Appendix E - Contents

Evaluation Unit Summary Sheets
Phase 1A Cultural Resources Report

Project Summary Sheets

Chiques Creek Watershed Project

Evaluation Unit 1

Evaluation Unit Description

Evaluation Unit (EU) 1 is located along a fourth-order stream reach of Little Chiques Creek. The site is primarily agricultural and forested land. EU 1's stream reach has several well-formed meanders with accelerated erosion occurring on the outer banks, likely focused by gravel bars in the stream channel. EU 1's riparian corridor is relatively well established but of poor quality because it is perched on a considerable legacy sediment terrace. EU 1's wetlands are relatively low quality and dominated by invasive species such as garlic mustard, multiflora rose, and reed canary grass. EU 1 is immediately upstream of EU 2, and EUs 1 and 2 would be best treated as a single project.

- Average eroded bank height: 5.0 ft
- Average legacy sediment depth: 4.9 ft
- Approximate legacy sediment volume: 63,000 CY
- Stream length: 2,530 ft
- Approximate 2-year storm event flow: 2,130 cfs
- Approximate 10-year storm event flow: 5,640 cfs

Non-Viable Alternatives

The reasons the following treatment alternatives are non-viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
    - Stream system is in relatively poor health
    - Significant stream bank erosion
    - Significant legacy sediment accumulation
    - Wetlands are in poor health and dominated by invasive species
    - PNDI report did not show any threatened/endangered species on site to prevent implementing a different treatment alternative
    - No previously completed restoration projects on site improving stream health
    - Riparian buffer is perched on a significant legacy sediment terrace and disconnected from historic floodplain
2. **Reforest/install riparian buffer**
    - Riparian buffer is perched on a significant legacy sediment terrace with no existing opportunity to reconnect to groundwater flows
3. **Stabilize legacy sediment in place**
    - Fourth-order stream velocities and lack of groundwater connection could create challenges to establishing bioengineering stabilization techniques
    - Structural stabilization practices are likely necessary because of above bullet point and could potentially further degrade the quality of existing aquatic habitat and contribute to erosion in other areas of the stream
    - Stream bank erosion is not localized, indicating bank erosion is due to a different issue, likely the considerable legacy sediment volume

Viable Alternatives

The reasons the following treatment alternative is viable, as informed by the EU visit, is summarized below.

1. **Remove legacy sediment & site restoration**
    - Significant legacy sediment accumulation
    - Lindside silt loam hydric soils mapped along both sides of the stream could be exposed once legacy sediment is removed and suggest that the riparian corridor could be amenable to vegetation growth
    - Overall poor habitat quality throughout the site's floodplain that could be improved by removing legacy sediment and establishing a connection to historic floodplain
    - Stream banks can be accessed from Meadow View Road for construction

Figure 1: EU 1 overview

Figure 2: Typical section of stream at EU 1

Recommended Alternative – Remove legacy sediment & site restoration

Legacy sediment removal (LSR) at EU 1 would allow the stream to be reconnected to the historic floodplain, while reducing channel velocity and preventing future bank erosion. Up to 63,000 CY of sediment at EU 1 could be removed from Chiques Creek Watershed's floodplain. LSR would create a non-eroded and stable stream bank with a channel to accommodate a low flow storm event. Flows that exceed the stream channel capacity would enter the floodplain, minimizing the kinetic energy within the channel. Following site restoration, LSR would improve riparian buffer and wetland health by exposing hydric soils and reconnecting these areas to groundwater flows.

Chiques Creek Watershed Project

Evaluation Unit 2

Evaluation Unit Description

Evaluation Unit (EU) 2 is located along a fourth-order stream reach of Little Chiques Creek. The site is primarily agricultural and forested land. EU 2's riparian corridor is relatively well established but of poor quality because it is perched on a considerable legacy sediment terrace. EU 2's wetlands are relatively low quality and dominated by invasive species such as garlic mustard, multiflora rose, bamboo, and reed canary grass. There are existing gabion baskets along the bottom of the stream bank and young canopy tree plantings in the riparian corridor. EU 2 is immediately downstream of EU 1, and EUs 1 and 2 would be best treated as a single project.

- Average eroded bank height: 6.0 ft
- Average legacy sediment depth: 5.5 ft
- Approximate legacy sediment volume: 65,000 CY
- Stream length: 1,110 ft
- Approximate 2-year storm event flow: 2,130 cfs
- Approximate 10-year storm event flow: 5,640 cfs

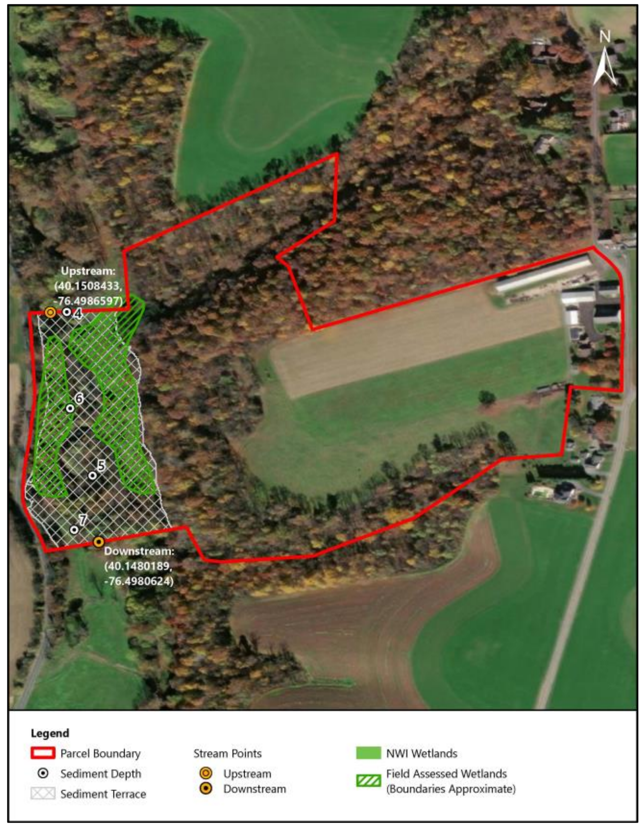

Figure 1: EU 2 overview

Figure 2: Typical section of stream at EU 2

Non-Viable Alternatives

The reasons the following treatment alternatives are non-viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
   - Stream system is in relatively poor health
   - Significant stream bank erosion
   - Significant legacy sediment accumulation
   - Wetlands are in poor health and dominated by invasive species
   - PNDI report did not show any threatened/endangered species on site to prevent implementing a different treatment alternative
   - Existing restoration projects on site (gabion baskets, canopy tree plantings) are ineffective at mitigating sediment load in Chiques Creek Watershed
   - Riparian buffer is perched on a significant legacy sediment terrace and disconnected from historic floodplain
2. **Reforest/install riparian buffer**
   - Riparian buffer is perched on a significant legacy sediment terrace with no existing opportunity to reconnect to groundwater flows
3. **Stabilize legacy sediment in place**
   - Fourth-order stream velocities and lack of groundwater connection could create challenges to establishing bioengineering stabilization techniques
   - Structural stabilization practices are likely necessary because of above bullet point and could potentially further degrade the quality of existing aquatic habitat and contribute to erosion in other areas of the stream
   - Stream bank erosion is not localized, indicating bank erosion is due to a different issue, likely the considerable legacy sediment volume

Viable Alternatives

The reasons the following treatment alternatives are viable, as informed by the EU visit, are summarized below.

1. **Remove legacy sediment & site restoration**
   - Significant legacy sediment accumulation
   - Lindside silt loam hydric soils mapped along both sides of the stream could be exposed once legacy sediment is removed and suggest that the riparian corridor could be amenable to vegetation growth
   - Overall poor habitat quality throughout the site's floodplain that could be improved by removing legacy sediment and establishing a connection to historic floodplain
   - Stream banks can be accessed from Meadow View Road for construction

Recommended Alternative – Remove legacy sediment & site restoration

Legacy sediment removal (LSR) at EU 2 would allow the stream to be reconnected to the historic floodplain, while reducing channel velocity and preventing future bank erosion. Up to 65,000 CY of sediment at EU 2 could be removed from Chiques Creek Watershed's floodplain. LSR would create a non-eroded and stable stream bank with a channel to accommodate a low flow storm event. Flows that exceed the stream channel capacity would enter the floodplain, minimizing the kinetic energy within the channel. Following site restoration, LSR would improve riparian buffer and wetland health by exposing hydric soils and reconnecting these areas to groundwater flows.

Chiques Creek Watershed Project

Evaluation Unit 3

Evaluation Unit Description

Evaluation Unit (EU) 3 is located along a third-order stream reach of Brubaker Run. The site is primarily agricultural land, and there are several areas where drainage from the pasture flows unobstructed into Brubaker Run. Livestock can access the stream at EU 3, which could be contributing to stream bank erosion. EU 3's stream reach is relatively straight with some small meanders. EU 3's riparian corridor is significantly lacking and perched on a considerable legacy sediment terrace. EU 3's wetlands are low quality, primarily composed of pasture, and dominated by invasive species such as poison hemlock, reed canary grass, multiflora rose, and common cocklebur.

- Average eroded bank height: 4.0 ft
- Average legacy sediment depth: 4.6 ft
- Approximate legacy sediment volume: 40,000 CY
- Stream length: 3,810 ft
- Approximate 2-year storm event flow: 280 cfs
- Approximate 10-year storm event flow: 720 cfs

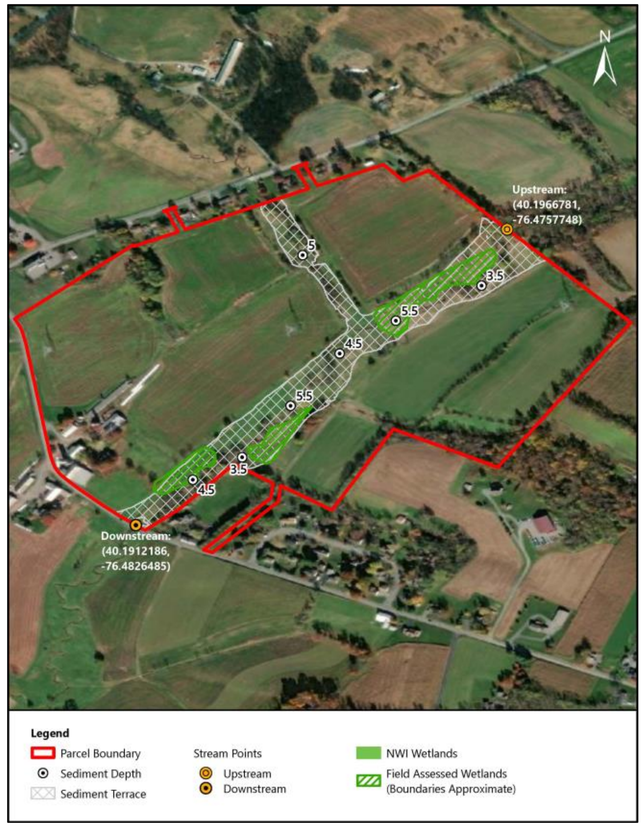

Figure 1: EU 3 overview

Non-Viable Alternatives

The reasons the following treatment alternative is non-viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
   - Stream system is in relatively poor health
   - Moderate stream bank erosion
   - Significant legacy sediment accumulation
   - Wetlands are in poor health, primarily composed of pasture, and dominated by invasive species
   - PNDI report did not show any threatened/endangered species on site to prevent implementing a different treatment alternative
   - No previously completed restoration projects on site improving stream health
   - Riparian buffer is perched on a significant legacy sediment terrace and disconnected from historic floodplain
2. **Stabilize legacy sediment in place**
   - Third-order stream velocities and lack of groundwater connection could create challenges to establishing bioengineering stabilization techniques
   - Structural stabilization practices are likely necessary because of above bullet point and could potentially further degrade the quality of existing aquatic habitat and contribute to erosion in other areas of the stream
   - Stream bank erosion is not localized, indicating bank erosion is due to a different issue, likely the considerable legacy sediment volume

Figure 2: Typical section of stream at EU 3

Viable Alternatives

The reasons the following treatment alternatives are viable, as informed by the EU visit, are summarized below.

1. **Remove legacy sediment & site restoration**
   - Significant legacy sediment accumulation
   - Rowland silt loam hydric soils mapped along both sides of the stream could be exposed once legacy sediment is removed and suggest that the riparian corridor could be amenable to vegetation growth
   - Overall poor habitat quality throughout the site's floodplain that could be improved by removing legacy sediment and establishing a connection to historic floodplain
   - Stream banks can be accessed from Elizabethtown Road for construction
2. **Reforest/install riparian buffer**
   - Riparian buffer is primarily composed of pasture and not forested
   - Riparian buffer could be reconnected to groundwater flows once legacy sediment is removed

Recommended Alternative – Remove legacy sediment & site restoration, reforest/install riparian buffer

Legacy sediment removal (LSR) at EU 3 would allow the stream to be reconnected to the historic floodplain, while reducing channel velocity and preventing future bank erosion. Up to 40,000 CY of sediment at EU 3 could be removed from Chiques Creek Watershed's floodplain. LSR would create a non-eroded and stable stream bank with a channel to accommodate a low flow storm event. Flows that exceed the stream channel capacity would enter the floodplain, minimizing the kinetic energy within the channel. LSR would expose hydric soils and create groundwater connection opportunities in the riparian corridor. Creating a riparian buffer after LSR at EU 3 would help stabilize the stream banks by anchoring the soil along the stream banks with the riparian buffer's root system and reduce the risk of bank slumping or collapse. The pasture drainage could indicate groundwater outflows, and vegetating those areas provides another floodplain reconnection opportunity. The pasture drainage areas also provide opportunities to establish a slightly different vegetation community, such as hydrophytic species, from the rest of the riparian area. Installing a fence around the new riparian buffer would prevent stream bank erosion from livestock.

Chiques Creek Watershed Project

Evaluation Unit 4

Evaluation Unit Description

Evaluation Unit (EU) 4 is located along a fifth-order stream reach of Little Chiques Creek. The site is primarily agricultural land. EU 4's stream reach has a large meander that follows the eastern edge of the boundary with accelerated erosion on the outer bank, likely focused by gravel bars in the stream channel. EU 4's riparian corridor is relatively well established, especially along the inside bank of the meander bend, but of poor quality because it is perched on a considerable legacy sediment terrace. EU 4's wetlands are relatively low quality and dominated by invasive species such as garlic mustard.

