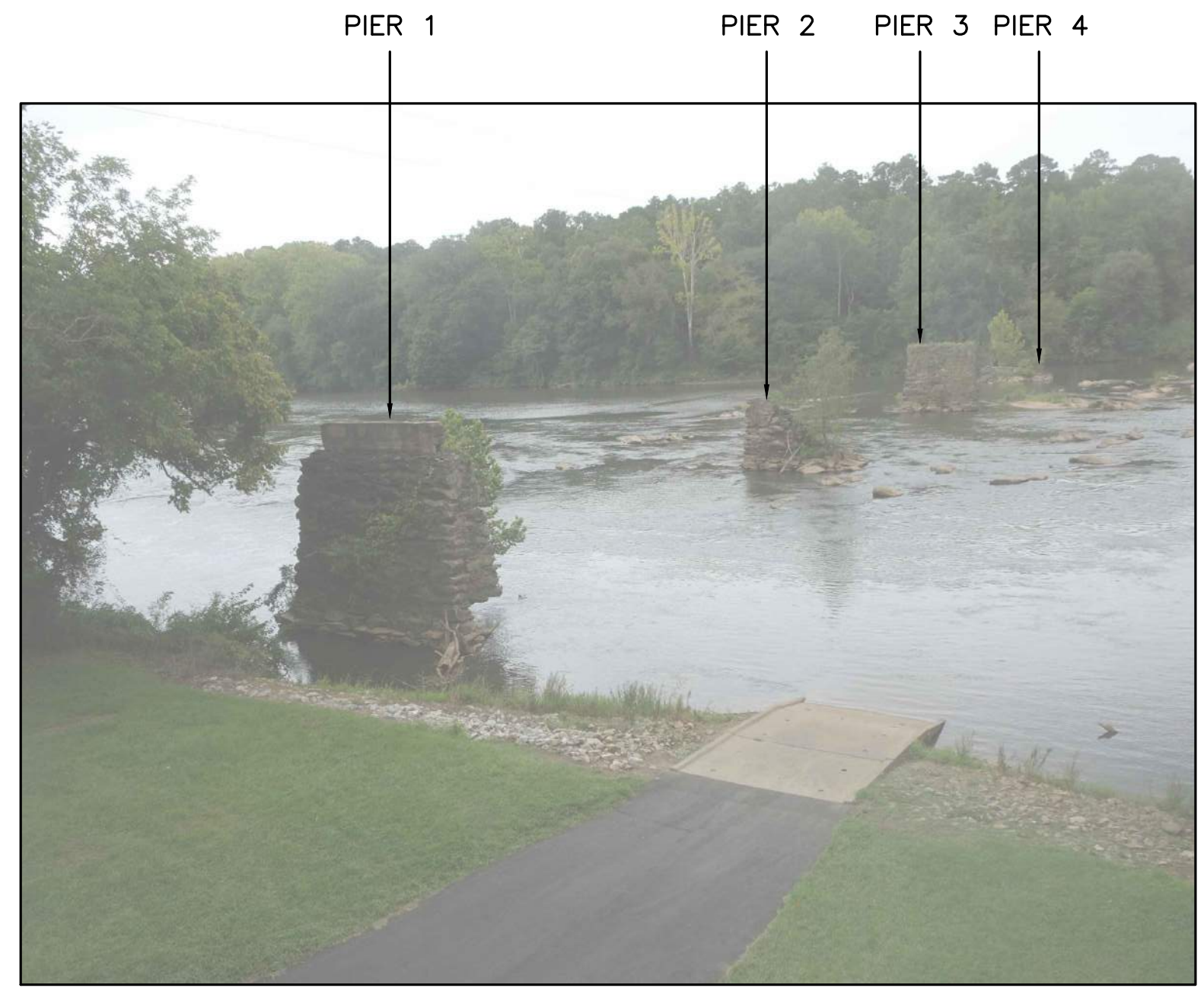
INDEX		
SHEET	SUB SHEET	TITLE OF SHEET
1	G0	COVER SHEET
2	G1	SITE PLAN
3	G2	GENERAL NOTES AND SCOPE OF WORK
4	A1	PIER 1 NORTH AND EAST ELEVATIONS
5	A2	PIER 1 SOUTH AND WEST ELEVATIONS
6	A3	PIER 2 NORTH AND EAST ELEVATIONS
7	A4	PIER 2 SOUTH AND WEST ELEVATIONS
8	A5	PIER 3 NORTH AND EAST ELEVATIONS
9	A6	PIER 3 SOUTH AND WEST ELEVATIONS
10	A7	PIER 4 NORTH AND EAST ELEVATIONS
11	A8	PIER 4 SOUTH AND WEST ELEVATIONS
12	A9	REPAIR DETAILS

HORSESHOE BEND NATIONAL MILITARY PARK
MILLER BRIDGE PIERS CONCEPTUAL REPAIR SCENARIOS
MARCH 20. 2019

A/E FIRM - A/E CONTRACT NUMBER		Mark	Sheet	REVISION	Date	Initial	QUALITY DESIGN CERTIFICATION			NOT FOR CONSTRUCTION	TITLE OF DRAWING		DRAWING NO.					
PRIME: PANAMERICAN CONSULTANTS, LTD. MEMPHIS, TENNESSEE							☐ Prepared in Accordance with Design Development (Title I) Drawing No. _____				REPAIR SCENARIOS		_____					
ARCHITECT/STRUCTURAL ENGINEER: WISS, JANNEY, ELSTNER ASSOCIATES, INC. NORTHBROOK, ILLINOIS							☐ Variance from Design Development (Title I) Approved by Superintendent on _____ Date _____				LOCATION WITHIN PARK MILLER BRIDGE PIERS		PKG. NO. _____	SHEET 1				
CONTRACT NO. P16PC00097							☐ Construction Drawing Not Preceded by Design Development (Title I)				NAME OF PARK HORSESHOE BEND NATIONAL MILITARY PARK							
							Project Manager _____ Date _____				REGION SOUTHEAST							
											COUNTY TALLAPOOSA		STATE ALABAMA					
													OF 12					

BASIC DATA: UNIGRID MAP

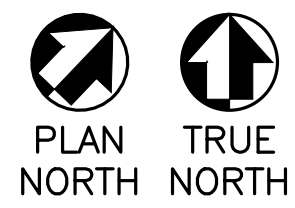
12/5/2018 - AUTOCAD 2014 - G1 SITEPLAN.dwg - XREFS: XG-22x34.dwg



1
G1 VIEW OF PIERS FROM SOUTH SIDE OF RIVER



2
G1 AERIAL VIEW



NOT FOR CONSTRUCTION

DESIGNED: DS KMI	SUB SHEET NO. G1	TITLE OF SHEET SITE PLAN AND OVERVIEW Horseshoe Bend National Military Park Tallapoosa County, Alabama	DRAWING NO. _____
DRAWN: TC ERP			PMIS/PKG NO. _____
TECH. REVIEW: LE			SHEET 2 OF 12
DATE: 20 MAR. 2019			

12/5/2018 - AUTOCAD 2014 - G2 GENNOTE.dwg - XREFS: XG-22x34.dwg, XA-ELEV.dwg

GENERAL NOTES

1. COMPLY WITH ALL CODES, ORDINANCES, RULES, STANDARDS, REGULATIONS, ORDERS, AND LEGAL REQUIREMENTS OF THE NATIONAL PARK SERVICE AND AUTHORITIES HAVING JURISDICTION WHICH BEAR ON THE PERFORMANCE OF THE WORK. ALL WORK SHALL BE CONDUCTED IN ACCORDANCE WITH OSHA REQUIREMENTS.
2. PROVIDE PROTECTION PLAN FOR ALL NATURAL AND CULTURAL RESOURCES POTENTIALLY AFFECTED BY THE WORK OF THIS PROJECT FOR REVIEW BY THE NATIONAL PARK SERVICE PRIOR TO BEGINNING WORK.
3. VERIFY ALL DIMENSIONS AND CONDITIONS IN THE FIELD. DO NOT SCALE DRAWINGS.
4. PROVIDE ACCESS FOR INSPECTION BY THE CONTRACTING OFFICER’S REPRESENTATIVE OF THE WORK IN PROGRESS.
5. IF NEEDED DEPENDING ON WATER LEVELS AT PIERS, PROVIDE COFFERDAM OR OTHER ENCLOSURE TO PROVIDE DRY WORK AREA AT BASE OF PIERS.
6. PROTECT ALL HISTORIC MATERIALS THROUGHOUT THE WORK.

SUMMARY OF WORK

SCENARIO 1 – ACCEPT THE DETERIORATED CONDITION OF THE PIERS AND ALLOW THEM TO CONTINUE TO DETERIORATE

THIS SCENARIO IS BEING CONSIDERED FOR PIER 4.

NO WORK ON THE PIER IS INCLUDED UNDER THIS SCENARIO, OTHER THAN REMOVAL OF VEGETATION.

SCENARIO 2 – STABILIZE/REPAIR THE PIERS USING IN–KIND MATERIALS

THIS SCENARIO IS BEING CONSIDERED FOR PIERS 1, 2, AND 3.

THE WORK OF THIS SCENARIO INCLUDES THE FOLLOWING:

1. CAREFULLY REMOVE VEGETATION FROM PIERS.
2. AT THE BASE OF THE PIER, INSTALL STONE SET IN CEMENTITIOUS GROUT AT THE PERIMETER OF THE PIER.
3. WHERE STONE IS MISSING WITHIN THE EXISTING CONFIGURATION OF THE PIER, INSTALL REPLACEMENT STONE OBTAINED LOCALLY, SET IN MORTAR.
4. REMOVE AND RESET LOOSE STONE IN MORTAR.
5. WASH STONE WITH LOW PRESSURE WATER TO REMOVE MUD AND DEBRIS.
6. PREPARE AND REPOINT ERODED MORTAR JOINTS (ASSUME 100 PERCENT OF MORTAR JOINTS REQUIRE REPOINTING).
7. INSTALL A CEMENTITIOUS PARGE COATING ON THE TOP SURFACE OF THE PIER ONLY.

SCENARIO 3 – STABILIZE/REPAIR THE PIERS USING OTHER THAN IN–KIND MATERIALS

THIS SCENARIO IS BEING CONSIDERED FOR PIERS 1, 2, AND 3.

THE WORK OF THIS SCENARIO INCLUDES THE FOLLOWING:

1. CAREFULLY REMOVE VEGETATION FROM PIERS.
2. AT THE BASE OF THE PIER, INSTALL CONCRETE AT THE PERIMETER OF THE PIER.
3. WHERE STONE IS MISSING WITHIN THE EXISTING CONFIGURATION OF THE PIER, INSTALL CONCRETE.
4. REMOVE AND RESET LOOSE STONE IN MORTAR.
5. WASH STONE WITH LOW PRESSURE WATER TO REMOVE MUD AND DEBRIS.
6. PREPARE AND REPOINT ERODED MORTAR JOINTS (ASSUME 100 PERCENT OF MORTAR JOINTS REQUIRE REPOINTING).
7. INSTALL A CEMENTITIOUS PARGE COATING ON THE TOP SURFACE OF THE PIER ONLY.