- Average eroded bank height: 6.0 ft
- Average legacy sediment depth: 5.7 ft
- Approximate legacy sediment volume: 43,000 CY
- Stream length: 2,480 ft
- Approximate 2-year storm event flow: 2,650 cfs
- Approximate 10-year storm event flow: 7,290 cfs

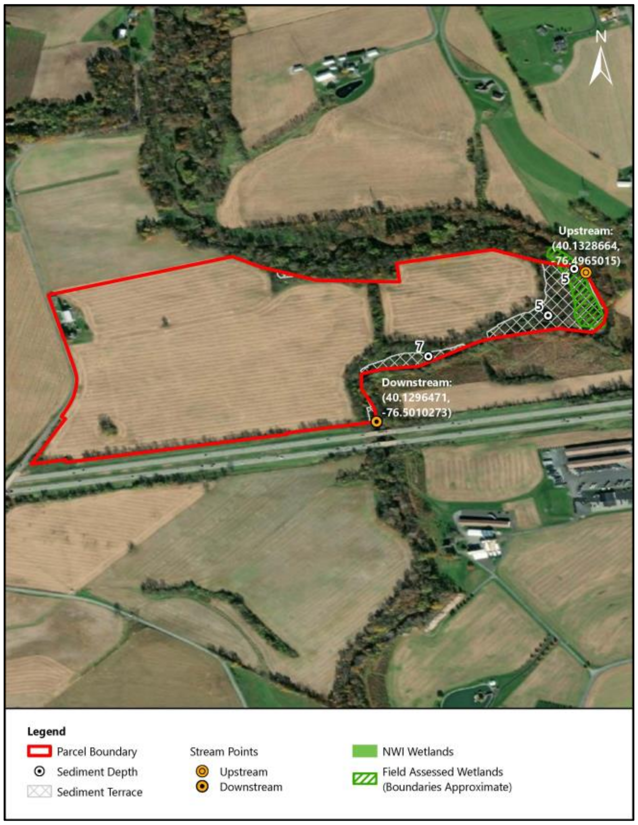

Figure 1: EU 4 overview

Figure 2: Typical section of stream at EU 4

Non-Viable Alternatives

The reasons the following treatment alternatives are non-viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
    - Stream system is in relatively poor health
    - Significant stream bank erosion
    - Significant legacy sediment accumulation
    - Wetlands are in poor health and dominated by invasive species
    - PNDI report did not show any threatened/endangered species on site to prevent implementing a different treatment alternative
    - No previously completed restoration projects on site improving stream health
    - Riparian buffer is perched on a significant legacy sediment terrace and disconnected from historic floodplain
2. **Reforest/install riparian buffer**
    - Small discontinuous area of Duffield silt loam hydric soils along stream bank and non-hydric Hagerstown silt loam in riparian buffer are not amenable to vegetation growth
    - Riparian buffer is perched on a significant legacy sediment terrace with no existing opportunity to reconnect to groundwater flows
3. **Stabilize legacy sediment in place**
    - Fifth-order stream velocities and lack of groundwater connection could create challenges to establishing bioengineering stabilization techniques
    - Structural stabilization practices are likely necessary because of above bullet point and could potentially further degrade the quality of existing aquatic habitat and contribute to erosion in other areas of the stream
    - Stream bank erosion is not localized, indicating bank erosion is due to a different issue, likely the considerable legacy sediment volume

Viable Alternatives

The reasons the following treatment alternatives are viable, as informed by the EU visit, are summarized below.

1. **Remove legacy sediment & site restoration**
    - Significant legacy sediment accumulation
    - Duffield silt loam hydric soils could be exposed and reconnected to the stream channel once legacy sediment is removed and suggest that the riparian corridor could be amenable to vegetation growth
    - Hagerstown silt loam non-hydric soil could provide an opportunity for a gradual transition from non-hydric to hydric soils once legacy sediment is removed
    - Overall poor habitat quality throughout the site's floodplain that could be improved by removing legacy sediment and establishing a connection to historic floodplain
    - Stream banks can be accessed from I-283 for construction

Recommended Alternative – Remove legacy sediment & site restoration

Legacy sediment removal (LSR) of the legacy sediment terrace, which is primarily located at the inner bank of the downstream meander at EU 4, would allow the stream to be reconnected to the historic floodplain, while reducing channel velocity and preventing future bank erosion. Up to 43,000 CY of sediment at EU 4 could be removed from Chiques Creek Watershed's floodplain. LSR would create a non-eroded and stable stream bank with a channel to accommodate a low flow storm event. Flows that exceed the stream channel capacity would enter the floodplain, minimizing the kinetic energy within the channel. Following site restoration, LSR would improve riparian buffer and wetland health by exposing hydric soils and reconnecting these areas to groundwater flows.

Chiques Creek Watershed Project

Evaluation Unit 5

Evaluation Unit Description

Evaluation Unit (EU) 5 is located along a third-order stream reach of Shells Run. The site is primarily agricultural land, and there are several areas where drainage from pasture flows unobstructed into Shells Run. Livestock can access the stream at EU 5, which could be contributing to stream bank erosion. EU 5's stream reach is relatively straight and not meandering. EU 5's riparian corridor is significantly lacking and perched on a considerable legacy sediment terrace. EU 5's wetlands are low quality, primarily composed of pasture, and dominated by invasive species such as poison hemlock and multiflora rose. EU 5 is closely downstream of EU 8, and EUs 5 and 8 would be best treated as a single project.

- Average eroded bank height: 4.0 ft
- Average legacy sediment depth: 3.6 ft
- Approximate legacy sediment volume: 27,000 CY
- Stream length: 1,720 ft
- Approximate 2-year storm event flow: 720 cfs
- Approximate 10-year storm event flow: 1,720 cfs

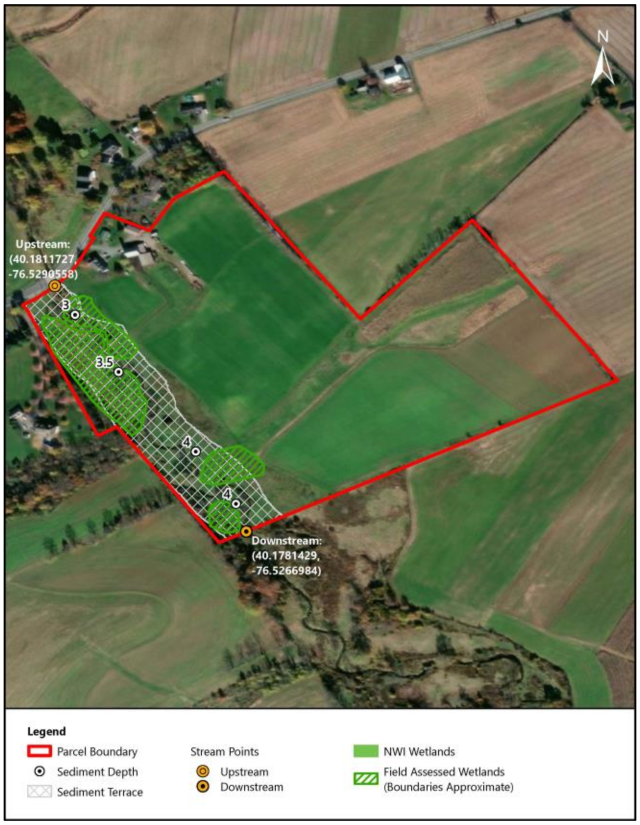

Figure 1: EU 5 overview

Figure 2: Typical section of stream at EU 5

Non-Viable Alternatives

The reasons the following treatment alternative is non-viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
    - Stream system is in relatively poor health
    - Moderate stream bank erosion
    - Moderate legacy sediment accumulation
    - Wetlands are in poor health, primarily composed of pasture, and dominated by invasive species
    - PNDI report did not show any threatened/endangered species on site to prevent implementing a different treatment alternative
    - No previously completed restoration projects on site improving stream health
    - Riparian buffer is perched on a significant legacy sediment terrace and disconnected from historic floodplain
2. **Stabilize legacy sediment in place**
    - Third-order stream velocities and lack of groundwater connection could create challenges to establishing bioengineering stabilization techniques
    - Structural stabilization practices are likely necessary because of above bullet point and could potentially further degrade the quality of existing aquatic habitat and contribute to erosion in other areas of the stream
    - Stream bank erosion is not localized, indicating bank erosion is due to a different issue, likely the considerable legacy sediment volume

Viable Alternatives

The reasons the following treatment alternatives are viable, as informed by the EU visit, are summarized below.

1. **Remove legacy sediment & site restoration**
    - Moderate legacy sediment accumulation
    - Rowland silt loam hydric soils mapped along both sides of the stream could be exposed once legacy sediment is removed and suggest that the riparian corridor could be amenable to vegetation growth
    - Overall poor habitat quality throughout the site's floodplain that could be improved by removing legacy sediment and establishing a connection to historic floodplain
    - Stream banks can be accessed from Rife Run Road or W Hernley Road for construction
2. **Reforest/install riparian buffer**
    - Riparian buffer is primarily composed of pasture and not forested
    - Riparian buffer could be reconnected to groundwater flows once legacy sediment is removed

Recommended Alternative – Remove legacy sediment & site restoration, reforest/install riparian buffer

Legacy sediment removal (LSR) at EU 5 would allow the stream to be reconnected to the historic floodplain, while reducing channel velocity and preventing future bank erosion. Up to 27,000 CY of sediment at EU 5 could be removed from Chiques Creek Watershed's floodplain. LSR would create a non-eroded and stable stream bank with a channel to accommodate a low flow storm event. Flows that exceed the stream channel capacity would enter the floodplain, minimizing the kinetic energy within the channel. LSR would expose hydric soils and create groundwater connection opportunities in the riparian corridor. Creating a riparian buffer after LSR at EU 5 would help stabilize the stream banks by anchoring the soil along the stream banks with the riparian buffer's root system and reduce the risk of bank slumping or collapse. The pasture drainage could indicate groundwater outflows, and vegetating those areas provides another floodplain reconnection opportunity. The pasture drainage areas also provide opportunities to establish a slightly different vegetation community, such as hydrophytic species, from the rest of the riparian area. Installing a fence around the new riparian buffer would prevent stream bank erosion from livestock.

Chiques Creek Watershed Project

Evaluation Unit 6

Evaluation Unit Description

Evaluation Unit (EU) 6 is located along a second-order stream reach of Rife Run. The site is primarily agricultural land. EU 6's stream reach is meandering, and bank erosion is generally localized to sharp meanders where tree fall has occurred. EU 6's riparian corridor and wetlands are in good condition because of a seemingly high groundwater table, although there are some monotypic pockets of invasive species in the wetlands such as reed canary grass and multiflora rose.

- Average eroded bank height: 2.0 ft
- Average legacy sediment depth: 2.2 ft
- Approximate legacy sediment volume: 19,000 CY
- Stream length: 2,540 ft
- Approximate 2-year storm event flow: 250 cfs
- Approximate 10-year storm event flow: 630 cfs

Figure 1: EU 6 overview

Figure 2: Typical section of stream at EU 6

Non-Viable Alternatives

The reasons the following treatment alternatives are non-viable, as informed by the EU visit, are summarized below.

1. **Remove legacy sediment & site restoration**
   - Minimal legacy sediment accumulation
   - Overall good habitat quality throughout the site's floodplain
   - Stream banks can only be accessed through property, which could present construction access issues
2. **Reforest/install riparian buffer**
   - Riparian buffer is already connected to groundwater flows and historic floodplain
   - Riparian buffer is well established
3. **Stabilize legacy sediment in place**
   - Third-order stream velocities and lack of groundwater connection could create challenges to establishing bioengineering stabilization techniques
   - Structural stabilization practices are likely necessary because of above bullet point and could potentially further degrade the quality of existing aquatic habitat and contribute to erosion in other areas of the stream
   - Stream bank erosion is not localized, indicating bank erosion is due to a different issue, likely the considerable legacy sediment volume

Viable Alternatives

The reasons the following treatment alternative is viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
   - Stream system is in good health
   - Low stream bank erosion
   - Minimal legacy sediment accumulation
   - Wetlands are in good health and invasive species are limited to monotypic pockets
   - Rowland and Bowmansville silt loam hydric soils mapped along both sides of the stream appear to be exposed and suggest that the riparian corridor is amenable to vegetation growth
   - PNDI report showed threatened/endangered species may be present on site, which could affect implementing a different treatment alternative
   - Riparian buffer is connected to groundwater flows and historic floodplain
   - Stream banks can only be accessed through property, which could present construction access issues if implementing a different treatment alternative

Recommended Alternative – Do nothing

Overall, EU 6 is a good example of a healthy stream system in the Chiques Creek Watershed. There is minimal stream bank erosion, a high groundwater table, and minimal legacy sediment accumulation, allowing the stream to be well connected to the historic floodplain. The riparian corridor and wetlands are well established and connected to groundwater flows. There is some active erosion at sharp meanders in Site 6's stream reach, but these appear to be contributing a relatively minimal amount of sediment to the Chiques Creek Watershed and are caused by tree fall, which is a natural part of a stream system. At EU 6, implementing any other treatment alternative and altering the existing stream system would likely cause more negative effects than benefits.

Chiques Creek Watershed Project

Evaluation Unit 7

Evaluation Unit Description

Evaluation Unit (EU) 7 is located along a second-order stream reach of Doe Run. The site is an agrotourism operation and primarily agricultural land, and there are several areas where drainage from the pasture flows unobstructed into Doe Run. EU 7's stream reach has several well-formed meanders. EU 7's riparian corridor is significantly lacking with some young canopy tree plantings but not much undergrowth. EU 7's emergent marsh wetlands are relatively low quality and dominated by invasive species, while the forested wetlands are also relatively low quality but have fewer invasive species. The parent material at EU 7 is present at relatively shallow depths, perching the groundwater table and limiting the legacy sediment depth.