NOTE: ALL REPAIRS ARE CONCEPTUAL. REFER TO ACCOMPANYING MEMO DATED 3 DECEMBER 2018 FOR ADDITIONAL INFORMATION ON SCOPE OF REPAIRS.

NOT FOR CONSTRUCTION

DESIGNED: DS KMI	SUB SHEET NO. G2	TITLE OF SHEET GENERAL NOTES AND SCOPE OF WORK Horseshoe Bend National Military Park Tallapoosa County, Alabama	DRAWING NO. _____
DRAWN: TC ERP			PMIS/PKG NO. _____
TECH. REVIEW: LE			SHEET
DATE: 20 MAR. 2019			3 OF 12

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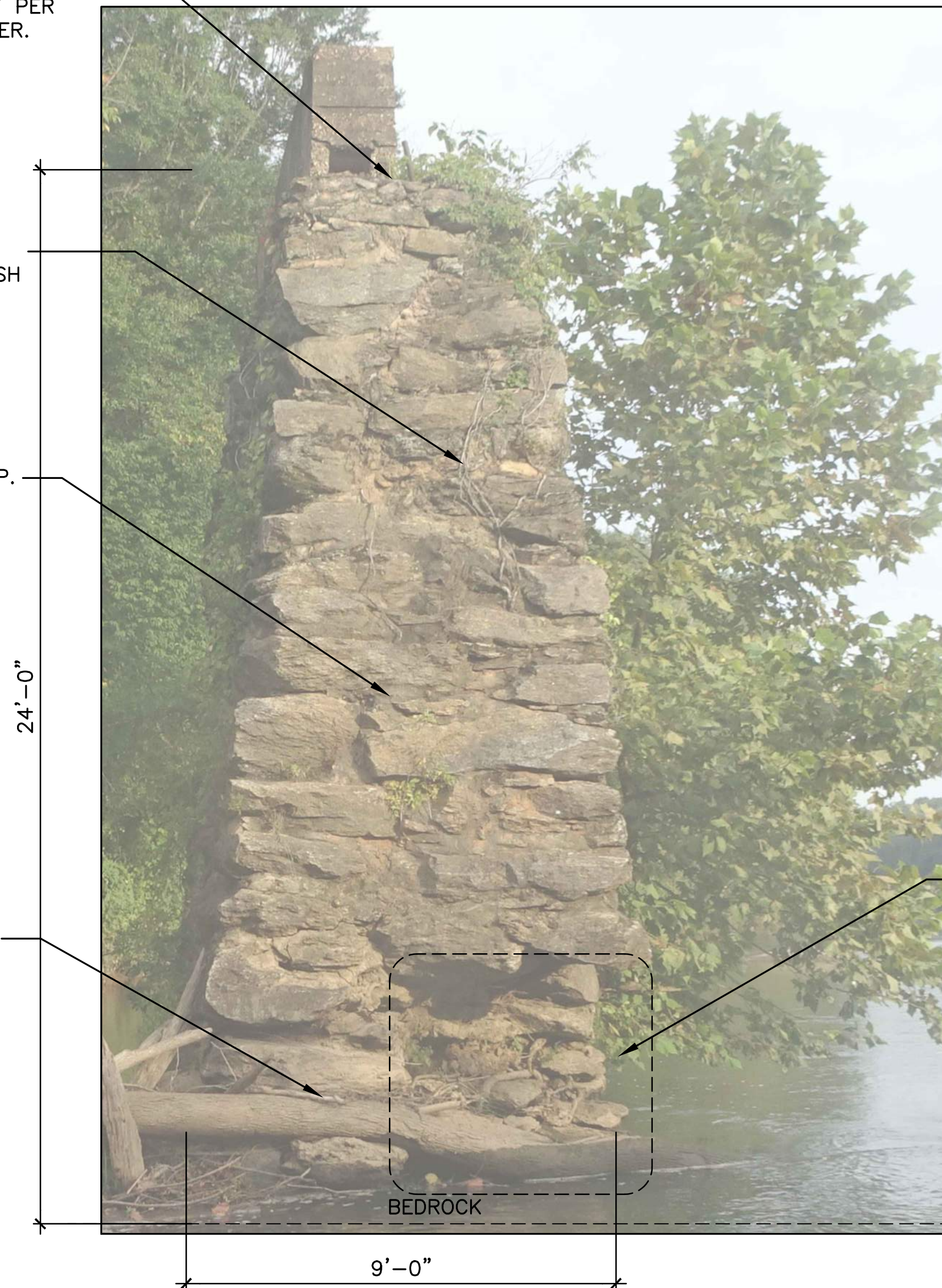
INSTALL NEW CEMENTITIOUS
PARGE COAT ON TOP SURFACE
OF PIER, SLOPE MIN. 1/4" PER
FOOT TO PERIMETER OF PIER.

REMOVE ALL VEGETATION.
CUT WOODY STUMPS FLUSH
WITH STONE SURFACE.

REPOINT ALL JOINTS, TYP.

SCENARIO 2: INSTALL
STONE SET IN GROUT AT
PERIMETER OF PIER AT
BASE. SLOPE DOWN TO
BEDROCK. SEE DETAIL
4/A9.

SCENARIO 3: INSTALL
CONCRETE AT PERIMETER
OF PIER AT BASE. SLOPE
DOWN TO BEDROCK. SEE
DETAIL 5/A9.



1 PIER 1 - EAST (UPSTREAM) ELEVATION
A1

SCENARIO 2: INSTALL NEW
STONE UNITS WITH UNITS
MATCHING ORIGINAL STONE TYPE
AND COURSING. SET IN FULL
MORTAR BED. FOLLOW ORIGINAL
PROFILE OF PIER. SEE DETAIL
2/A9.

SCENARIO 3: INSTALL
CAST-IN-PLACE CONCRETE.
FOLLOW OVERALL BATTERED
PROFILE OF PIER. SEE DETAIL
3/A9.

INSTALL NEW CEMENTITIOUS
PARGE COAT ON TOP SURFACE
OF PIER, SLOPE MIN. 1/4" PER
FOOT TO PERIMETER OF PIER.

REMOVE ALL VEGETATION. CUT
WOODY STUMPS FLUSH WITH
STONE SURFACE.

REPOINT ALL JOINTS, TYP.



2 PIER 1 - NORTH ELEVATION
A1

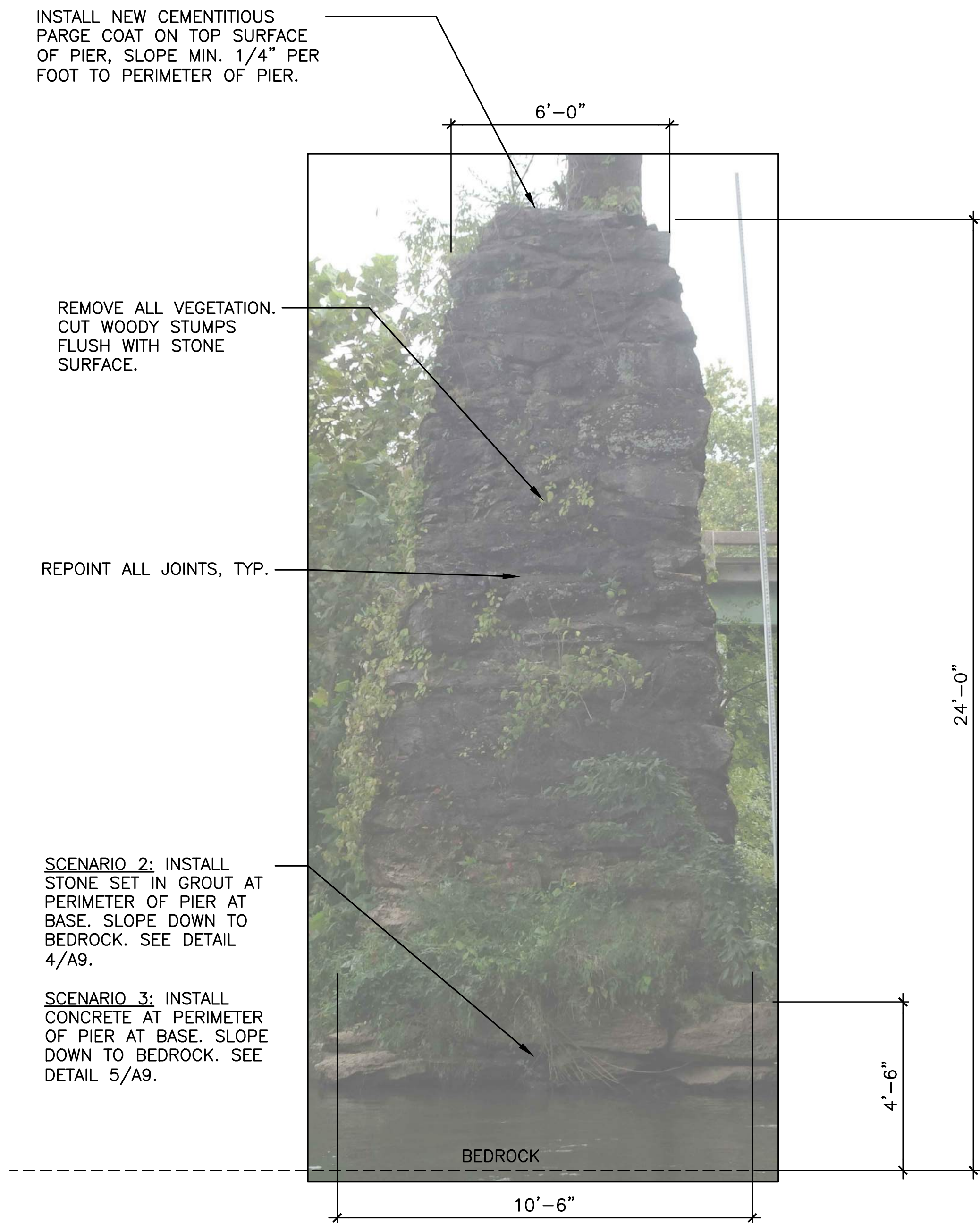
SCENARIO 2: INSTALL STONE
SET IN GROUT AT PERIMETER
OF PIER AT BASE. SLOPE DOWN
TO BEDROCK. SEE DETAIL 4/A9.

SCENARIO 3: INSTALL CONCRETE
AT PERIMETER OF PIER AT
BASE. SLOPE DOWN TO
BEDROCK. SEE DETAIL 5/A9.

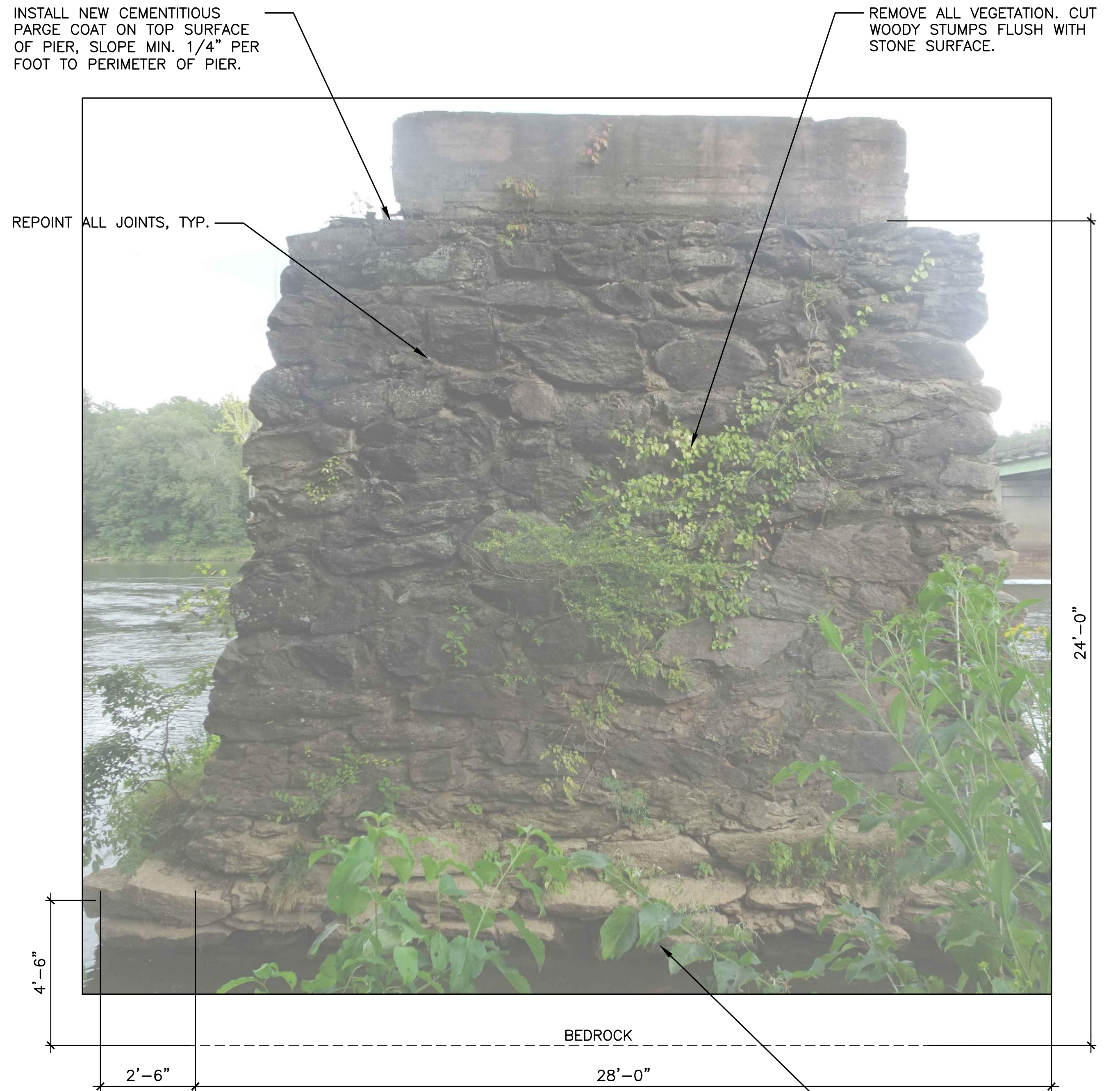
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DRAWN: TC ERP			PMIS/PKG NO. _____
TECH. REVIEW: LE			SHEET 4 OF 12
DATE: 20 MAR. 2019			

12/5/2018 - AUTOCAD 2014 - A2 PIER 1 S-W.dwg XREFS: XG-22x34.dwg, XA-ELEV.dwg



1
A2 PIER 1 - WEST (DOWNSTREAM) ELEVATION

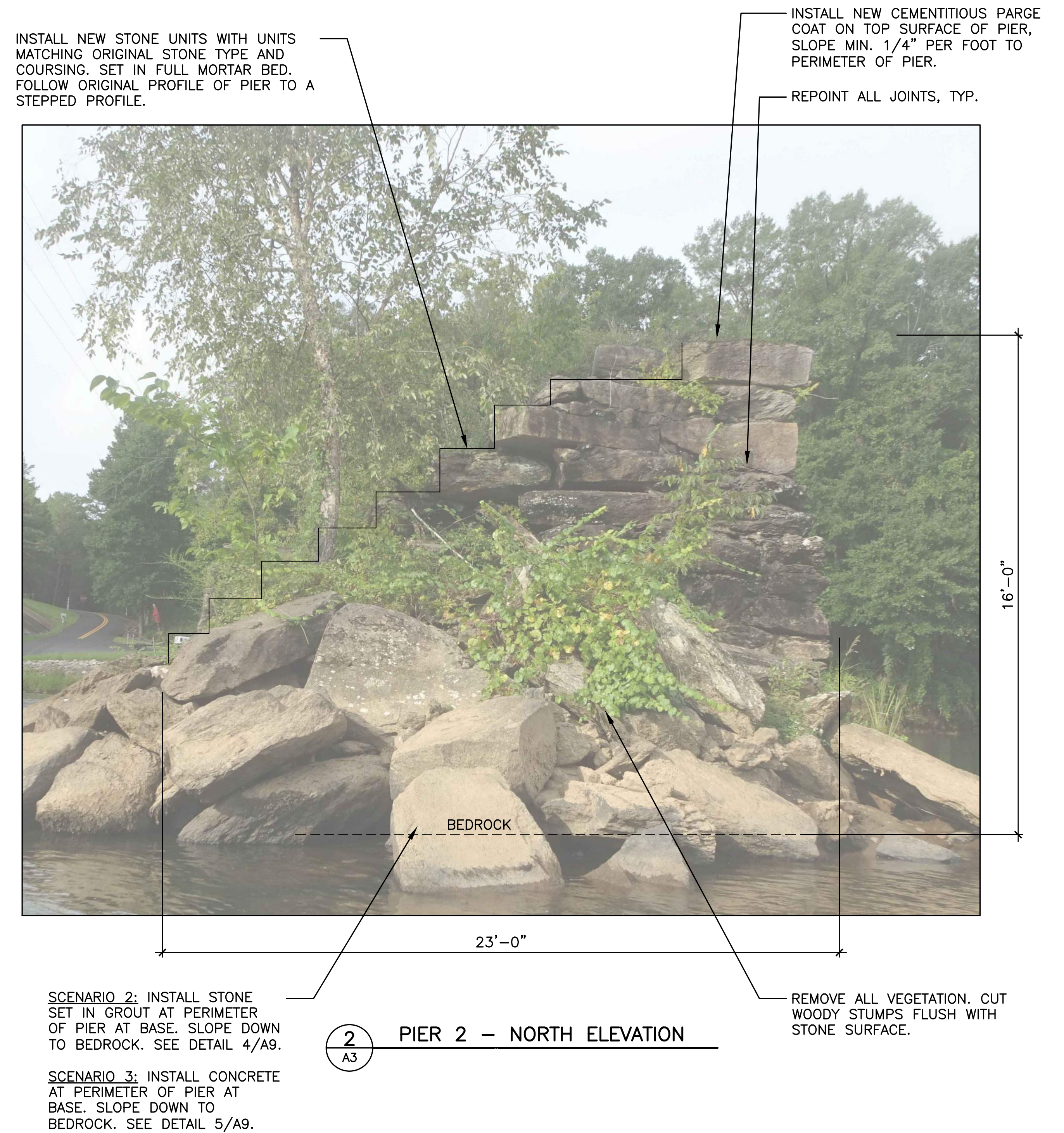
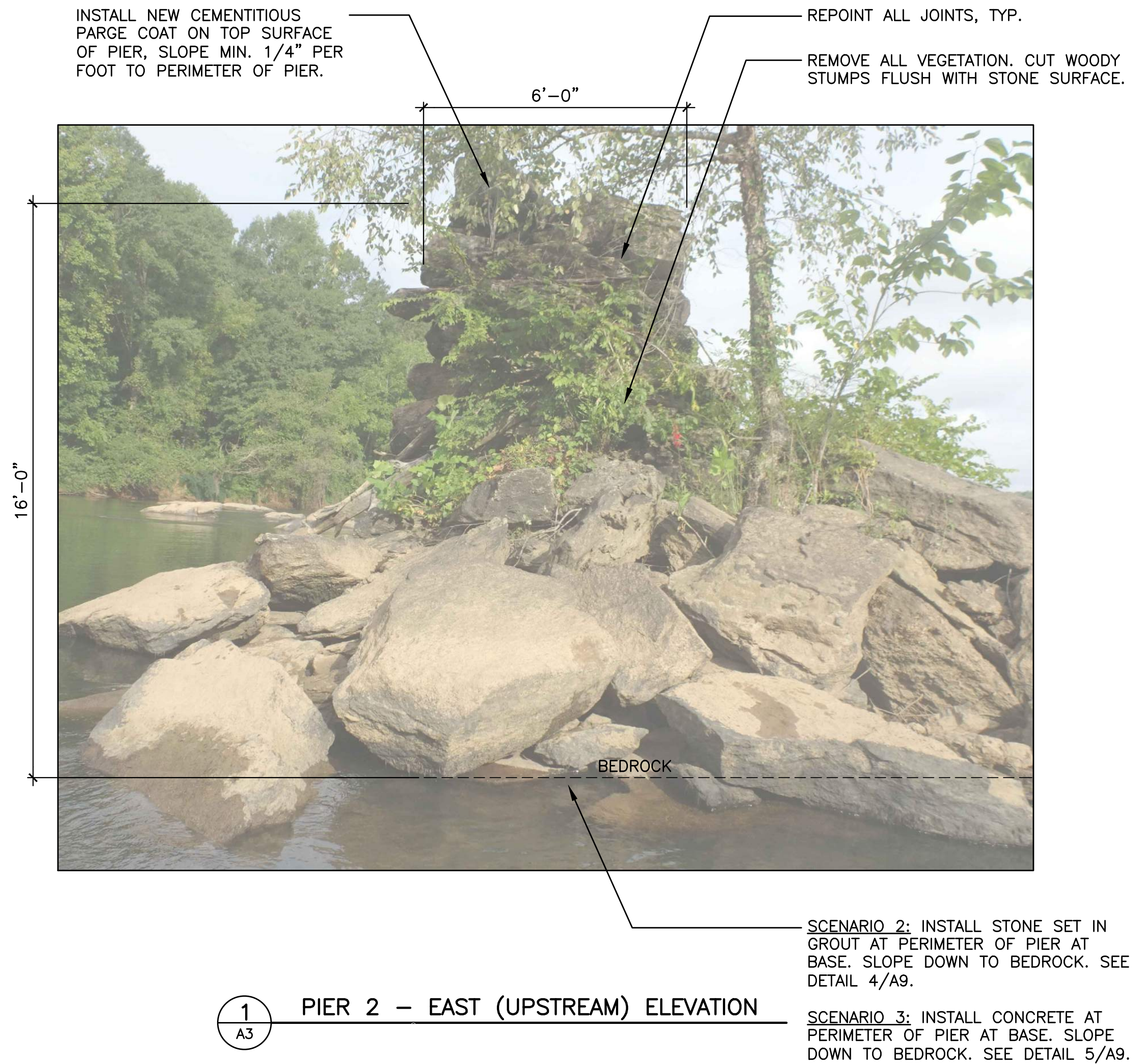