- Average eroded bank height: 3.0 ft
- Average legacy sediment depth: 2.3 ft
- Approximate legacy sediment volume: 17,000 CY
- Stream length: 2,900 ft
- Approximate 2-year storm event flow: 90 cfs
- Approximate 10-year storm event flow: 240 cfs

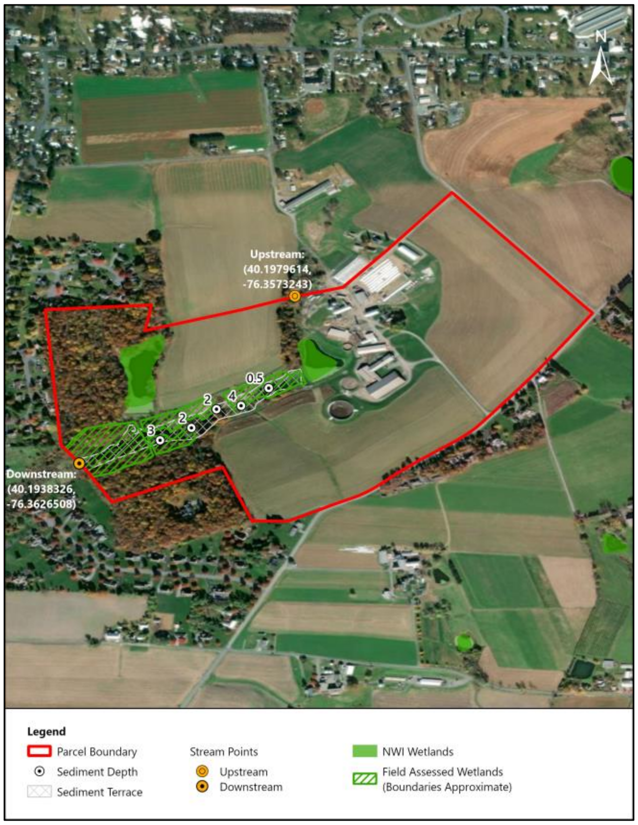

Figure 1: EU 7 overview

Non-Viable Alternatives

The reasons the following treatment alternatives are non-viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
   - Wetlands are in poor health and dominated by invasive species
   - PNDI report did not show any threatened/endangered species on site to prevent implementing a different treatment alternative
   - Existing restoration projects on site (canopy tree plantings) are ineffective at mitigating sediment load in Chiques Creek Watershed
   - Riparian buffer is significantly lacking and poorly established
2. **Remove legacy sediment & site restoration**
   - Minimal legacy sediment accumulation
   - Groundwater table appears to be high, limiting the legacy sediment depths
   - Stream banks can only be accessed through property, which could present construction access issues
3. **Stabilize legacy sediment in place**
   - Stream banks are minimally eroding and contributing insignificant sedimentation to the Chiques Creek Watershed

Figure 2: Typical section of stream at EU 7

Viable Alternatives

The reasons the following treatment alternative is viable, as informed by the EU visit, are summarized below.

1. **Reforest/install riparian buffer**
   - Riparian buffer is primarily composed of pasture and not forested
   - Rowland silt loam hydric soils mapped along both sides of the stream appear to be exposed and suggest that the riparian corridor is amenable to vegetation growth
   - Groundwater table appears to be high, providing an opportunity to establish a healthy riparian buffer with groundwater connections
   - Actively eroding stream banks could likely be stabilized by the root systems of a riparian buffer

Recommended Alternative – Reforest/install riparian buffer

Creating a riparian buffer at EU 7 would help stabilize the stream banks by anchoring the soil along the stream banks with the riparian buffer's root system, reducing the risk of bank slumping or collapse. There is minimal legacy accumulation at EU 7 and the groundwater table appears high, so it is likely that a riparian buffer would be well connected to groundwater flows and the historic floodplain. Rowland silt loam hydric soils mapped along both sides of the stream appear to be exposed and suggest that the riparian corridor is amenable to vegetation growth. The pasture drainage could indicate groundwater outflows, and vegetating those areas provides another floodplain reconnection opportunity. The pasture drainage areas also provide opportunities to establish a slightly different vegetation community, such as hydrophytic species, from the rest of the riparian area. Installing a fence around the new riparian buffer would prevent stream bank erosion from livestock. The existing wetlands would benefit from replacing the invasive species with native species, especially the emergent marsh areas on EU 7, by creating healthier habitats, providing erosion control, improving water quality, and bolstering nutrient cycling processes.

Chiques Creek Watershed Project

Evaluation Unit 8

Evaluation Unit Description

Evaluation Unit (EU) 8 is located along a third-order stream reach of Shells Run and is bisected by one of its second-order tributaries. The site is primarily agricultural land, and there are several areas where drainage from the agricultural land flows unobstructed into the tributary to Shells Run. EU 8's stream reaches have several well-formed meanders. EU 8's riparian corridor along Shells Run is relatively well established but of poor quality because it is perched on a considerable legacy sediment terrace. EU 8's riparian corridor along the tributary is significantly lacking and mostly an herbaceous layer kept short by grazing. EU 8's wetlands are relatively low quality and dominated by invasive species such as multiflora rose and reed canary grass. EU 8 is closely upstream of EU 5, and EUs 5 and 8 would be best treated as a single project.

- Average eroded bank height: 5.0 ft (main reach), 2.0 ft (tributary)
- Average legacy sediment depth: 2.6 ft
- Approximate legacy sediment volume: 23,000 CY
- Stream length: 880 ft (main reach), 1,370 ft (tributary)
- Approximate 2-year storm event flow: 540 cfs
- Approximate 10-year storm event flow: 1,290 cfs

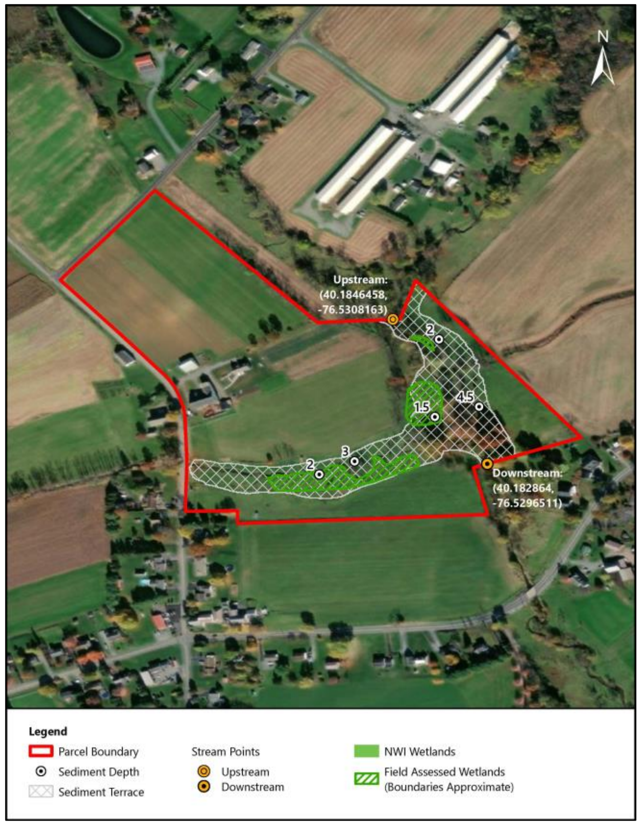

Figure 1: EU 8 overview

Figure 2: Typical section of main reach at EU 8

Non-Viable Alternatives

The reasons the following treatment alternative is non-viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
    - Stream system is in relatively poor health
    - Significant stream bank erosion in Shells Run
    - Significant legacy sediment accumulation along Shells Run
    - Wetlands are in poor health and dominated by invasive species
    - PNDI report did not show any threatened/endangered species on site to prevent implementing a different treatment alternative
    - No previously completed restoration projects on site improving stream health
    - Riparian buffer along Shells Run is perched on a significant legacy sediment terrace and disconnected from historic floodplain
    - Riparian buffer along tributary is significantly lacking and poorly established

Viable Alternatives

The reasons the following treatment alternatives are viable, as informed by the EU visit, are summarized below.

1. **Remove legacy sediment & site restoration**
    - Significant legacy sediment accumulation along Shells Run
    - Rowland silt loam hydric soils mapped along both sides of Shells Run could be exposed once legacy sediment is removed and suggest that the riparian corridor could be amenable to vegetation growth
    - Overall poor habitat quality throughout the site's floodplain that could be improved by removing legacy sediment and establishing a connection to historic floodplain
    - Stream banks can be accessed from Trail Road N or E Town Road for construction
2. **Reforest/install riparian buffer**
    - Riparian buffer along tributary is primarily composed of pasture and not forested
    - Rowland silt loam hydric soils mapped along both sides of the tributary appear to be exposed and suggest that the riparian corridor is amenable to vegetation growth
    - Groundwater table along tributary appears to be high, providing an opportunity to establish a healthy riparian buffer
    - Actively eroding tributary stream banks could likely be stabilized by the root systems of a riparian buffer
3. **Stabilize legacy sediment in place**
    - Stream banks are actively eroding along the tributary and contributing to sedimentation in the Chiques Creek Watershed
    - Expected stream velocity and depth in tributary are amenable to stream bank stabilization alternatives

Recommended Alternative – Remove legacy sediment & site restoration, reforest/install riparian buffer, stabilize legacy sediment in place

Legacy sediment removal (LSR) at EU 8 along Shells Run would allow Shells Run to be reconnected to the historic floodplain, while reducing channel velocity and preventing future bank erosion. Up to 15,000 CY of sediment at EU 8 could be removed from Chiques Creek Watershed's floodplain. LSR would create a non-eroded and stable stream bank with a channel to accommodate a low flow storm event in Shells Run. Flows that exceed the stream channel capacity would enter the floodplain, minimizing the kinetic energy within the channel. Following site restoration, LSR would improve riparian buffer and wetland health along Shells Run by exposing hydric soils and reconnecting these areas to groundwater flows. A riparian buffer along EU 8's tributary should be established. This would help stabilize the tributary's stream banks by anchoring the soil along the stream banks with the riparian buffer's root system and reduce the risk of bank slumping or collapse. The agricultural drainage could indicate groundwater outflows, and vegetating those areas provides another floodplain reconnection opportunity. The agricultural drainage areas also provide opportunities to establish a slightly different vegetation community, such as hydrophytic species, from the rest of the riparian area. Installing stream bank stabilization measures, such as armored slopes, tree revetments, brush mattresses, or vegetated geogrids, along the tributary could provide further stabilization, especially at areas where the stream bank erosion appears to be localized.

Chiques Creek Watershed Project

Evaluation Unit 9

Evaluation Unit Description

Evaluation Unit (EU) 9 is located along a fourth-order stream reach of Little Chiques Creek and is bisected by one of its second-order tributaries. The site is primarily maintained lawn, and there are several areas where drainage from the lawn flows unobstructed into the tributary to Little Chiques Creek. The tributary and upstream extent of Little Chiques Creek at EU 9 have several well-formed meanders, but the downstream extent of Little Chiques Creek at EU 9 is relatively straight. EU 9's riparian corridor along Little Chiques Creek is relatively well established but of poor quality because it is perched on a considerable legacy sediment terrace. EU 9's riparian corridor along the tributary is significantly lacking and maintained lawn up to the top of bank. EU 9's wetlands are relatively low quality and dominated by invasive species such as poison hemlock, Japanese honeysuckle, common chickweed, multiflora rose, and reed canary grass.

- Average eroded bank height: 7.0 ft (main reach), 3.0 ft (tributary)
- Average legacy sediment depth: 4.2 ft
- Approximate legacy sediment volume: 32,000 CY
- Stream length: 2,660 ft (main reach), 1,460 ft (tributary)
- Approximate 2-year storm event flow: 1,320 cfs
- Approximate 10-year storm event flow: 3,460 cfs

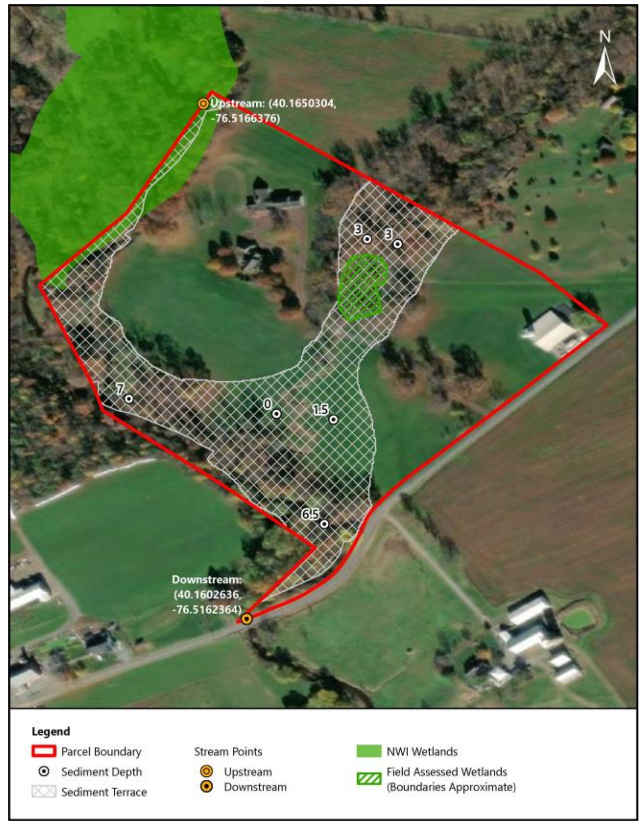

Figure 1: EU 9 overview

Figure 2: Typical section of main reach at EU 9

Non-Viable Alternatives

The reasons the following treatment alternative is non-viable, as informed by the EU visit, are summarized below.

1. **Do nothing**
   - Stream system is in relatively poor health
   - Significant stream bank erosion in Little Chiques Run
   - Significant legacy sediment accumulation along Little Chiques Creek
   - Wetlands are in poor health and dominated by invasive species
   - PNDI report did not show any threatened/endangered species on site to prevent implementing a different treatment alternative
   - No previously completed restoration projects on site improving stream health
   - Riparian buffer along Little Chiques Creek is perched on a significant legacy sediment terrace and disconnected from historic floodplain
   - Riparian buffer along tributary is significantly lacking and poorly established

Viable Alternatives

The reasons the following treatment alternatives are viable, as informed by the EU visit, are summarized below.

1. **Remove legacy sediment & site restoration**
   - Significant legacy sediment accumulation along Little Chiques Creek
   - Rowland silt loam hydric soils mapped along both sides of Little Chiques Creek could be exposed once legacy sediment is removed and suggest that the riparian corridor could be amenable to vegetation growth
   - Overall poor habitat quality throughout the site's floodplain that could be improved by removing legacy sediment and establishing a connection to historic floodplain
   - Stream banks can be accessed from Echo Valley Road for construction
2. **Reforest/install riparian buffer**
   - Riparian buffer along tributary is primarily composed of maintained lawn and not forested
   - Rowland silt loam hydric soils mapped along both sides of the tributary appear to be exposed and suggest that the riparian corridor is amenable to vegetation growth
   - Groundwater table along tributary appears to be high, providing an opportunity to establish a healthy riparian buffer
   - Actively eroding tributary stream banks could likely be stabilized by the root systems of a riparian buffer
3. **Stabilize legacy sediment in place**
   - Stream banks are actively eroding along the tributary and contributing to sedimentation in the Chiques Creek Watershed
   - Expected stream velocity and depth in tributary are amenable to stream bank stabilization alternatives

Recommended Alternative – Remove legacy sediment & site restoration, reforest/install riparian buffer, stabilize legacy sediment in place

Legacy sediment removal (LSR) at EU 9 along Little Chiques Creek would allow Little Chiques Creek to be reconnected to the historic floodplain, while reducing channel velocity and preventing future bank erosion. Up to 32,000 CY of sediment at EU 9 could be removed from Chiques Creek Watershed's floodplain. LSR would create a non-eroded and stable stream bank with a channel to accommodate a low flow storm event in Little Chiques Creek. Flows that exceed the stream channel capacity would enter the floodplain, minimizing the kinetic energy within the channel. Following site restoration, LSR would improve riparian buffer and wetland health by exposing hydric soils and reconnecting these areas to groundwater flows. A riparian buffer along EU 9's tributary should be established. This would help stabilize the tributary's stream banks by anchoring the soil along the stream banks with the riparian buffer's root system and reduce the risk of bank slumping or collapse. Revegetating areas where water is directly flowing from the maintained lawn to the tributary could both mitigate these flows and help foster healthier wetland habitats. Installing stream bank stabilization measures, such as armored slopes, tree revetments, brush mattresses, or vegetated geogrids, along the tributary could provide further stabilization, especially at areas where the stream bank erosion appears to be localized.