2
A2 PIER 1 - SOUTH ELEVATION

NOT FOR CONSTRUCTION

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DATE: 20 MAR. 2019			

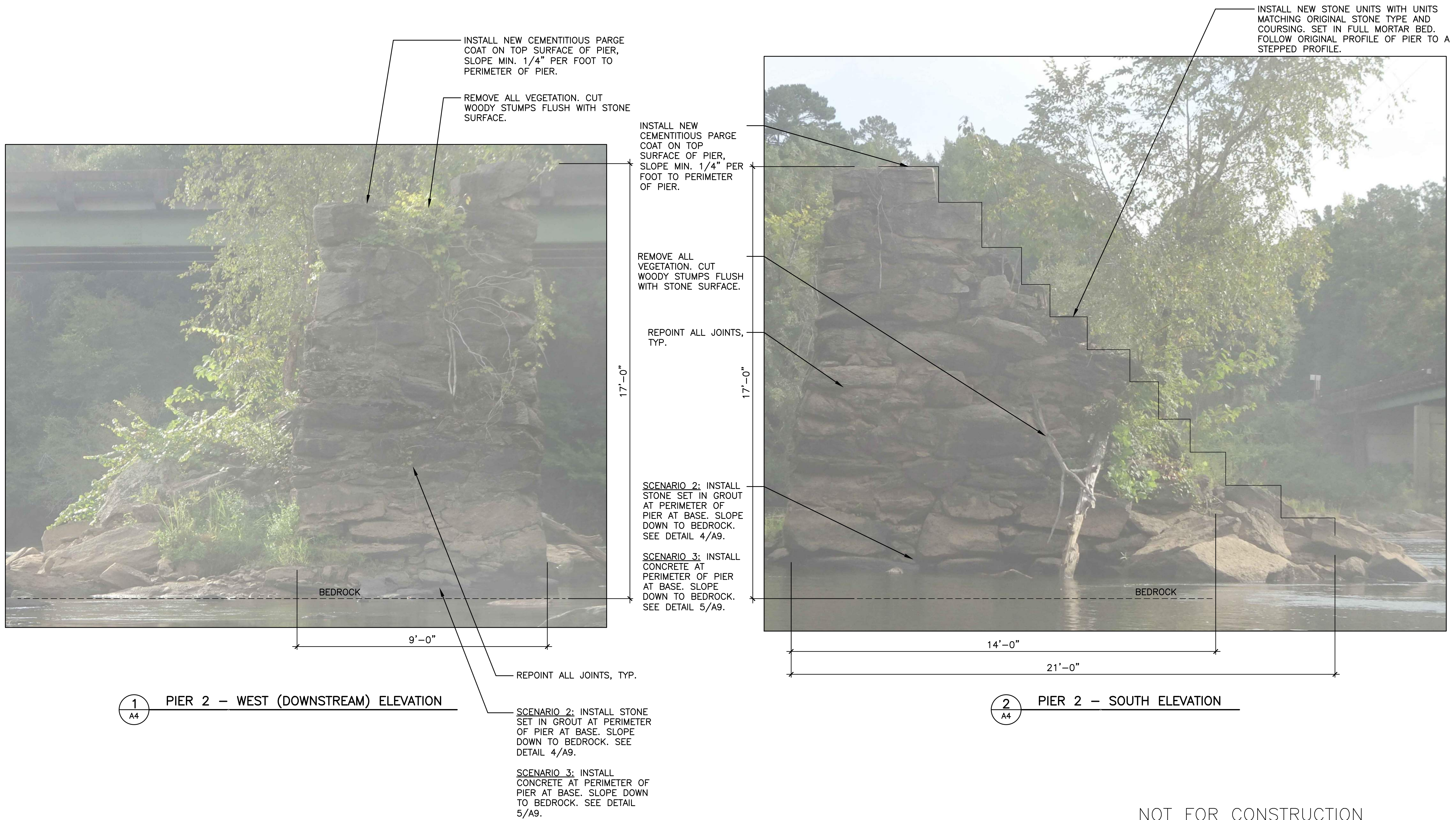
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DATE: 20 MAR. 2019			

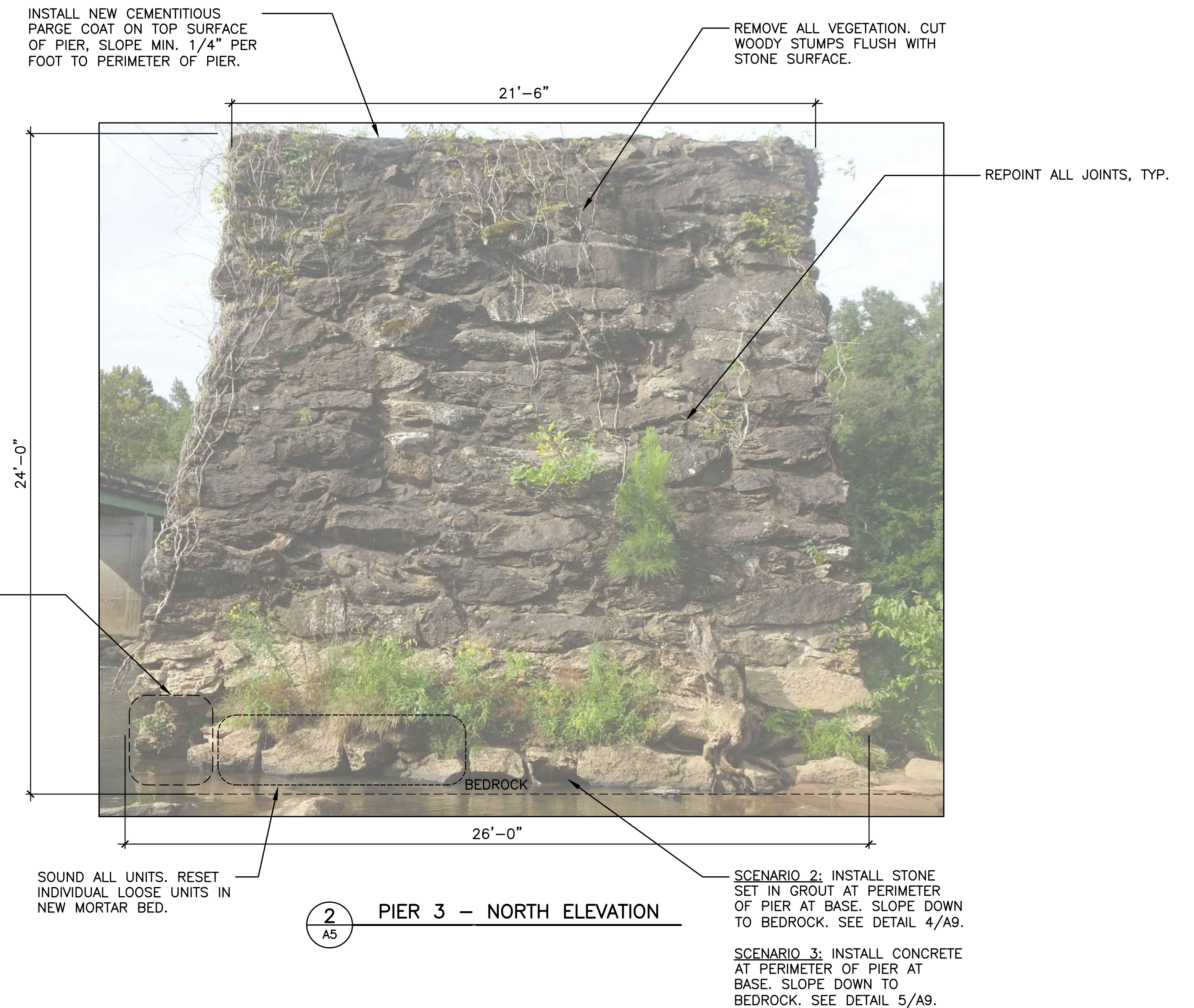
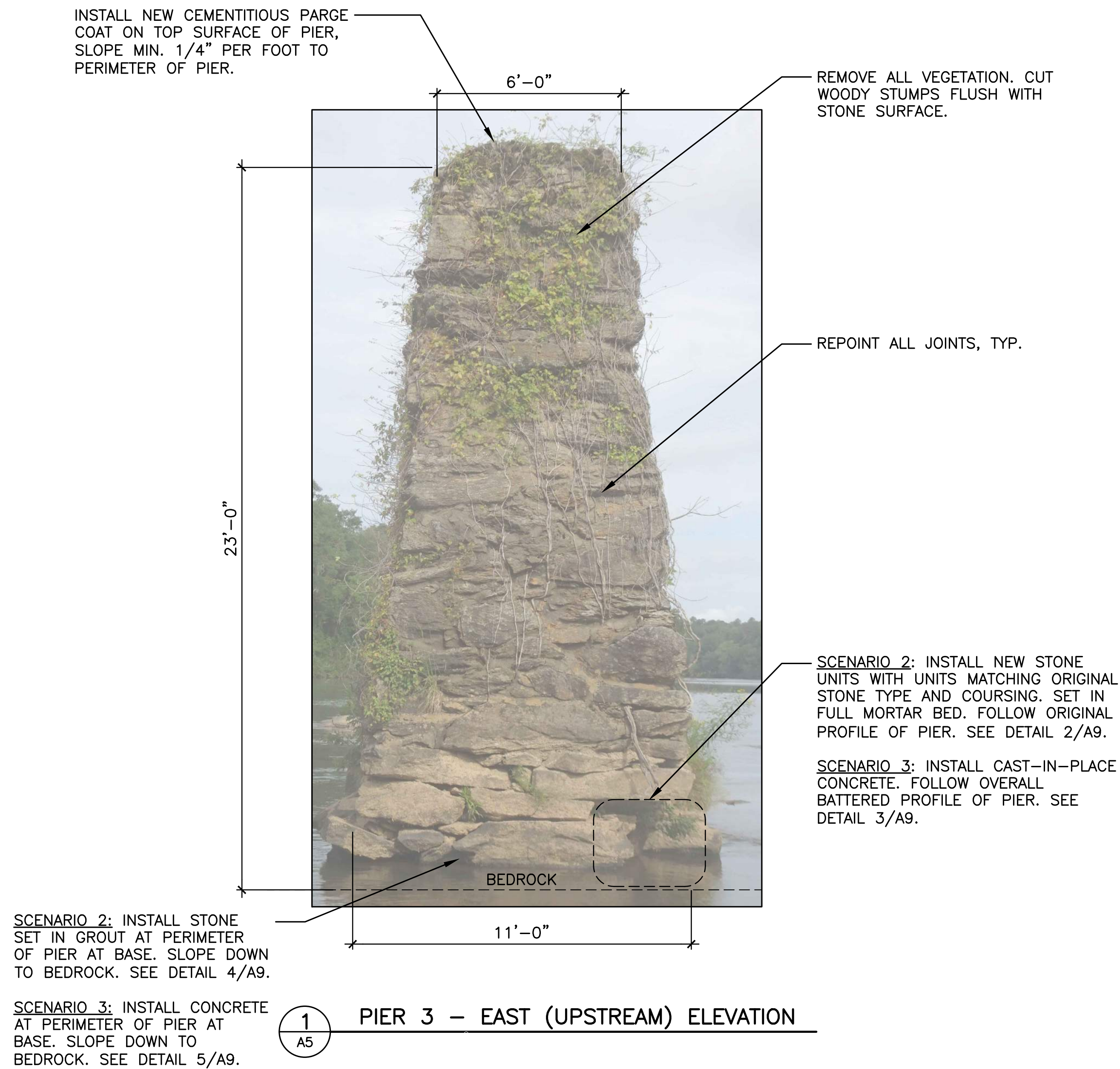
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DATE: 20 MAR. 2019			

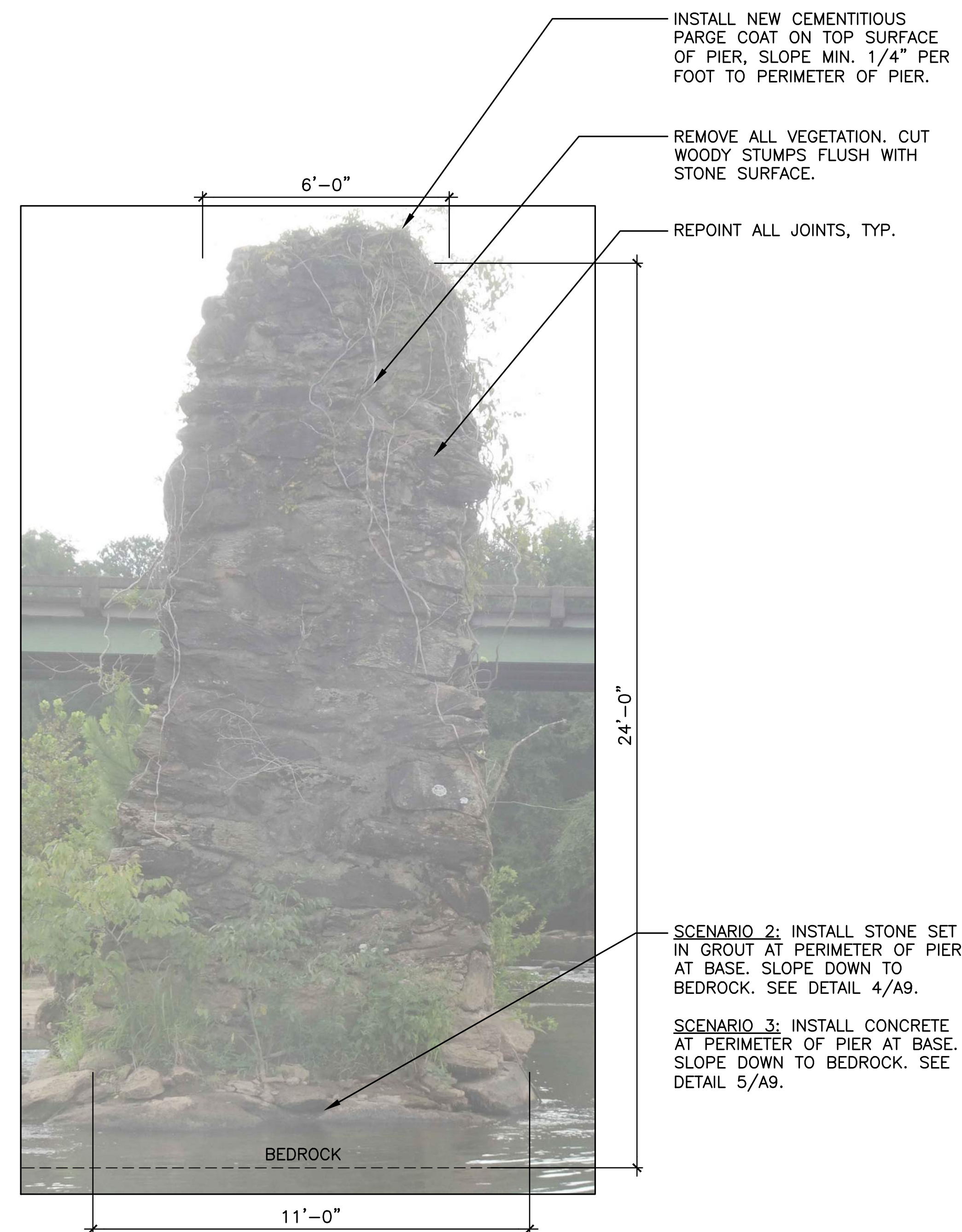
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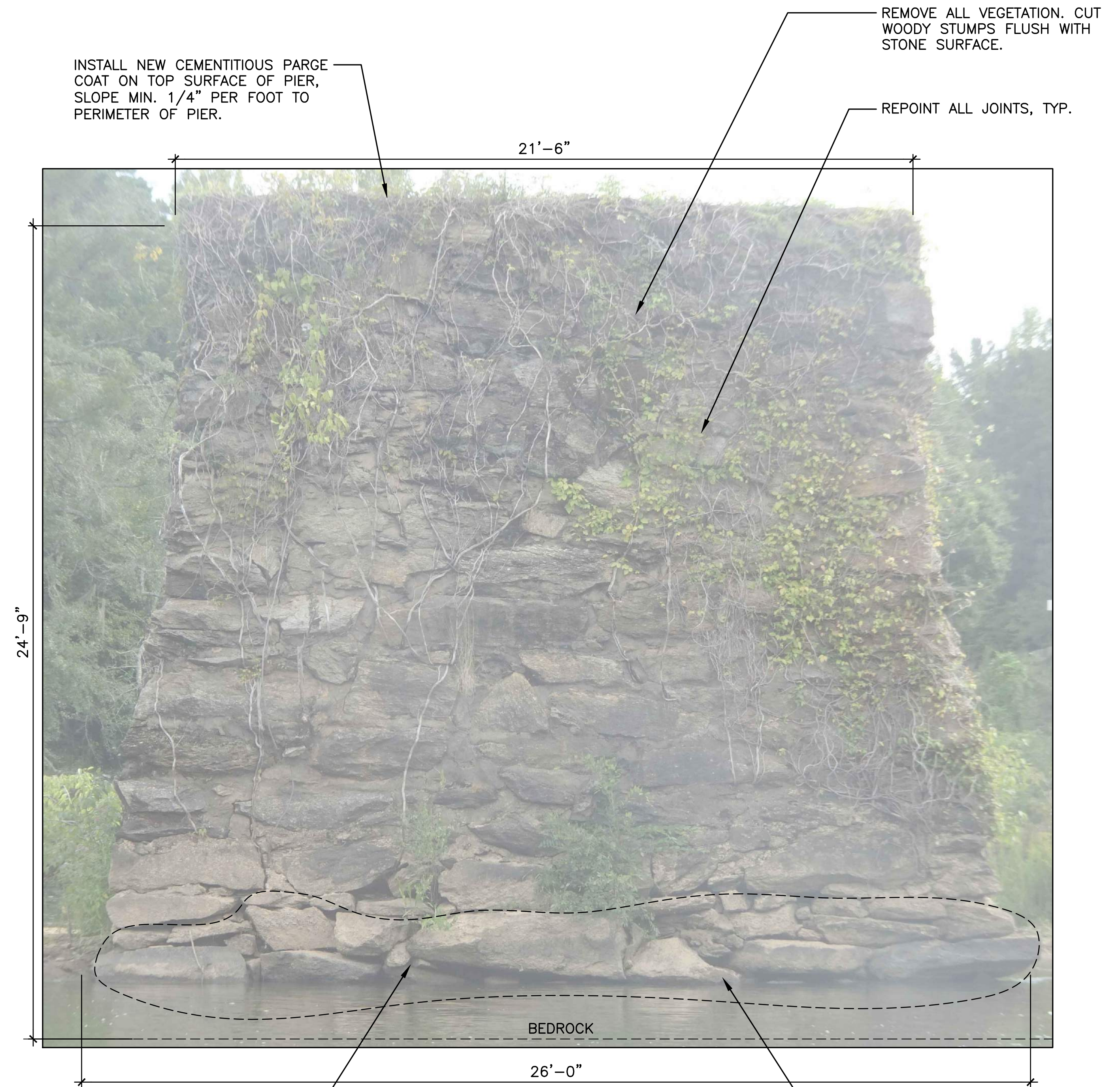
NOT FOR CONSTRUCTION

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TECH. REVIEW: LE			SHEET 8 OF 12
DATE: 20 MAR. 2019			

12/5/2018 - AUTOCAD 2014 - A6 PIER 3 S-W.dwg XREFS: XG-22x34.dwg, XA-ELEV.dwg



1 PIER 3 - WEST (DOWNSTREAM) ELEVATION
A6



2 PIER 3 - SOUTH ELEVATION
A6

NOT FOR CONSTRUCTION

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DRAWN: TC ERP			PMIS/PKG NO. _____
TECH. REVIEW: LE			SHEET 9 OF 12
DATE: 20 MAR. 2019			

12/5/2018 - AUTOCAD 2014 - A7 PIER 4 N-E.dwg XREFS: XG-22x34.dwg, XA-ELEV.dwg

REMOVE ALL VEGETATION. CUT
WOODY STUMPS FLUSH WITH
STONE SURFACE.



1
A7 PIER 4 - EAST (UPSTREAM) ELEVATION

REMOVE ALL VEGETATION. CUT
WOODY STUMPS FLUSH WITH
STONE SURFACE.