Chiques Creek Watershed Project

Evaluation Unit 10

Evaluation Unit Description

Evaluation Unit (EU) 10 is located along a second-order stream reach of a tributary to Brubaker Run. The site is primarily forested land. EU 10's stream reach is relatively straight along most of the site, suggesting that it was possibly channelized during the property development. EU 10's riparian corridor is moderately well established. EU 10 has a large emergent wetland spanning the right bank (looking downstream) of the stream reach that is connected to the historic floodplain but dominated by monotypic population of reed canary grass. EU 10 is steeply sloped from the property owner's driveway to the stream banks.

- Average eroded bank height: 3.0 ft
- Average legacy sediment depth: 1.8 ft
- Approximate legacy sediment volume: 13,000 CY
- Stream length: 2,520 ft
- Approximate 2-year storm event flow: 260 cfs
- Approximate 10-year storm event flow: 650 cfs

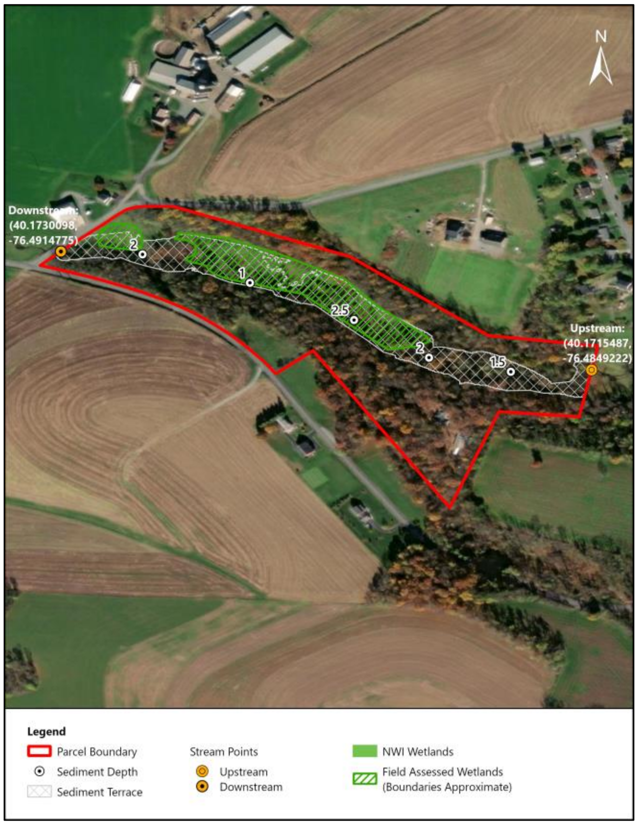

Figure 1: EU 10 overview

Non-Viable Alternatives

The reasons the following treatment alternatives are non-viable, as informed by the EU visit, are summarized below.

1. **Remove legacy sediment & site restoration**
   - Minimal legacy sediment accumulation
   - Groundwater table appears to be high
   - Site is steeply sloped down to stream banks, which could present construction access issues
2. **Stabilize legacy sediment in place**
   - Stream banks are minimally eroding and contributing insignificant sedimentation to the Chiques Creek Watershed

Viable Alternatives

The reasons the following treatment alternatives are viable, as informed by the EU visit, are summarized below.

1. **Reforest/install riparian buffer**
   - Rowland silt loam hydric soils mapped along both sides of the stream appear to be exposed and suggest that the riparian corridor is amenable to vegetation growth
   - Groundwater table appears to be high, providing an opportunity to establish a healthy riparian buffer
   - Actively eroding stream banks could likely be stabilized by the root systems of a more established riparian buffer
2. **Do nothing**
   - Low stream bank erosion
   - Minimal legacy sediment accumulation
   - Rowland silt loam hydric soils mapped along both sides of the stream appear to be exposed and suggest that the riparian corridor is amenable to vegetation growth
   - Riparian buffer and wetlands are connected to groundwater flows and historic floodplain
   - Wetlands are dominated by invasive species
   - Site is steeply sloped down to stream banks, which could present construction access issues if implementing a different treatment alternative

Figure 2: Typical section of stream at EU 10

Recommended Alternative – Reforest/install riparian buffer

Bolstering the existing riparian buffer at EU 10 would help stabilize the stream banks by anchoring the soil along the stream banks with the riparian buffer's root system and reduce the risk of bank slumping or collapse. Vegetating the riparian buffer with understory shrubs could help reduce sedimentation and provide flood control by absorbing and slowing down water. There is minimal legacy accumulation at EU 10 and the groundwater table appears high, so it is likely that a riparian buffer would be well connected to groundwater flows and the historic floodplain. Rowland silt loam hydric soils mapped along both sides of the stream appear to be exposed and suggest that the riparian corridor is amenable to vegetation growth. The existing wetlands would greatly benefit from replacing the invasive species with native species, especially the emergent wetland, by creating healthier habitats, providing erosion control, improving water quality, and bolstering nutrient cycling processes.

Phase 1A Cultural Resources Report

Phase IA Cultural Resources Assessment
Chiques Creek Watershed Project
Lancaster County, Pennsylvania

Prepared for:

USDA-Natural Resources Conservation Service
359 East Park Drive, Suite 2
Harrisburg, PA 17111

Prepared by:
WSP USA Inc.
Lauren Hayden, RPA
350 Mount Kemble Avenue, Suite 200
Morristown, New Jersey 07690

January 17, 2025

Phase IA Cultural Resources Assessment, Chiques Creek Watershed, Lancaster County, Pennsylvania

Final Report

WSP Project No.: 7526220010

Prepared by
Lauren Hayden

Approved by
Ghazoll Motlagh

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January 17, 2025

WSP USA, Inc.
350 Mount Kemble Avenue
Suite 200
Morristown, NJ 07690
Tel +1 502-267-0700

Management Summary

WSP USA Inc. (WSP) completed a Phase IA archaeological and architectural desktop review for the Chiques Creek Watershed Programmatic Environmental Assessment project (Project). The purpose of the Project is to identify and implement a programmatic approach to reducing the amount of nutrient-laden legacy sediment loads from the Chiques Creek Watershed entering the Chesapeake Bay.

The area of potential effects (APE) for this review included ten evaluation units (sites) located throughout the Chiques Creek Watershed. The ten sites range in size from 6.9 to 56.3 hectares (17 to 139 acres). The area within 1.6 kilometers (1 mile) buffer for each of the ten sites was identified as the study area.

The purpose of the Phase IA archaeological desktop review was to determine the extent to which the Project may affect archaeological and architectural cultural resources. The survey included a literature search and archaeological sensitivity assessment for each of the sites and associated study area. The Chiques Creek Watershed has approximately 36 previously identified pre-Contact archaeological sites. None of the pre-Contact archaeological sites are located within the APE; however, eleven of the Pre-Contact archaeological sites are located within the study area. The study area included 16 archaeological resources. Since all ten evaluation unit sites are near water sources and have well drained soils, the survey determined that those portions of the ten sites that are dry and level have moderate to high potential to contain pre-Contact archaeological resources.

Two previously identified architectural resources were recorded in the APE and an additional 47 resources were identified in the study area. Five District Resources were identified in the study area, but no District Resources were documented in the APE. Only the Risser's Mill Complex is recorded as an eligible District Resource located directly adjacent to the current proposed APE boundary.

The archival background research and cartographic review identified historic-period resources in Evaluation Sites 2, 3, 4, 5, 6, 7, and 8. The portions of these sites that are dry and level have moderate to high potential to contain historic-period archaeological resources.

It is recommended that additional archaeological investigation, such as a Phase IB archaeological survey, is warranted if there are to be any ground-disturbing activities to the areas classified as moderately and highly sensitive for archaeological resources.

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1.0 Introduction

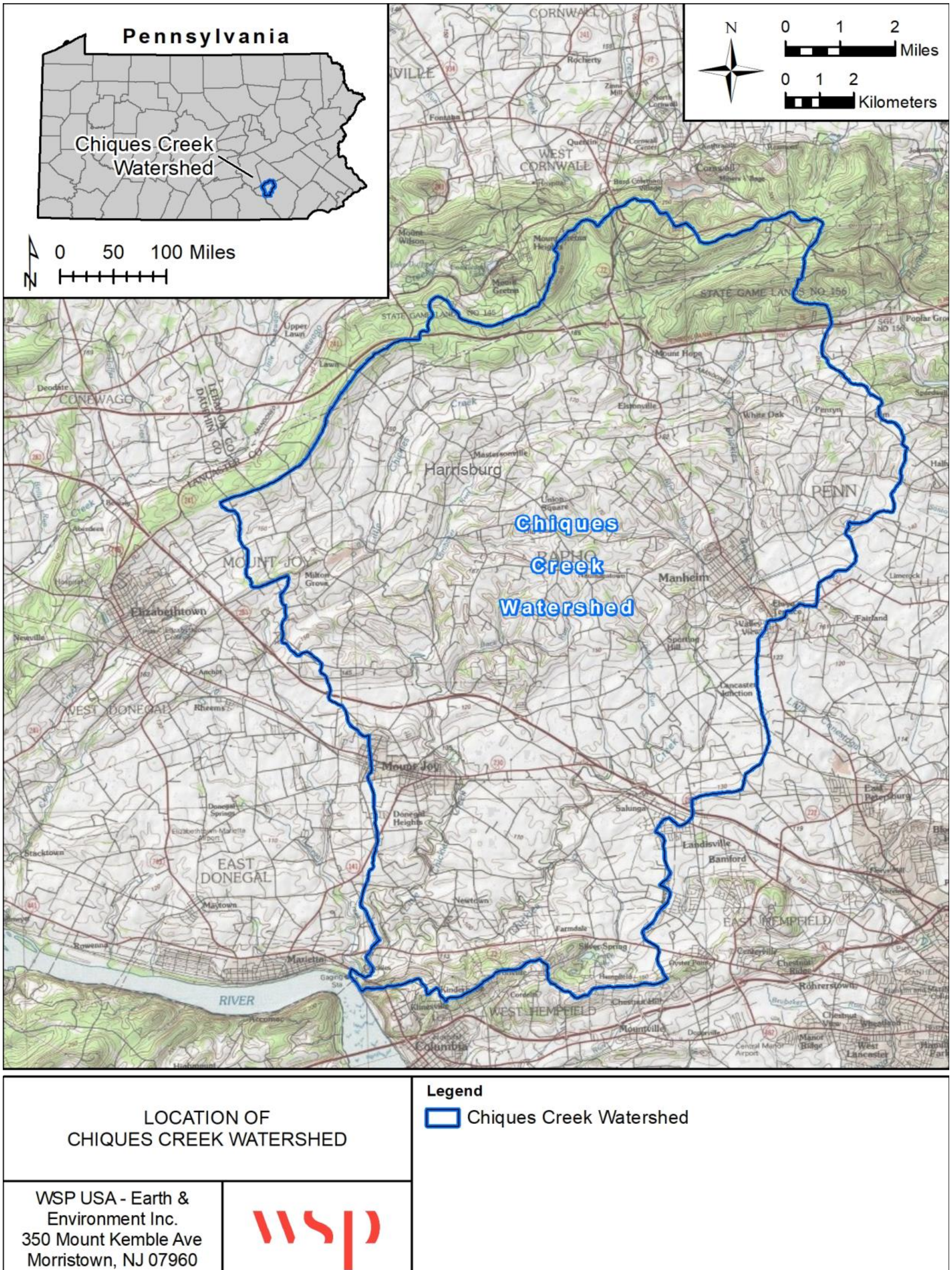
1.1 Description of Project

WSP USA Inc. (WSP) completed a Phase IA cultural resource assessment for the for the Chiques Creek Watershed Plan - Programmatic Environmental Assessment (Project). The purpose of the Project is to identify and implement a programmatic approach to reducing the amount of nutrient-laden legacy sediment loads from the Chiques Creek Watershed entering the Chesapeake Bay.

The Chiques Creek Watershed is a 110-square-mile basin located predominantly in Lancaster County, Pennsylvania. Chiques Creek is a tributary to the Susquehanna River, which is the largest freshwater input to the Chesapeake Bay (Figure 1). The Chiques Creek Watershed has been characterized by primarily agricultural land use, town and urban developments, and lack of forest cover. Historic mill dams throughout the watershed have disconnected the stream channel from the historic floodplain. In the Chiques Creek Watershed, sediment has collected behind these mill dams, burying the valley bottom of multi-channel stream systems, perching the alluvial terraces high above the base flow water elevation, and disconnecting the riparian corridor from groundwater flows. As a result, the Chiques Creek Watershed is stressed by siltation, streamflow alterations, excess suspended sediment, and nutrient enrichment. The highest individual sediment loading source is stream bank erosion of primarily legacy sediments, which accounts for more than 60 percent of the estimated total annual sediment load in Chiques Creek (Susquehanna River Basin Commission 2019). Legacy sediments eroded from the stream banks in the Chiques Creek Watershed introduce nutrients and sediment into the waterways, resulting in negative environmental and economic impacts in Chiques Creek and downstream water bodies, including the Chesapeake Bay.

The area of potential effects (APE) for this review included ten evaluation units (sites) located throughout the Chiques Creek Watershed. The ten sites range in size from 6.9 to 56.3 hectares (17 to 139 acres) (Figure 2). The area within 1.6 kilometers (1 mile) buffer for each of the ten sites was identified as the study area.

This Phase IA archaeological desktop review was completed in accordance with guidelines established by the PASHPO (PASHPO 2021). This study was performed in accordance with the National Historic Preservation Act (NHPA) of 1966, as amended (54 USC 306108); Procedures for the Protection of Historic and Cultural Properties (36 CFR 800); the Procedures for Determining Site Eligibility for the National Register of Historic Places (36 CFR 60 and 63); and the Secretary of the Interior's Standards for Archaeology and Historic Preservation. The project manager and project archaeologist meet or exceed the qualifications described in the Secretary of the Interior's Professional Qualifications Standards (*Federal Register* 48:190:44738-44739) (United States Department of the Interior 1983) and in 36 CFR § 66.3(b)(2) and 36 CFR § 61.