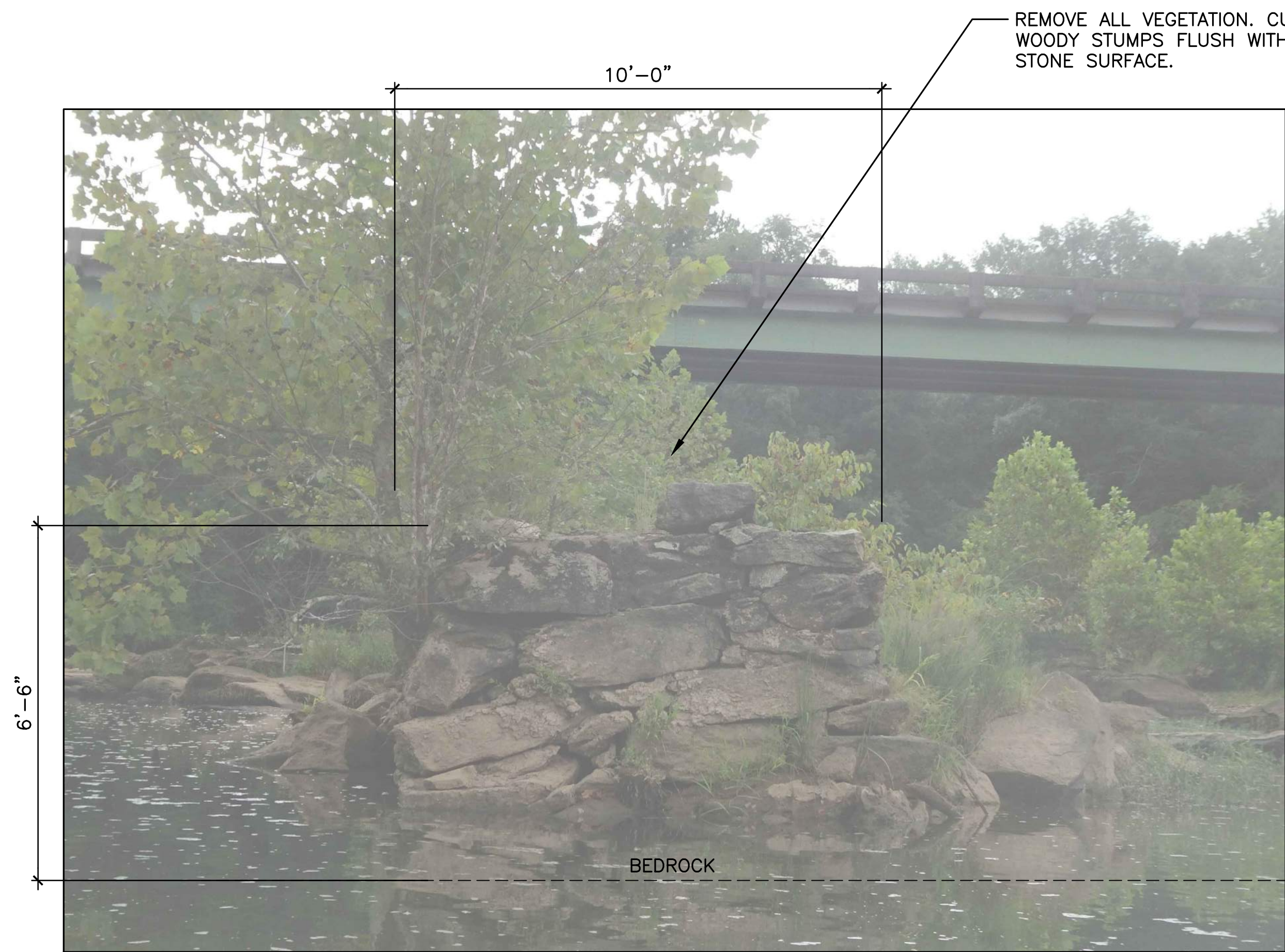


2
A7 PIER 4 - NORTH ELEVATION

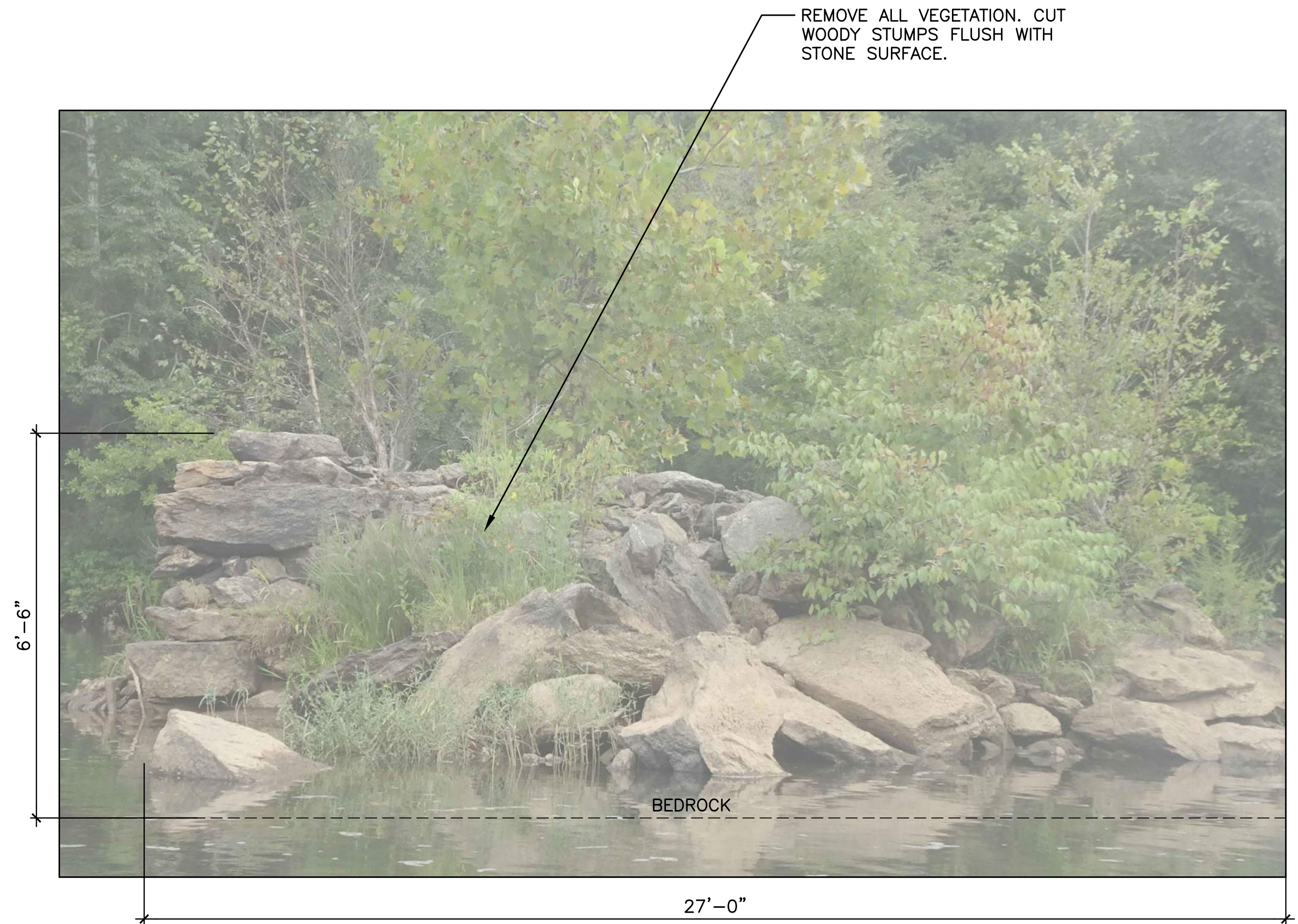
NOT FOR CONSTRUCTION

DESIGNED: DS KMI	SUB SHEET NO. A7	TITLE OF SHEET PIER 4 NORTH AND EAST ELEVATIONS Horseshoe Bend National Military Park Tallapoosa County, Alabama	DRAWING NO. _____
DRAWN: TC ERP			PMIS/PKG NO. _____
TECH. REVIEW: LE			SHEET 10 OF 12
DATE: 20 MAR. 2019			

12/4/2018 - AUTOCAD 2014 - A8 PIER 4 S-W.dwg XREFS: XG-22x34.dwg, XA-ELEV.dwg



1
A8 PIER 4 - WEST (DOWNSTREAM) ELEVATION

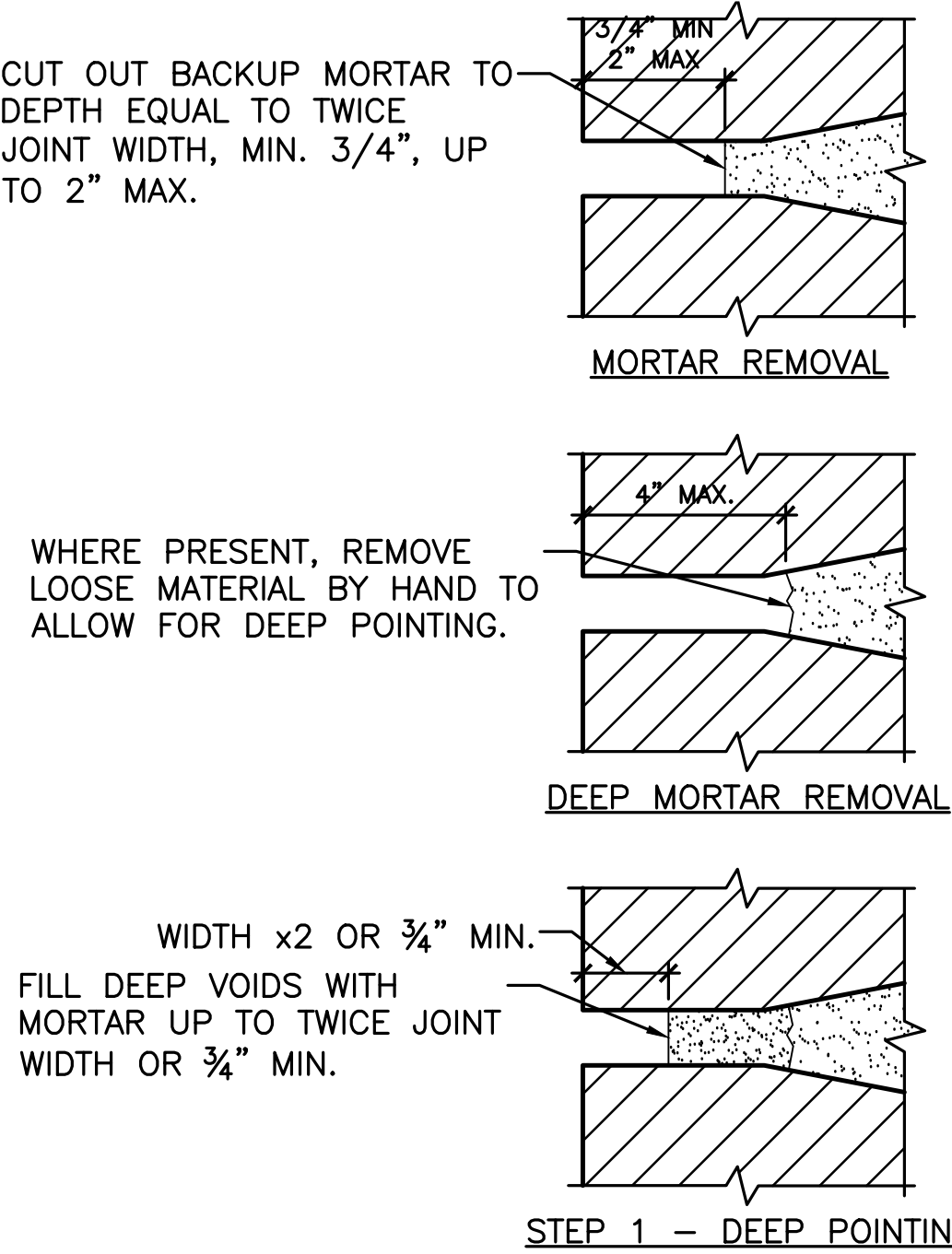


2
A8 PIER 4 - SOUTH ELEVATION

NOT FOR CONSTRUCTION

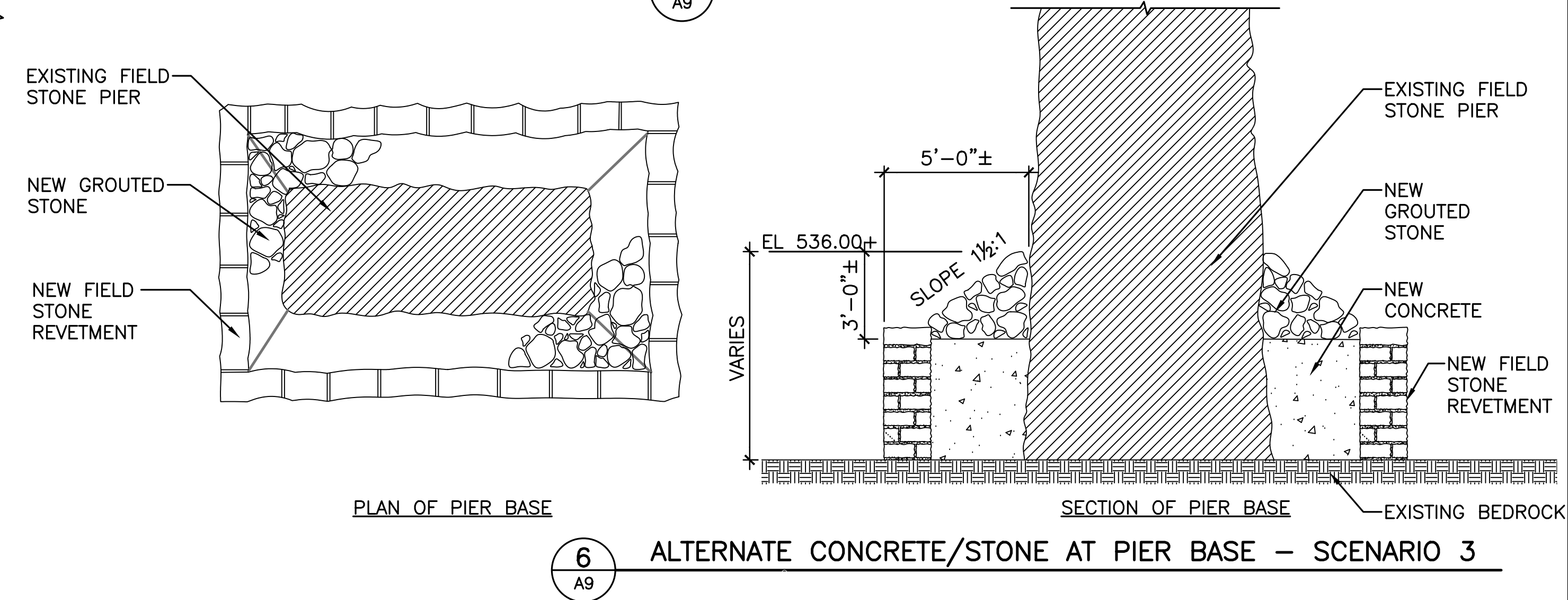
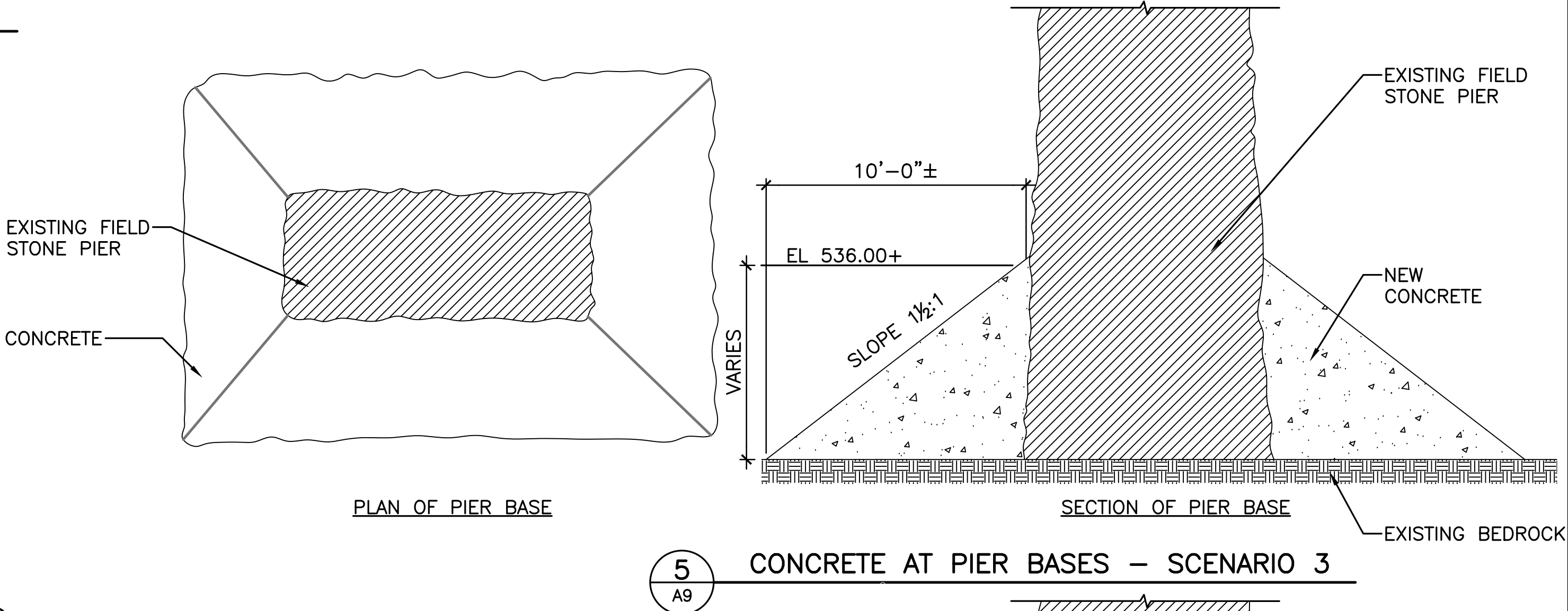
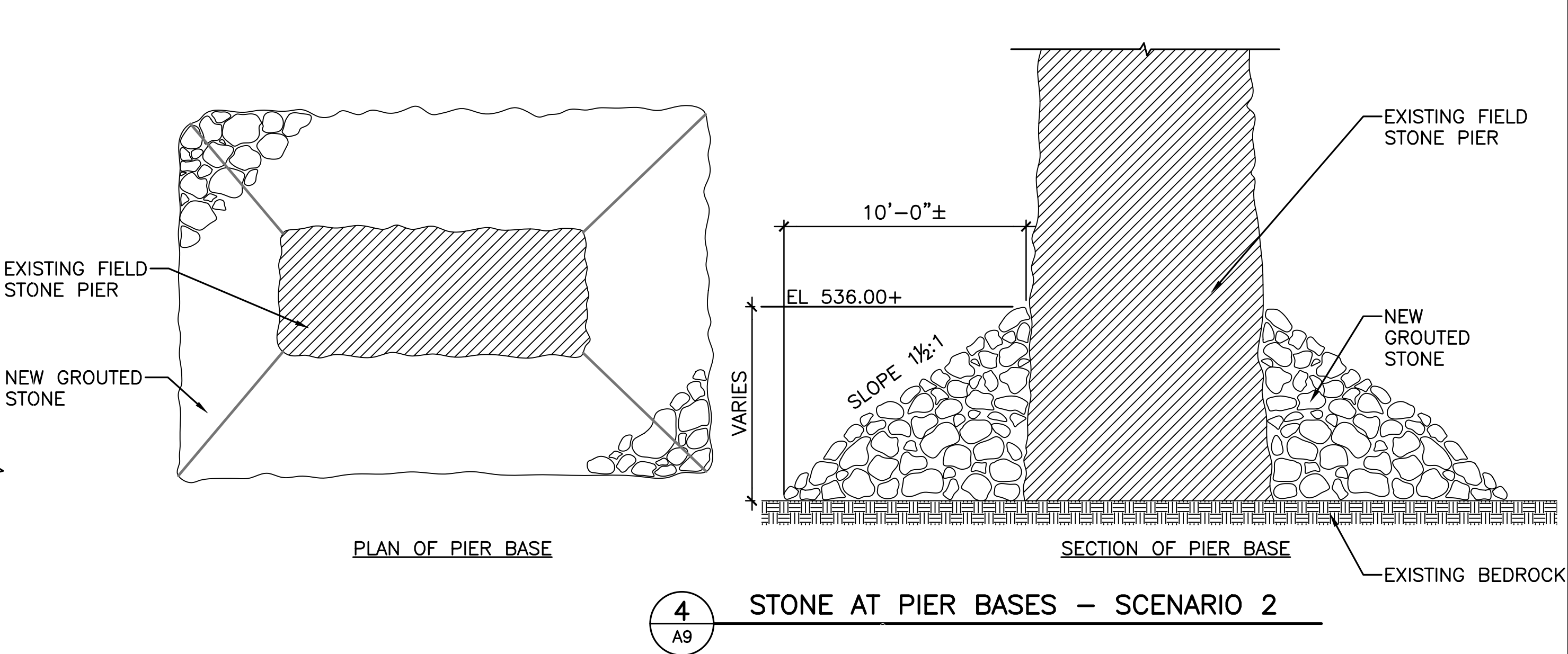
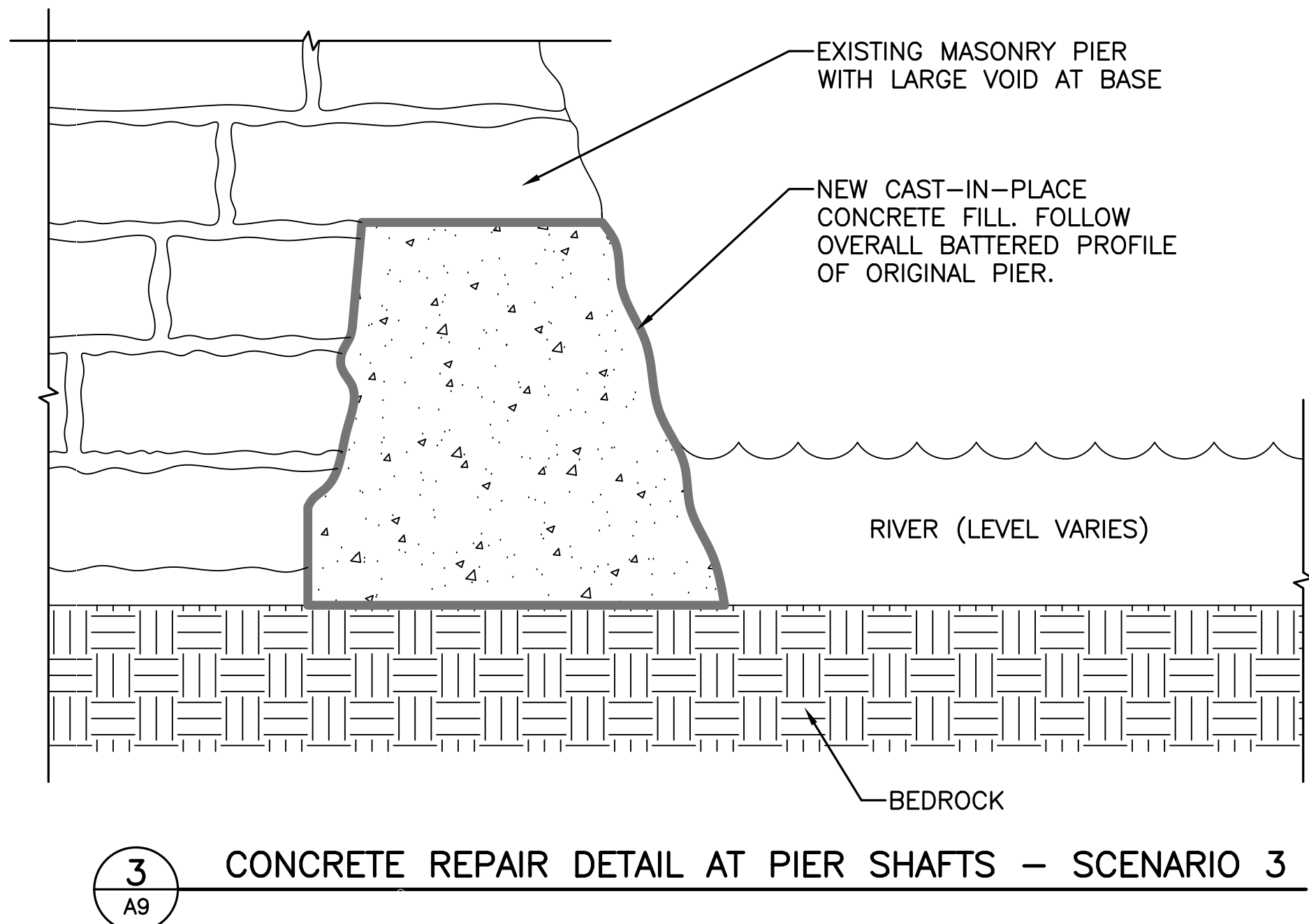
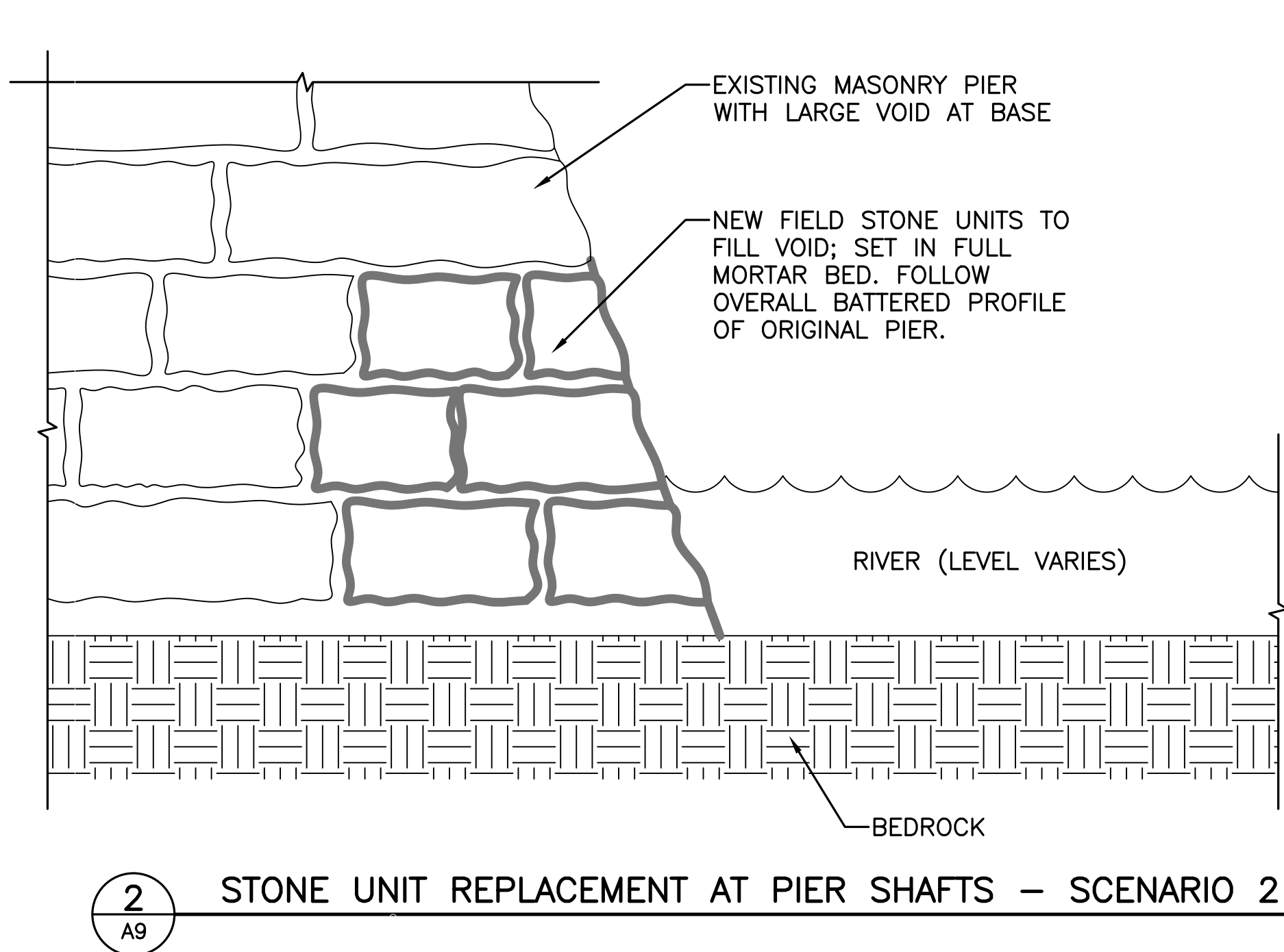
DESIGNED: DS KMI	SUB SHEET NO. A8	TITLE OF SHEET PIER 4 SOUTH AND WEST ELEVATIONS Horseshoe Bend National Military Park Tallapoosa County, Alabama	DRAWING NO. _____
DRAWN: TC ERP			PMIS/PKG NO. _____
TECH. REVIEW: LE			SHEET 11 OF 12
DATE: 20 MAR. 2019			