C:\GIS\ChiquesCreek_PA\SavedMaps\Fig1_Watershed.mxd Source: USGS; Harrisburg, PA (1985) 100K Topographic Map

Figure 1: Location of Chiques Creek Watershed

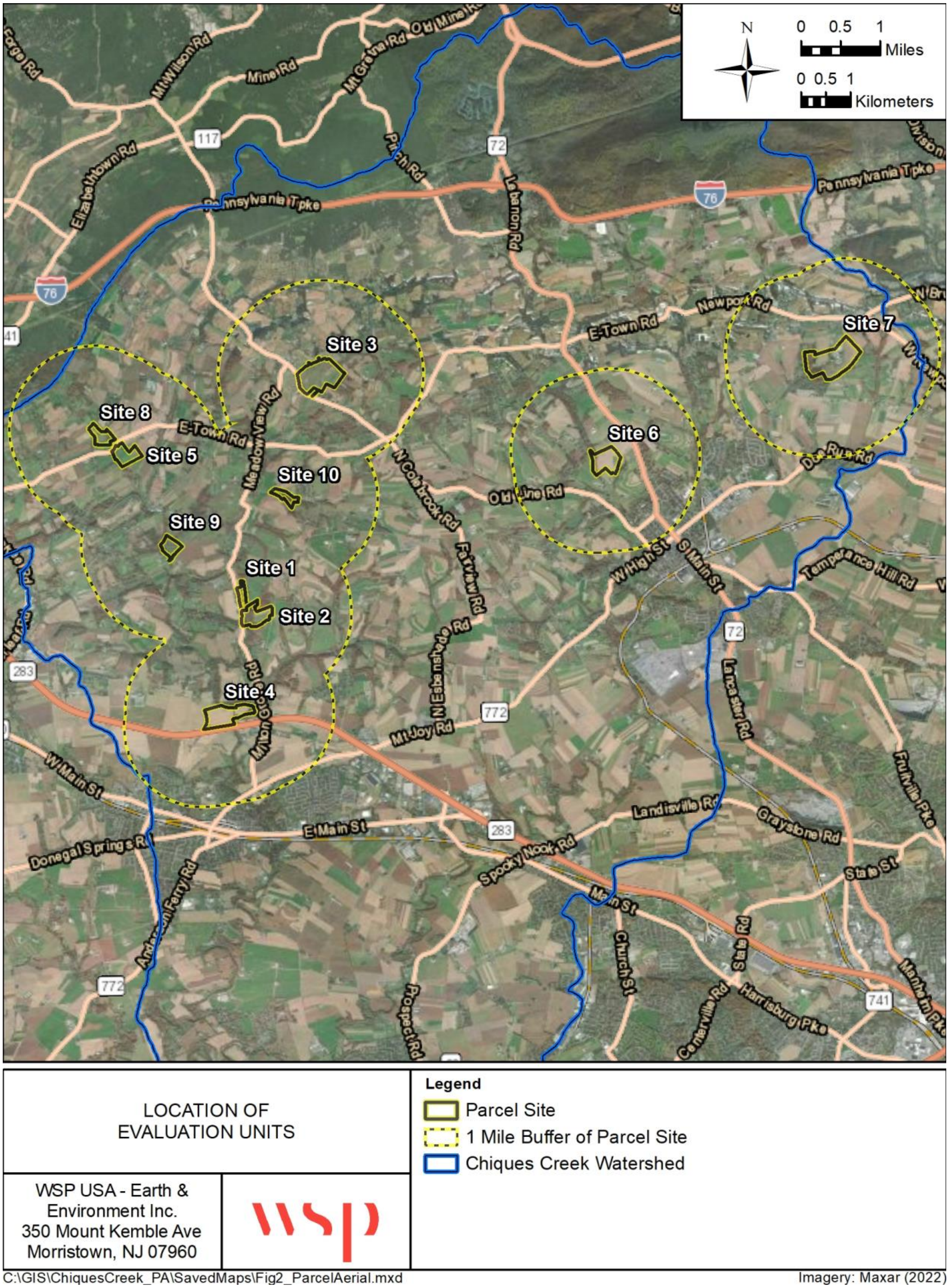


Figure 2: Location of Evaluation Units

1.2 Scope of Work

The Phase IA archaeological and architectural desktop review included a literature review and archaeological sensitivity assessment. To identify historic properties in the APE and study area, a WSP Archaeologist who meets the Secretary of the Interior's Professional Qualifications Standards reviewed available information, including the National Register of Historic Places (NRHP) listings, National Historic Landmark (NHL) listings, archaeological site records, architectural resource records, published archaeological and historical studies, and cultural resource survey reports from the Pennsylvania State Historic Preservation Office (PA SHPO). The background review was completed by using Pennsylvania's Historic & Archaeological Resource Exchange (PA-SHARE). Data from the site and survey records search was conducted in January 2024.

The research also consisted of a review of regional histories, a study of nineteenth- and twentieth-century maps and plans, and historic aerial imagery. Archaeological sensitivity for archaeological resources was assessed based on factors such as potential for intact subsurface soils, relationship to nearby known archaeological sites, topography, proximity to water, and historical land use. This review supported efforts to determine the presence of any known cultural resources in the Project area and the wider study area and aid in the creation of input variables for the GIS-based predictive model described in this report.

1.3 Research Objectives

The objectives of the Phase IA cultural resource assessment included the following.

- Development of historic, pre-Contact, and environmental contexts.

- Identification of all previously documented archaeological and architectural resources in the APE and the 1-mile study area.

- Description of previously documented archaeological resources, including their horizontal and vertical extent, structure, artifact and feature content and distribution, temporal and cultural associations, soil characteristics, and environmental variables.

- Assessment of the pre-Contact and post-Contact archaeological sensitivity of the project areas and a classification of the project areas into areas of high, moderate, low, and no archaeological sensitivity.

- Preparation of a report that describes, in detail, the purpose, methods, and findings of the investigations and recommendations for future land planning for the Project.

2.0 Literature Review

The following discussion is a synthesis of the environmental and cultural history and the settlement/ subsistence patterns of pre-Contact and post-Contact period groups in Lancaster County, Pennsylvania and surrounding areas, when applicable.

2.1 Environmental Setting and Physiography

2.1.1 Physiology and Geology

The evaluation units are located in the Piedmont Lowland and Gettysburg-Newark Lowland sections of the Piedmont physiographic province (Pennsylvania Department of Conservation and Natural Resources [PADCNR] 2024).

The Piedmont Lowland Section consists of broad, moderately dissected valleys separated by broad, low hills. The section is developed on primarily limestone and dolomite, with some phyletic shale and sandstone. The basic drainage pattern within the section is dendritic, although some areas have little to no pattern because of the well-developed subsurface drainage. Elevations in the section range from 18 to 213 meters (60 to 700 feet), although most areas in the section have a relief of less than 30 meters (100 feet) (PADNCR 2024).

The Gettysburg-Newark Lowland Section consists mainly of rolling low hills and valleys developed on sedimentary rock. Isolated higher hills developed on diabase; baked sedimentary rock and conglomerates also exist in this section. The basic drainage pattern is dendritic and soils are usually red. Topographic relief ranges from 30 to 61 meters (100 to 200 feet) with localized hills measuring up to 183 meters (600 feet). Elevations range from 6 to 413 meters (20 to 1,355 feet) (PADCNR 2024).

2.1.2 Soils

According to the National Resources Conservation Service (NRCS), several different soil types exist within the Project Area (Table 1). Most of the mapped soil types are well-drained soils typically found on hillslopes and hills.

TABLE 1

SOILS IN THE APE

EVALUATION UNIT	NAME	SLOPE %	DRAINAGE	LANDFORM
1	Bedington channery silt loam (BeD)	15-25	Well-drained	Hills
	Lindside silt loam (Ln)	0-3	Moderately well drained	Valleys, flood plains, and drainageways
	Bedington silt loam (BdC)	8-15	Well-drained	Hillslopes
2	Bedington silt loam (BdB)	3-8	Well-drained	Hillslopes
	Bedington silt loam (BdC)	8-15	Well-drained	Hillslopes
	Bedington channery silt loam (BeD)	15-25	Well-drained	Hills
	Lindside silt loam (Ln)	0-3	Moderately well drained	Valleys, flood plains, and drainageways

TABLE 1 (continued)

EVALUATION UNIT	NAME	SLOPE %	DRAINAGE	LANDFORM
3	Bedington silt loam (BdC)	8-15	Well-drained	Hillslopes
	Bedington channery silt loam (BeD)	15-25	Well-drained	Hills
	Bedington silt loam (BdB)	3-8	Well-drained	Hillslopes
	Rowland silt loam (Rd)	0-3	Moderately well drained	Flood plains
	Bucks silt loam (BuB)	3-8	Well-drained	Hillslopes
	Bucks silt loam (BuC)	8-15	Well-drained	Hillslopes
	Landsdale loam (LaB)	3-8	Well-drained	Hillsides
	Readington silt loam (RaB)	3-8	Moderately well drained	Hills
	Landsdale loam (LaC)	8-15	Well-drained	Hillsides
4	Hagerstown silty clay loam (HbD)	15-30	Well-drained	Valley floors and ridges
	Elk silt loam (EcA)	0-3	Well-drained	Terraces
	Hagerstown silty clay loam (HbC)	8-15	Well-drained	Valley floors and ridges
	Hagerstown silt loam (HaB)	3-8	Well-drained	Hills
5	Bucks silt loam (BuB)	3-8	Well-drained	Hillslopes
	Landsdale loam (LaB)	3-8	Well-drained	Hillsides
	Ungers loam (UaC)	8-15	Well-drained	Mountain slopes
	Mount Lucas silt loam (MdB)	3-8	Somewhat poorly drained	Hillslopes
	Rowland silt loam (Rd)	0-3	Moderately well drained	Flood plains
	Landsdale loam (LaC)	8-15	Well-drained	Hillsides
6	Bedington silt loam (BdC)	8-15	Well-drained	Hillslopes
	Bedington silt loam (BdB)	3-8	Well-drained	Hillslopes
	Bedington silt loam (BdA)	0-3	Well-drained	Hillslopes
	Rowland silt loam (Rd)	0-3	Moderately well drained	Flood plains
	Bowmansville silt loam (Bo)	0-3	Somewhat poorly drained	Flood plains
7	Bedington silt loam (BdB)	3-8	Well-drained	Hillslopes
	Bedington silt loam (BdA)	0-3	Well-drained	Hillslopes
	Bedington silt loam (BdC)	8-15	Well-drained	Hillslopes
	Bedington channery silt loam (BeD)	15-25	Well-drained	Hills
	Rowland silt loam (Rd)	0-3	Moderately well drained	Flood plains
8	Rowland silt loam (Rd)	0-3	Moderately well drained	Flood plains
	Landsdale loam (LaC)	8-15	Well-drained	Hillsides
	Landsdale loam (LaB)	3-8	Well-drained	Hillsides
	Bucks silt loam (BuB)	3-8	Well-drained	Hillslopes

TABLE 1 (continued)

EVALUATION UNIT	NAME	SLOPE %	DRAINAGE	LANDFORM
9	Ungers loam (UaB)	3-8	Well drained	Mountain slopes
	Readington silt loam (RaB)	3-8	Moderately well drained	Hills
	Rowland silt loam (Rd)	0-3	Moderately well drained	Flood plains
	Landsdale loam (LaB)	3-8	Well-drained	Hillsides
	Landsdale loam (LaB)	3-8	Well-drained	Hillsides
10	Bedington silt loam (BdB)	3-8	Well-drained	Hillslopes
	Blairton silt loam (Bm)	3-10	Moderately well drained	Depressions
	Bedington channery silt loam (BeD)	15-25	Well-drained	Hills

2.1.3 Hydrology

The Chiques Creek Watershed is a 110-square-mile basin located predominantly in Lancaster County, Pennsylvania. Chiques Creek is a tributary to the Susquehanna River, which is the largest freshwater input to the Chesapeake Bay. The Chiques Creek Watershed has been characterized by primarily agricultural land use, town and urban developments, and lack of forest cover.

2.1.4 Past Climates and Paleoenvironments

The present terrain and vegetation of southeastern Pennsylvania reflects several factors operating over the past 11,000 years: the relatively minor climate fluctuations of the Holocene; the impact of Native American land use; and three centuries of Euro-American agriculture, deforestation, and mining activities. Prior to the arrival of humans some 13,000 years ago, this region had been affected by dramatic changes of climate, flora, and fauna during the Pleistocene.

Paleoenvironmental data (mainly pollen) have been obtained from Buckle's Bog in the Allegheny Mountains in westernmost Maryland (Maxwell and Davis 1972), and from Crystal Lake and Mercer Bog in western Pennsylvania (Walker and Hartman 1960). To the west, several sites in the unglaciated Allegheny Plateau have provided relevant data (Shane 1987, 1994). These local records can be supplemented by contemporaneous data gathered from more distant locations.

During glacial periods of the Pleistocene, two vast ice sheets, the Laurentide in the east and the Cordilleran in the west, covered most of Canada. The influence of the ice and global depression of temperatures squeezed vegetation bands southward. The ice sheets also blocked the flow of Siberian air masses so that, paradoxically, winters were generally not very severe during the Pleistocene (Yu and Wright 2001). These conditions allowed the development of ecosystems lacking precise modern analogues and the coexistence of plants and animals that today occupy separate ecological zones.

At the peak of the Last Glacial Maximum, about 21,000 BP (circa 24,000 cal BP[1]), the northern limit of deciduous forest lay well to the south of the project region, at around 33° latitude. To the north, a taiga-like

[1] Dates in this report are presented variously in several formats: "rcbp" and "BP" refer to uncalibrated radiocarbon dates before present ("present" by accepted convention is AD 1950); "cal BP" refers to calibrated or calendrical years before 1950 (generally earlier than radiocarbon ages by as much as 2,000 years at 11,000 rcbp [=13,000 cal BP]; "BC"

coniferous forest dominated by pine and spruce prevailed, dotted with open parklands that were probably maintained by the feeding and trampling of resident megaherbivores, including mastodons. A few oaks and northern hardwoods were probably interspersed among the conifers.

Deglacial warming and retreat of the ice sheets in mid-latitudes of the Northern Hemisphere began about 17,500 cal BP and accelerated at the abrupt onset of the Bølling-Allerød interstadial at 14,700 cal BP. Throughout the region of eastern North America between 29 and 41 degrees N latitude, this warming event is manifested as an increase in pollen of temperate arboreal taxa (*Quercus, Carya, Fagus, Fraxinus,* and *Ostrya/Carpinus*) (Kneller and Peteet 1999:143).