12/5/2018 - AUTOCAD 2014 - A9 DETAILS.dwg - XREFS: XG-22x34.dwg, XA-ELEV.dwg



1
A9

JOINT REPOINTING



NOT FOR CONSTRUCTION

DESIGNED: DS KMI	SUB SHEET NO. A9	TITLE OF SHEET REPAIR DETAILS	DRAWING NO. _____
DRAWN: TC ERP			PMIS/PKG NO. _____
TECH. REVIEW: LE			SHEET 12 OF 12
DATE: 20 MAR. 2019		Horseshoe Bend National Military Park Tallapoosa County, Alabama	

APPENDIX C: CONCEPTUAL COST ESTIMATE

Horseshoe Bend National Military Park- Miller Bridge Piers**Conceptual Cost Estimates for Repair Scenarios**

March 20, 2019

Scenario 1 - All Piers

DESCRIPTION	UNIT PRICE	UNIT OF MEASURE	QUANTITY	COST
Remove all vegetation and cut woody stumps flush with stone surface at all piers	\$8	Sq Ft	4000	\$ 32,000
Construction mobilization and general conditions ¹	\$24,000	Per Project	1	\$ 24,000
Estimated Construction Cost			SUBTOTAL	\$ 56,000
Design and Development Fees (10%)				\$ 5,600
Profit and Overhead (10%)				\$ 5,600
Project Management Fees (10%)				\$ 5,600
Total Construction Cost				\$ 72,800
Construction Contingency (20%)				\$ 14,560
Total Project Budget - Scenario 1				\$ 87,360

Scenario 2 - All Piers (unless noted otherwise)

DESCRIPTION	UNIT PRICE	UNIT OF MEASURE	QUANTITY	COST
Remove all vegetation and cut woody stumps flush with stone surface at all piers	\$8	Sq Ft	4000	\$ 32,000
Repair cemenitious parging at top of Pier 1, 2, and 3	\$35	Sq Ft	450	\$ 15,750
Repoint all joints at Pier 1, 2, and 3	\$16	LF	4000	\$ 64,000
Install new stone units to match existing stone type and coursing at Pier 1, 2, and 3. At Pier 2, coursing to match stepped profile.	\$125	Sq Ft	110	\$ 13,750
Install stone set in grout at perimeter base of Pier 1, 2, and 3	\$175	Cu Ft	3000	\$ 525,000
Sound and reset units at Pier 3	\$125	Sq Ft	5	\$ 625
Construction mobilization and general conditions ²	\$130,000	Per Project	1	\$ 130,000
Estimated Construction Cost			SUBTOTAL	\$ 781,125
Design and Development Fees (10%)				\$ 78,113
Profit and Overhead (10%)				\$ 78,113
Project Management Fees (10%)				\$ 78,113
Total Construction Cost				\$ 1,015,463
Construction Contingency (20%)				\$ 203,093
Total Project Budget - Scenario 2				\$ 1,218,555

DESCRIPTION	UNIT PRICE	UNIT OF MEASURE	QUANTITY	COST
Scenario 3 - All Piers (unless noted otherwise)				
Remove all vegetation and cut woody stumps flush with stone surface at all piers	\$8	Sq Ft	4000	\$ 32,000
Repair cemenitious parging at top of Pier 1, 2, and 3	\$35	Sq Ft	450	\$ 15,750
Repoint all joints at Pier 1, 2, and 3	\$16	LF	4000	\$ 64,000
Install new stone units to match existing stone type at Pier 2. Coursing to match stepped profile.	\$125	Cu Ft	75	\$ 9,375
Install new cast-in-place concrete where stone units are missing at Pier 1 and 3	\$150	Cu Ft	35	\$ 5,250
Install concrete at perimeter base of Pier 1, 2, and 3	\$150	Cu Ft	3000	\$ 450,000
Sound and reset units at Pier 3	\$125	Sq Ft	5	\$ 625
Construction mobilization and general conditions ³	\$150,000	Per Project	1	\$ 150,000
Estimated Construction Cost			SUBTOTAL	\$ 727,000
Design and Development Fees (10%)				\$ 72,700
Profit and Overhead (10%)				\$ 72,700
Project Management Fees (10%)				\$ 72,700
Total Construction Cost				\$ 945,100
Construction Contingency (20%)				\$ 189,020
Total Project Budget - Scenario 3				\$ 1,134,120
<i>Notes</i> 1. Estimate includes boat for access and scaffolding for accessing elevations of Piers 1 and 3. 2. Estimate is 20 percent of cost of remaining repair items. It includes boat access to piers for performing work, scaffolding to access elevations, and localized barricades and sump systems to maintain the immediate area around Piers 1, 2, and 3 dry as part of work performed during low-water seasons or in coordination with upstream dam releases. Additional costs for mobilization and access would be assumed if cofferdams are used. 3. Estimate is 20 percent of cost of remaining repair items. It includes boat access to piers for performing work, scaffolding to access elevations, and either use of tremie concrete or localized barricades and sump system to maintain the immediate area around Piers 1, 2, and 3 dry. Additional costs for mobilization and access would be assumed if cofferdams are used.				