Temperatures dropped slightly and gradually during the two millennia after the sudden Bølling-Allerød warming, then around 10,900 BP (circa 12,900 cal BP), temperatures plunged over several decades to near-glacial cold (Yu and Eicher 1998). This was the onset of the Younger Dryas, a cold spell across the whole Northern Hemisphere that lasted for about 1,300 years until approximately 10,000 BP (11,600 cal BP). Paleobotanists have only recently begun to compile and analyze high-resolution pollen records that clearly show the effects of the Younger Dryas on regional flora. Although the Younger Dryas was formerly thought to have affected only the Canadian Maritimes and the southern Midwest (Wright 1989), studies conducted over the past two decades have shown rapid responses by vegetation in northern New Jersey (Peteet et al. 1993), southern Ontario (Yu and Eicher 1998), Ohio and Indiana (Shane 1987, 1994), and central Kentucky (Wilkins et al. 1991). Generally, the climate-induced vegetation changes are more easily recognized at locations near ecotones. Plants and animals responded rapidly (generally with lag times of fewer than 100 years [Williams et al. 2001]) to the new temperature and precipitation patterns.

The shifting of atmospheric circulation patterns during the Younger Dryas seems to have caused some regionally specific climate changes that contrast with broader continental-scale patterns. At Browns Pond in western Virginia, a hemlock-birch-pine forest prevailed from 11,280 to 10,050 BP. The increase in hemlock (*Tsuga*) and decline of fir (*Abies*) in this interval are interpreted as indicators of warming. The same trends are evident at Buckle's Bog and Big Run Bog, located north of Browns Pond (Kneller and Peteet 1999:145). Kneller and Peteet (1999:145) contend that "increasing warmth and moisture at 11,300 BP in the central Appalachians can be consistent with a cold reversal in the North Atlantic region. If a steep temperature gradient exists between cold subpolar waters and warmer subtropical waters, then storm-track-associated moisture will be concentrated along the maximum thermal gradient." This explanation of increased rainfall does not account very well for the apparent temperature anomaly, however.

At Buckle's Bog, non-arboreal pollen, resembling assemblages from modern treeless tundra, is predominant in the "sedge zone" between 19,000 and 12,700 BP (Carbone 1976:28; Maxwell and Davis 1972; Mead 1980). However, a spruce forest flourished not far away, at lower elevations (Maxwell and Davis 1972). Between 12,700 and 10,500 BP (14,700 and 12,500 cal BP), spruce and pine pollen predominated, indicating a shift, first to an open boreal woodland, then to a closed coniferous-deciduous forest dominated by white pine. The main deciduous element of this period is oak, with only trace amounts of other trees. Pine, birch, and hemlock increased sharply after 10,500 BP (12,500 cal BP). Subsequently, pine dropped off dramatically while oak became prevalent, accompanied by increasing numbers of chestnut and beech. Hickory pollen rises from trace levels only within the last 5,000 years in the Buckle's Bog record.

Shane (1987, 1994) presents syntheses of pollen records from the Allegheny Plateau and Till Plains of Ohio and Indiana. A spruce-tamarack forest, with minor representation of oak, covered the region before 13,500 BP (16,500 cal BP). During the period of warming from 16,500 cal BP to 13,000 cal BP, the percentages

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and "AD" are uncalibrated dates before and after Year 1 (as used in many previous chronological schemes for this region); "cal AD" and "cal BC" denote calibrated calendar ages according to standard Western usage.

of oak, ash, and ironwood increased. Trace amounts of beech and hickory pollen are found, in such low numbers that local absence of the trees is inferred. Spruce declined while fir became prominent; however, a resurgence of spruce between 13,000 and 12,500 cal BP indicates a regional cooling of about 2 to 3 degrees C, which is probably a local manifestation of the Younger Dryas cold reversal. On the Allegheny Plateau jack or red pines appeared suddenly around 10,400 BP, accompanied by hemlock. White pines arrived soon afterward. By 9000 BP the entire region was covered by a diverse deciduous forest, comprising oak, ash, ironwood, elm, maple, hickory, walnut, and basswood.

Elsewhere in the Plateau and Ridge and Valley regions, the few Late Pleistocene/Early Holocene pollen sequences lack the temporal resolution and detail needed to recognize clear signals of the Younger Dryas or the Pre-Boreal Oscillation (a brief cold event at circa 11,300 cal BP). At Hack Pond in Augusta County, Virginia, the transition from a late-glacial boreal forest dominated by spruce and pine to a northern hardwood forest was dated to about 9520±200 BP (Craig 1969). At Cranberry Glades in West Virginia, an analogous vegetation shift was dated to 9434±840 BP (Guilday et al. 1964). At Potts Mountain Pond in Alleghany County, Virginia, spruce and fir disappear from the pollen record at 9100 BP, while oak increases dramatically, and hemlock achieves its peak frequency (Watts 1979).

In the 1980s recovery of fruit, berry, and grape seeds (along with fish bones) from a Paleoindian hearth at the Shawnee-Minisink Site on the upper Delaware in Pennsylvania raised questions about the character of Terminal Pleistocene environments in the Middle Atlantic region (Dent 1985, 1991, 2007). Renewed excavations have exposed another hearth (dated very precisely to 10,935 radio carbon years before present [rcbp]) containing seeds as well as hickory nutshell (Gingerich 2007, 2011). The presence of hickory is startling because pollen of this typically thermophilic tree is very rare or entirely absent from most regional profiles until the middle Holocene. This is a stark reminder of the peculiarity of Late Glacial environments, where more equable seasonality permitted coexistence of seemingly disharmonious biota.

Arguments employing the concepts of disharmonious biota and refugia within anomalous micro-climate zones have been advanced by Adovasio et al. (1980, 1985) to account for the evident discrepancy between radiocarbon dates of ca. 16,000 to 11,000 BP and the Holocene-like floral and faunal remains from Stratum IIa of Meadowcroft Rockshelter. This site is located near Avella, Pennsylvania, in the southwest corner of the state. Charred wood, nutshells and pits from the lowest levels represent walnut, hickory, oak, black cherry, sycamore, beech, hornbeam, and blackgum. Faunal remains include white-tailed deer, eastern chipmunk, southern flying squirrel, passenger pigeon. toad, colubrid snake, and deer mouse. Although it is remotely conceivable that these species very rapidly colonized selected patches of the Allegheny Plateau in the early Bølling, it is more likely that these typically Holocene remains are intrusive: "It is not reasonable to view the Upper Ohio Valley as a temperate biotic refugium during late glacial times, i.e. prior to ca. 12,000 years ago, due to its geographic location and the well-documented paleontological record, both botanical and zoological, of the mid-Appalachian area....The faunal sequence post-dates the Wisconsinan/Holocene environmental change from boreal to temperate conditions..." (Guilday and Parmalee 1982:173).

The Younger Dryas ended abruptly about 10,000 BP (circa 11,600 cal BP) (Friedrich et al. 2004; Steffensen et al. 2008) when, within just a few years, temperatures rose to a level that was sustained with relatively minor change throughout the ensuing Holocene epoch. Temperatures rose about 15 degrees Celsius to Holocene levels in Greenland (White et al. 2001); at mid-latitudes the warming was about 4 or 5 degrees C. Again, vegetation in the eastern U.S. responded rapidly. In the north, open tundra was replaced by boreal forest, and farther south, forests that had been dominated by coniferous trees were invaded by deciduous species spreading from the Southeast.

The climate of the Holocene has been very stable, as compared to the sharp warm/cold swings of the Pleistocene. Nevertheless, episodes of significant abrupt change can be seen in several records. Most notably, analyses of North Atlantic sediments have demonstrated a roughly 1450-year (±500) recurrence of ice-rafted debris (IRD) events (known as "Bond events"), which are interpreted as markers of sudden cold episodes accompanied by major reorganizations of atmospheric circulation (Bond et al. 2001). The eight Bond events are dated to about 11,100, 10,300, 9400, 8100, 5900, 4200, 2800, and 1400 cal BP. Each time, reduced solar output is thought to have triggered changes in stratospheric ozone that caused cooling of the atmosphere in high northern latitudes, a slight southward shift of the northern subtropical jet stream, and decreased Northern Hadley circulation. These atmospheric changes would then have led to increased North Atlantic drift ice, cooling of the ocean surface and atmosphere above Greenland, and reduced precipitation in low latitudes.

Recently, Springer et al. (2008) reported that Bond events are expressed locally as decades-long droughts in a 7,000-year-old speleothem from Buckeye Creek Cave, West Virginia. These droughts, at ca. 5800, 4600, 3800, 3000, 2000, 1300, and 600 cal BP, are attributed to a shifted jet stream, caused ultimately by solar minima leading to cooling of the ocean surface.

Viau et al. (2002) examined radiocarbon dates obtained for more than 700 pollen diagrams from across North America. These dates tend to cluster at significant discontinuities in the climate record. The major pollen transitions identified by Viau et al. within the past 14,000 calendar years occur at 13,800, 12,900, 10,190, 8100, 6700, 4030, 2850, 1650, and 600 cal BP. These vegetation changes were pan-continental. Four of them correspond rather closely to Bond events (10,190=10,300, 8100=8100, 4030=4200, and 2850=2800 cal BP).

Bond events also are roughly coincident with the Rapid Climate Change episodes during the Holocene, marked by montane glacier advances around the world, and chemical changes in Greenland ice indicative of atmospheric changes over Siberia (Mayewski et al. 2004). These RCC episodes (too extended to be considered transient events) date to ca. 8900 to 8100, 5800 to 5300, 4200 to 3800, 3300 to 2500, 1400 to 1100, and 600 to 0 cal BP.

Three events are particularly salient in the climatic record. The 8200 cal BP cold event was the biggest abrupt climate event since the Younger Dryas ended (Alley et al. 1997). It has been attributed to the final massive draining of glacial Lake Agassiz into the North Atlantic. Its effects may have lasted for about 400 years. The 4200 cal BP Bond event is contemporaneous with a centuries-long megadrought in the interior of North America (Booth et al. 2005). It also roughly coincides with the beginning of neo-glaciation in the northern hemisphere. The 2800 cal BP Bond event shows up very strongly in the strontium/calcium ratios from Buckeye Creek Cave (Springer et al. 2008: figure 1). In Scandinavia (presumably also affected by the same climatic factors as the eastern United States), "During the period between 3000 and 2000 cal BP (1050 and 50 BC) the climate was cold on repeated occasions, and glaciers expanded frequently and became larger than they were even during the Little Ice Age" (Karlen and Larsson 2007:413).

Based on orbital parameters, July sunlight at 30 degrees north was most intense early in the Holocene, about 10,000 to 9000 cal BP (Berger and Loutre 1991). However, "optimum" or Hypsithermal warming in eastern North America was not coeval with strongest insolation, but instead was delayed until about 8000 cal BP. This lag is attributable to the persistence of a shrunken remnant of the Laurentide ice sheet in eastern Canada, which continued to influence the region's climate and vegetation until about 8000 cal BP (Shuman et al. 2002). The gigantic periglacial meltwater lake, Lake Agassiz, also affected early Holocene climate. Its catastrophic drainage into the North Atlantic by way of the St. Lawrence River is widely suspected to be the cause of a dramatic but short-lived hemispheric cooling event at 8200 cal BP (7500 rcbp).

It has generally been assumed that the Hypsithermal or Altithermal (ca. 9000 to 5000 cal BP) was a warm and dry period in the Southeast, as it was in the Midwest. However, the pollen sequence from a peat core at Fort Bragg, North Carolina, has been recently interpreted as indicating a climate that was both warmer and wetter than present (Goman and Leigh 2004). Goman and Leigh suggest that the Bermuda High shifted to the north and east of its present position between 9000 and 6000 cal BP, changing atmospheric circulation and generating frequent tropical storms. The stratigraphy of the floodplain of Raven Fork in the southern Blue Ridge Mountains has been interpreted recently as supporting this scenario of a wet early Holocene (Leigh and Webb 2006). Sedimentation on footslopes and alluvial/colluvial fans was more rapid in the early Holocene (11,000-6,000 cal BP) than later (except for the anomalous post-Contact period of accelerated erosion). Leigh and Webb ascribe the sediment deposits to heavier rainfall and flooding owing to more frequent tropical storms. The greater frequency of summer storms is attributable to the warmer ocean surface between 12,000 and 6,000 cal BP and the northward shift of the Bermuda High.

Diamond and Giles (1987) dated the Hypsithermal in the Ridge and Valley province to about 8500 to 4000 rcbp. The main regional trends in this period were the expansion of hickory and the entry of significant numbers of chestnut and black gum. By 4000 rcbp oak had increased to 75 percent of the arboreal pollen at Potts Mountain Pond.

At Saltville in southwestern Virginia, hemlock (*Tsuga canadensis*) suffered a dramatic collapse at 4700 rcbp (5400 cal BP). This is a local expression of the abrupt transregional hemlock collapse at that date. Although the immediate cause of the collapse seems to have been a pathogen or insect infestation (Bhiry and Filion 1996), hemlocks were probably susceptible owing to cold, arid climate episodes, coincident with the 5900 to 5800 cal BP Bond event and the 5800-5300 cal BP rapid climate change (Bennett and Fuller 2002; Calcote 2003; Foster et al. 2006).

Based on several indices, including abrupt onset of neoglaciation in South America and the Alps, some climate specialists would pinpoint the middle to late Holocene transition, on a global scale, at 5200 cal BP (e.g., Thompson et al. 2006). A later date of about 4000 rcbp (4500 cal BP) is often cited to demarcate the onset in eastern North America of the late Holocene, which was generally cooler and moister than the mid-Holocene. At Potts Mountain Pond oak remained dominant after 4000 rcbp but pine began increasing to 30 percent of pollen.

A global climate event around 4200 cal BP was manifested as a centuries-long “megadrought” in North America and elsewhere (Booth et al. 2005). By 3500 rcbp the modern oak-chestnut forest was established throughout the Ridge and Valley and southeastern Pennsylvania region (Braun 1950; Diamond and Giles 1987).

The arrival of European colonists to the Mid-Atlantic region in the mid-seventeenth century happened to coincide with severe droughts as well as some of the coldest temperatures of the so-called Little Ice Age (Osborn and Briffa 2006; Stahle et al. 1998). These climatic episodes probably stressed regional vegetation, which may have caused some significant soil erosion; however, these natural and pre-Contact human stresses were not as severe compared with the impact of European agricultural practices, lumbering, and mining.

2.2 Pre-Contact Context

The pre-Contact cultural sequence of Pennsylvania generally conforms to that defined for the Eastern Woodlands region as local developments in later prehistory. This sequence is conventionally divided into three main periods: Paleoindian (9000 to 8000 BC, 11,000 to 9500 cal BC); Archaic (8000 to 1200 BC, 9500 to 1450 cal BC); and Woodland (1200 BC to AD 1000, 1450 cal BC to AD 1600). The distinctive transitional cultures that flourished between the Late Archaic and Early Woodland may require revision to include a Terminal Archaic, or Transitional, period.

2.2.1 Paleoindian Period

Pennsylvania figures in ongoing debates over the timing and process of the first human occupation of North America because the Meadowcroft Rockshelter is located in the southwestern part of the state. Stratum IIa at this site produced radiocarbon dates of ca. 16,000 to 11,000 rcbp in association with prismatic blades and a "Miller Lanceolate" projectile point (Adovasio et al. 1999). Dates older than 11,000 rcbp might indicate a "pre-Clovis" human presence. As noted above, the plant and animal remains from Meadowcroft are anomalous for an ostensibly Terminal Pleistocene occupation. Some authors (e.g., MacDonald 2003) have observed the resemblance of the Miller point to Late Archaic Steubenville points; this suggests the possibility of dislocation of artifacts by rodent burrowing. Dates from features in Stratum IIa are said to be in stratigraphic order, but in the absence of a detailed final report, this assertion is unverifiable. Meadowcroft will remain controversial and dubious until it has been fully reported (e.g., MacDonald 2003).

The first convincingly attested occupants of the Middle Atlantic region were Paleoindian hunters, who entered the region around 13,000 cal BP (11,000 rcbp). The Paleoindians arrived at a time of abrupt climate changes at the end of the Wisconsin glacial, as spruce-dominated boreal vegetation was replaced by northward expansion of deciduous forest and animals migrated to new ranges or were driven to extinction. The diagnostic Paleoindian artifact is the basally fluted, lanceolate Clovis point; typically associated tools include scrapers and gravers for working hides and bones. These tools were often made of preferred high-quality stones such as jasper, chalcedony, and chert.

Previously identified Paleoindian sites in southeastern Pennsylvania are limited. PA-SHARE identifies only 15 archaeological resources in Lancaster County with Paleoindian cultural affiliation (PA-SHARE 2024). None of these sites are located in the Chiques Creek Watershed. Most previously recorded Paleoindian sites in southeastern Pennsylvania consist of isolated point finds and surface sites the contain low frequencies of projectile points and other hunting-related artifacts. Due to poor preservation and site type scarcity, generalities regarding Paleoindian subsistence and environmental adaptations can be inferred using Paleoindian studies from other geographies.

In the high Plains of the western United States, Clovis points have been found at kill sites alongside the skeletons of mammoths, but east of Missouri there is no unequivocal evidence of mammoth or mastodon hunting by Eastern Paleoindians, even though radiocarbon dates show that mastodons and other Pleistocene megafauna persisted in the East at least as late as 11,000 cal BC. Bone is usually very poorly preserved on Eastern Paleoindian sites; the few odd bits of identifiable calcined bone that have been recovered indicate hunting of caribou or other cervids by the more northern bands; deer may have been a staple in the diet of more southern groups. Finds at the Shawnee-Minisink Site in the upper Delaware valley, now precisely dated to 10,935±15 rcbp (Waters and Stafford 2007) show that the Paleoindian diet also included fish as well as berries and fruits (Dent 1985, 1991, 1999; Gingerich 2007, 2011).

Stylistic variations in fluted points suggest gradual change and regional differentiation over time, from an original ubiquitous Clovis or Early Paleoindian type, through the Mid-Paleoindian Quad, Cumberland, and Debert types, to the Late Paleoindian Dalton and Hardaway types (Gardner 1974, 1989). The small number of Dalton points found north of the Carolinas may indicate a population collapse between 10,900 and 9500 cal BC (Gardner 1989:39), perhaps caused by the sudden relapse to cold glacial climate in the Northern Hemisphere during the Younger Dryas episode (12,900 to 11,600 cal BP).

Occupation and land use throughout the Paleoindian period in the Middle Atlantic states appears to have consisted of small, highly mobile bands following major drainage systems, with a notable absence along the central spine of the Appalachians (Lane and Anderson 2001). Sites are often found on high terraces and upland bluffs in stream valleys and near wetland basins. Site types for the Paleoindian period include base camps, quarry sites, quarry reduction stations, quarry-related base camps, base camp maintenance stations, and outlying hunting stations, though Paleoindian sites often consist of isolated projectile point finds. The largest and most intensively used sites have been found near high-quality lithic resources. Unlike later populations, Paleoindians made limited use of caves and rock shelters, apparently preferring open-air locations (Custer 1989, 1996; Gardner 1974; Walthall 1998).

2.2.2 Early Archaic Period

After 9500 cal BC (the end of the Younger Dryas stadial) the regional population seems to have rebounded rapidly. Throughout the Middle Atlantic region, Early Archaic (9500 to 8000 cal BC) sites, which frequently occur on large river terraces or upland surfaces, are more numerous than Paleoindian sites. A marked stylistic change is evident in the projectile points of the early Early Archaic; they begin to be notched near the base, either in the sides or the corners, instead of basally thinned. The meaning of this change in hafting technique is unclear. Because the spearthrower or atlatl was probably already used by Paleoindians, the new point styles cannot indicate its introduction, as was formerly speculated (Gardner 1974). Although high-quality lithic materials were still preferred for points and other tools, Early Archaic groups also began to exploit local stones, such as quartz and quartzite.

Early Archaic site distribution is Lancaster County is more prevalent than Paleoindian, but overall identification of this specific temporal association is low. PA-SHARE search results identify approximately 43 previously recorded archaeological sites with Early Archaic occupation recorded (PA-SHARE 2024).

Early and Middle Archaic sites commonly occur on slopes, saddles, and ridgetops. In the Raccoon Creek watershed of southwestern Pennsylvania, sites with Kirk and Palmer points mainly occur on floodplains or first terraces of creeks or rivers, although some sites also are found in upland settings. This evident shift from Paleoindian land-use patterns may indicate a change in preferred travel routes, or perhaps the establishment of longer-term base-camps in riverine settings (MacDonald 2003:36).

2.2.3 Middle Archaic and Late Archaic Periods

The Middle Archaic period roughly corresponds to the Hypsithermal, a climatic episode marked at the continental scale by rising temperatures, decreasing precipitation (but perhaps not in the Southeast [Goman and Leigh 2004]), and the development of more seasonally variable climate. The warmest temperatures of the entire Holocene actually occurred at the beginning of the period, around 7500 cal BC. An oak-hemlock-hickory forest dominated the Mid-Atlantic region, and deer became the dominant large mammal. The growing human population changed its subsistence-settlement patterns. Sites are larger and more numerous, and a more diverse toolkit implies a broader range of subsistence activities than in the Early Archaic.

In Pennsylvania, site frequency increases sharply (by 135 percent) from the Early to the Middle Archaic, as demarcated by bifurcate-base points (Adovasio and Carr 2009). However, MacDonald (2003:41) observed a static population (as measured by sites per century) over this span in the Raccoon Creek drainage of westernmost Pennsylvania. Middle to Late Archaic site distribution in Lancaster County (PA-SHARE 2024) indicates that this regional trend for increased site frequency is mirrored at the county level. Approximately 428 previously recorded archaeological resources in Lancaster County are temporally affiliated with Middle to Late Archaic site occupation (PA-SHARE 2024). Additional sites in Lancaster County have an unspecific Archaic chronological affiliation, as a more specific temporal identification could not be determined. Archaic site types in Lancaster County typically conform to cultural sequence generalizations detailed below.

During the Middle Archaic period sites begin to appear in locations that had been previously ignored, such as upland swamps and interior ridgetops (Gardner 1987); however, base camps were still located primarily in the floodplains of major drainages. The appearance of new tool types specifically designed for wood-working, seed-grinding, and nut-cracking (e.g., axes and adzes, mauls, grinding slabs, and nutting stones) and the location of sites in previously unused locations indicate an increasing reliance on plants for food and construction materials. During the Middle Archaic period procurement of high-quality lithic material was no longer an important component of the settlement pattern, as most artifacts were manufactured from locally available lithic materials. As one example of this trend, the jasper source at Flint Run on the Shenandoah was abandoned after the Early Archaic (Gardner 1974). This change may reflect increasing circumscription of band territories as a growing population filled in available environments and their movements became restricted. A noteworthy technological change is the shift from carefully made and curated unifacial scrapers to the expedient tools found in Middle Archaic and later assemblages (Adovasio and Carr 2009; Gardner 1989).

2.2.4 Terminal or Transitional Archaic Period

East of the Appalachians, regional subsistence-settlement patterns and projectile point technology changed dramatically after 2200 cal BC. The new riverine focus is associated with the appearance of Savannah River points, which mark the onset of a Transitional or Terminal Archaic period. The widespread appearance of broadspear points probably marks a rapid intrusive expansion northward by a population originating in the coastal plain of Georgia and the Carolinas (Kinsey 1972; Mouer 1990). It is probably not a coincidence that the spread of this new tool type is contemporaneous with a centuries-long "megadrought" in North America and elsewhere (Booth et al. 2005). This abrupt climate change may have destabilized local cultures and thus facilitated expansion of the broadspear-makers. The broadspear expansion also coincides with the intrusion of the coastal-based Stallings Island culture into the mid-Savannah River valley. This pottery-making group displaced the resident Mill Branch phase, which is presumably ancestral to the more northern broadspear-producing cultures (Sassaman 2006a). Continued northward expansion of the broadspear-makers beyond Virginia is indicated by the appearance of Lehigh/Koens-Crispin points in Pennsylvania and New Jersey, and Snook Kill points in New York (Kinsey 1972). Around 1500 BC (1900 cal BC), the Perkiomen and Susquehanna point types were probably developed in Pennsylvania from northern Savannah River variants and were spread back, by diffusion or migration, into parts of northern Virginia, such as the Potomac Valley.

Apart from broadspears, Transitional assemblages include two other significant new artifact types: grooved groundstone axes, which replace earlier chipped stone forms; and carved soapstone (steatite) bowls. Soapstone was quarried in the Piedmont of Virginia, Maryland, and Pennsylvania (Holland et al. 1981). Vessels were carved at the quarries and transported in finished form, probably by canoe. Excavations at the Burning Spring Branch Site (46KA142) on the Kanawha River show that steatite bowls imported from Virginia were replaced over time by locally produced sandstone bowls in identical shapes and sizes (United States Army Corps of Engineers [USACE] 2008). Soapstone pots were clearly used for cooking, but it is not yet known what foods (fish, meat, seeds, tubers, or nuts) they were used to process, or why such containers suddenly became necessary or desirable. Although there was a long history of use of heated soapstone chunks for boiling in the Savannah River Valley, the creation of bowls of this material seems to be an innovation that arose after the initial expansion phase. Radiocarbon dates on external soot residues on stone bowls cluster between 3700 and 2800 rcbp, coeval with the Susquehanna Broadspear complex (Sassaman 2006b). Increased reliance on heavy soapstone bowls could suggest a decrease in mobility and led to a more sedentary-settlement pattern which supported an increase in overall regional population density.

Approximately 124 sites with Transitional period occupations are recorded in Lancaster County (PA-SHARE 2024). Several of these recorded sites have been excavated, including the eligible Kent-Hally

Site and the Piney Island Site, which were both occupied repeatedly during the Late Archaic and Transitional periods. Both sites are located along the southwestern border of Lancaster County.

2.2.5 Early and Middle Woodland Periods

The distinctive attribute of Woodland cultures is their manufacture of pottery. The widespread use of ceramics is often associated with the supposition that pottery production is linked to population sedentism, and a stable food supply brought on first by increased reliance on horticulture and later developments in agricultural practices (Custer 1996).

Fiber-tempered pottery was already being made during the Late Archaic in the Southeast, on the Georgia coast by 3300 cal BC and on the Savannah River at 3100 cal BC (Sassaman 2006a). In the Middle Atlantic region ceramic technology appears only much later, after 1450 cal BC, where its appearance denotes the start of the Early Woodland period (Gardner and McNett 1971).

The earliest ceramic type in Pennsylvania and the surrounding region is Marcey Creek Plain (Kinsey 1972, Smith 1978). The modeled clay vessels of the Marcey Creek type (ca. 3200 to 2800 rcbp, 1450 to 1000 cal BC) imitate the shapes of flat-bottomed soapstone pots, including lug handles, and are even tempered with bits of soapstone. This ceramic type has a wide distribution throughout the Susquehanna Valley and likely originated in the Potomac before being brought north through the Lower Susquehanna River Valley (Smith 1978). The Marcey Creek type site (Site 44AR2), where these early ceramics were first recognized, was located in Arlington County, Virginia (Manson 1948). Marcey Creek-like potsherds, thick-walled and tempered with grit and steatite, were found in association with a Perkiomen broadspear and a Merom-like point at the Hansford Site; three radiocarbon dates for a cremation pit are 3030±100, 3040±75, and 3120±70 rcbp (Wilkins 1979; Youse 1992).

Only 97 sites with Early and Middle Woodland period occupations components have been recorded in Lancaster County, and very few of these have been excavated, leaving the Early and Middle Woodland period as one of the least understood periods in this area (PA-SHARE 2024).

2.2.6 Late Woodland Period

Although rare archaeological occurrences suggest that maize was already grown in eastern North America by ca. AD 500 or earlier (e.g., 2325±75 rcbp at Meadowcroft [Stuckenrath et al. 1982:80]), intensive maize horticulture was only adopted by many Middle Atlantic groups around cal AD 1000. Late Woodland sites are often located in floodplains of higher-order streams and adjacent to high-yield agricultural soils (Hantman and Klein 1992). Hunting, gathering, and fishing provided important dietary supplements. Storage of surplus crops permitted the establishment of small permanent hamlets and larger villages. Prior to cal AD 1250 to 1400, settlements were not stockaded, suggesting that inter- and intra-group hostilities did not play a significant role in the settlement pattern (Stewart 1993:171-173). Around cal AD 1250 to 1400, throughout the Middle Atlantic region, population density increased, nucleated settlements and palisaded villages were established, and there is evidence of population movement and displacement (Stewart 1993:172-173).

The changes in cultural patterns observed throughout the Middle Atlantic region may have occurred in response to a changing climate. The period between cal AD 1000 and 1200 (the Medieval Climatic Optimum) may have been characterized by increased dryness, whereas cool-moist to cool-dry conditions prevailed between AD 1300 and 1800 (the Little Ice Age) (Stewart 1993:165). Climate change may have resulted in decreased agricultural productivity and a concurrent increase in the availability of game animals (Carbone 1976; Gardner 1986:88; Walker and Miller 1992). A greater reliance on hunting may have aggravated competition for hunting territories, but more importantly, the increasing population and reduced agricultural productivity would have exacerbated competition for arable land (Custer 1986:135-136).

The dramatic increase in the number of small villages, and the deep cultural deposits and numerous storage pits found at these sites, suggests that Late Woodland populations were not only sedentary but were also expanding both spatially and in absolute numbers. In response to population growth, establishment of sedentary villages, and availability of food surpluses, more complex sociopolitical structures developed during this period. Thus, the middle Late Woodland period is characterized by the emergence, or in some areas the local reappearance, of ranked societies. These ranked societies developed into the complex tribes and chiefdoms encountered by the Europeans in the late sixteenth and early seventeenth centuries (Potter 1993; Turner 1976).

Approximately 165 sites with Late Woodland period components have been recorded in Lancaster County (PA-SHARE 2024). They include large villages as well as smaller hamlets and special-purpose camps. The village sites typically occur on upland flats near fifth-order drainage divides, whereas the smaller sites are located along streams. The Shenks Ferry culture is one of the earliest Late Woodland cultures identified in this region (Kinsey 1971). Several sites associated with this culture have been excavated. The Murry Site, located along the Susquehanna River, dates to approximately 1400 AD.

The Shenks Ferry culture was replaced by the Susquehannocks, Iroquoian speakers, around AD 1525 (PA SHPO 2015). The Susquehannocks have been associated with larger occupations than the receding Shenks Ferry culture. Susquehannock sites consist of large, fortified villages with longhouse structures approximately 60 to 80 feet long. These villages may have housed as many as 5,000 residents at one time. The home territory of the Susquehannock has been identified with the Susquehanna River, particularly those areas including present-day Cumberland, Dauphin, Lancaster, and York counties.

2.2.7 Late Pre-Contact to Contact Periods

At the time of initial European contact, the Susquehannock engaged in an extensive trade network with the Europeans, controlling the fur trade within the area for nearly a century (Commonwealth of Pennsylvania 2010). Extensive warfare with the neighboring Seneca populations in western New York, and the impacts of introduced diseases into the area, resulted in the decimation and defeat of the Susquehannock by AD 1675. With the decimation of the Susquehannock, the Iroquois Confederacy, centered in New York State, acquired control over the majority of their territory within present-day Pennsylvania (Zbiek 1994:21).

2.3 Regional Historic Context

The following history of Pennsylvania briefly summarizes the state's settlement, economy, and sociocultural and industrial development from the colonial period to the twentieth century (Louis Berger 2016).

2.3.1 Colonial Pennsylvania

Though there is no written history that demonstrates the first European entrance into Pennsylvania, it is likely that Europeans did not represent a significant presence in the region until the early sixteenth century. The Iberian fleet, in protection of colonial settlements in the Southeast, dominated the Atlantic and for a time precluded expansion of most European states into the region. Some believe that Giovanni da Verrazano, an Italian navigator in service to the French, may have been the first to penetrate the navigable reaches of the Delaware River in his 1524 exploration of the Atlantic coast. Whether this was the case or not, the Spanish grip on eastern North America was not significantly loosened until Jacques Cartier wintered on the banks of the St. Lawrence in 1535. Mariners from either nation may have entered and explored the Delaware River at sporadic intervals throughout the sixteenth century.

Early in the 1600s, the Dutch, after temporarily seizing Portuguese holdings in Brazil and the Caribbean, established settlements from Delaware to New York. So-called New Amsterdam would remain under that flag until 1644. Most historians agree that Henry Hudson, exploring for the Dutch West India Company, probably visited the region that would later become southeastern Pennsylvania in his 1609 search for the Northwest Passage. Whatever the case, in 1624 the Dutch West India Company did establish a small settlement on Burlington Island (just north of what would later become the City of Philadelphia).

The first permanent settlement in what is now Pennsylvania was established in 1643 by Johan Printz, a Swede, on Tinicum Island just below Philadelphia (Klein and Hoogenboom 1973:11). This settlement was linked to the New Sweden outpost, Fort Christina, on the lower Delaware, and to a later settlement farther up the river near present-day Chester, Pennsylvania. Earlier Dutch settlements had failed, and the Philadelphia area thus came under control of the Swedes for a short period of time. Dutch supremacy was reestablished in 1655, when soldiers from New Netherlands swept through the area and ended the short-lived Swedish colonial undertaking. The Dutch, however, were themselves soon evicted by the English. In 1664 the Duke of York, brother of King Charles II, seized control of all lands between already established English colonies to the south and north of what would soon become Pennsylvania (Klein and Hoogenboom 1973:23).

A result of a debt payment owed by King Charles II to William Penn's late father, Admiral Sir William Penn, the colony of Pennsylvania was established in 1681 with the signing of the Charter of Pennsylvania (Munger 1991:6; Soderlund and Dunn 1989:39). The charter was the largest of its time, furnishing William Penn with more than 45,000 square miles of land. Subsequently, William Penn appointed a set of commissioners to administer the distribution and rental of land in Pennsylvania (Munger 1991:29).

The proprietor's commissioners encountered immediate problems in the southeast, or Piedmont Province, as much of the riverfront property within the boundaries of Penn's grant was already settled. About 2,000 people, not including Native Americans, were living within the overall land grant (Dunn and Dunn 1982:3). Fifty or so frontier farmers inhabited the area that would become the city of Philadelphia (Cotter et al. 1992:33). Penn, to his credit, declared it a general policy of the undertaking not to usurp the property rights of any previous inhabitant of the area, including native peoples.

Pennsylvania's early settlers were largely English (many Quakers), German, Scots-Irish, African American, and, to a lesser extent, Welsh, Irish, French, Swedes, and Jews (Klein and Hoogenboom 1973:39-46; PHMC 2013). The vast majority of European settlers established ethnically homogenous areas; for example, the southeastern portion of the state (herein discussed as the Piedmont Province) was largely settled by English Quakers and, particularly after 1700, Germans. By the early to mid-eighteenth century, Scots-Irish began to settle central and western Pennsylvania, spreading out from the Alleghenies to points west (Klein and Hoogenboom 1973:39-46). The African American population in Pennsylvania was limited early in its colonization, and less than half (3,737 out of 10,200) of the early American Americans residing in colony were listed as enslaved in the 1790 census. However, religious sentiments lend to the condemnation of slavery in Pennsylvania, and the number of slaves in the state plummeted by the nineteenth century (Switala 2001:5).

2.3.2 Lancaster County

The earliest European settlement in present-day Lancaster County dates to circa 1709, when Mennonites from Switzerland settled along Little Beaver Creek and in the vicinity of present-day Lancaster City. The population of what is now Lancaster County during the early eighteenth century included Swiss Mennonites as well as French Huguenots, Scotch-Irish, English, Welsh, and Rhineland Germans. At the time of this initial European settlement, Lancaster County was part of Chester County, which was one of the three original counties established by William Penn. As population increased in the hinterlands of then Chester County, settlements were increasingly located farther from the county seat and municipal institutions. As a result, on May 10, 1729, Lancaster County was set apart from Chester County. The county seat in Lancaster was established in 1730 (Ellis and Evans 1883; Loose 2013; PHMC 2016). Settlement quickly progressed as diverse ethnicities and religious groups moved into the area.

The early eighteenth-century settlements in Lancaster County focused primarily upon agriculture. The rich limestone soil made it an ideal location for farming. Farmers planted a wide range of crops and livestock for home use and for sale. The fields were periodically left to lie fallow, with fallow land, woodlots, and meadowland occupying a significant portion of each farmer's land holdings.

From the start, Pennsylvania farming families participated in the global commodities trade, sending products across the Atlantic and to the Caribbean. Around 1730, historian Brooke Hunter notes, population growth, war, and crop failures in Europe stimulated an "explosive growth in demand" for grain, and Pennsylvanian farmers were well positioned to respond. They raised grain to sell to Philadelphia millers, who in turn exported flour. The burgeoning West Indies plantation economy soaked up all sorts of provisions including flour and meat. Pennsylvania-produced foodstuffs were also sent along the coastwise trade from New England to the Carolinas [PHMC 2016:13].

By 1733 a road had been established connecting Lancaster to Philadelphia. This highway further enabled farmers in Lancaster County to access outside markets.

Wheat was one of the preeminent crops raised by Lancaster County farmers; however, these farmers also produced rye, barley, oats, buckwheat, Indian corn, potatoes, turnips, cabbage, apples, peaches, cherries, flax, flax seed, hemp, pork, beef, mutton, eggs, wool, butter, and a variety of other vegetables and fruits. Farmers also raised and sold cattle, sheep, swine, poultry, and bees (PHMC 2016:13-14).

In addition to agricultural pursuits, early settlers in the county constructed gristmills, sawmills, and fulling mills along the watercourses in the area. Ironworks, including furnace and forge operations, were also established. Taverns and public houses operated near the gristmills and along the major thoroughfares of the time (Ellis and Evans 1883:23). The mills and ironworks also served a secondary function, providing a central meeting place for the establishment of agricultural markets and stores. "These stores were liberally and widely distributed, and virtually every southeastern Pennsylvania household was situated near at least one" (PHMC 2016:14).

Lancaster County played a significant role in both the French and Indian War and the Revolutionary War. During the French and Indian War, gunsmiths and metalworkers in the county produced rifles and other supplies for the British. During the Revolutionary War production of war supplies and materials increased in the county. County mills produced barrels of ground flour, and wagonmakers built Conestoga wagons and other vehicles. The local furnace and forge operations produced weapons and other equipment for the war. "Lancaster County became the arsenal, work shop and granary of the continental armies" (Loose 2013). On September 27, 1777, the Continental Congress, fleeing the British incursion into Philadelphia, held a session in Lancaster and established Lancaster as the temporary capital. The Pennsylvania government also established itself at Lancaster for the duration of the British occupation of Philadelphia. The Continental Congress later moved and reestablished itself in York County (Loose 2013).

Many Pennsylvania citizens took part in the revolution. Pennsylvanians supported the war as soldiers and manufacturers of arms and ships, as well as in the production and dispersal of supplies and food. Revolutionary sentiments were strong throughout the state. In the east, as indicated by one nineteenth-century historian, "there is not a part of Pennsylvania wherein the love of liberty displayed itself earlier or more strongly than in the county of York" (Carter 1834:76-77; Prowell 1914). In the west Fort Pitt was used as a base of western military operations. All over Pennsylvania men gathered, assembled militias, and set up frontier defenses. According to Hassler (1900), George B. Gibson was responsible for assembling the famed "Gibson's Lambs," a revolutionary company formed of men from the Monongahela Valley and Pittsburgh. This militia gained attention for their successes against the British and Tories in coastal Virginia (Hassler 1900:32). Some of Pennsylvania's western settlements were toppled during the war, such as Hannastown in Westmoreland County, which was destroyed in 1782.

Following the Revolutionary War Lancaster County resumed its continued growth, although its regional importance was diminished by increasing settlements in western Pennsylvania and the Ohio Valley. The boundaries of Lancaster County were truncated several times before and after the Revolutionary War. Between 1749 and 1752, York, Cumberland, and Berks counties were established from portions of Lancaster County. In 1772 and 1785, the territory of Lancaster County was further diminished by the establishment of Northumberland and Dauphin counties. The boundaries of Lancaster County were finally set with the establishment of Lebanon County in 1813 (Ellis and Evans 1883:25).

Although the city of Lancaster served as the state capital between 1799 and 1813, the economy of Lancaster County stagnated around that time because it was located far from a port. After the termination of the War of 1812, new industrial operations took hold, including gristmills, lime-burning operations (kilns), and ironworks. Approximately 300 flour (grist) mills were operating along the waterways in the county. Lime kilns were producing lime for soil fertilizer for farm operations in southern Lancaster County and neighboring counties. Local artisans also produced fine furniture, grandfather clocks, silverware, and pewterware. County residents also focused their efforts on land speculation and town building. Textile mills were established on creeks and other water courses. During the early to mid-nineteenth century, Lancaster County's major industry, in terms of investment and production, was charcoal iron production. Cold blast furnaces and forges in the county consumed acres of woodland in the form of charcoal fuel. Forges that converted pig iron into wrought iron were located along most of the creeks in the county (Loose 2013).

Following the Revolutionary War and into the mid-nineteenth century, farmers in Lancaster County shifted their operations from an extensive, mainly crop-based system to a more intensive crop-and-livestock system. As nonagricultural population in urban and industrial centers increased nationwide, farmers' attention shifted to producing meat and other bulky items that could be marketed locally, and hay, livestock, and dairy products became increasingly important components of the agricultural system in Lancaster County; cattle, swine, and butter dairying played important roles by 1850. Nevertheless, county farmers continued to produce a variety of crops and products. By 1850 Lancaster County was the largest producer of clover seed in Pennsylvania; the county was also the second largest producer of oats, potatoes, hay, and buckwheat (PHMC 2016). The agricultural census for that year indicates that there were approximately 6,000 farms in Lancaster County.

Several road systems were constructed in the early to mid-nineteenth century to connect the industrial and agricultural producers of Lancaster County to outside markets. Between 1794 and 1800, the Lancaster Pike was constructed connecting Lancaster to Philadelphia. This turnpike represented Pennsylvania's first great turnpike. Additional highways were built to connect Lancaster with towns inside and outside the county. In 1834 the Columbia and Philadelphia Railroad was extended through Lancaster, joining the Susquehanna River to Lancaster City. Beginning in the early 1800s, several companies were incorporated with the intent of establishing a navigable link between Conestoga Creek in Lancaster and the Susquehanna River. In 1825 the Conestoga Navigation Company was incorporated. The section considered for navigation extended from Reigart's Landing in southeastern Lancaster to Safe Harbor on the Susquehanna. The design for the proposed Conestoga Slackwater Canal proposed that the entire route consist of slackwater navigation with nine dam-lock combinations. After financial difficulties and weather events that destroyed and damaged several dams, the canal was completed in 1828. The opening of the Susquehanna and Tidewater Canal in 1840 provided the Conestoga Slackwater Canal with direct connections to Baltimore and the Main Line canal system. Although the canal system facilitated trade with Baltimore and other market cities, and despite the fact that the dams along the canal created power sources for mills established along the Conestoga, navigation of the system was never profitable. The canal had been abandoned by 1850 (American Canal Society Canal Index 2009).

With the growth of the railroads and closure of canal traffic in the mid-nineteenth century, manufacturing and industry diversified in Lancaster County. Cigars, cotton and silk cloth, beer, stoves, watches and clocks, and farm tools were manufactured in the county. The Rowe Motor Car Company and other small businesses began settling in the area. "Metalworking, automotive parts and small castings plants provided employment for thousands of countians [sic]" (Loose 2013). The production of iron ceased in Lancaster County at the close of the nineteenth century because of the shift from anthracite coal fuel to bituminous and the industry's subsequent expansion in the Appalachian region (Stapleton 1978:157).

Agricultural production in the county continued throughout the mid-nineteenth through early twentieth centuries and continued to be diversified. The single greatest addition to the farm system was the cultivation of tobacco. From 1850 to 1880, the production of tobacco in the county jumped from 2 million pounds annually to 37 million pounds. By 1919 Lancaster County accounted for 50 million pounds of annual tobacco production. The county produced exclusively cigar tobacco, however, and tobacco production in the county diminished with the increasing popularity of cigarettes throughout the twentieth century. Beginning around 1900, fluid milk dairying became a more prominent component of the Lancaster County farming economy, fueled by demand from cities and the introduction of the refrigerated rail car. Simultaneously, home butter production was curtailed. The poultry business also expanded during the twentieth century (PHMC 2016:46).

During the twentieth century candy, confectionery, and cigar-making operations in Lancaster County began to close. Larger industrial operations, including the Armstrong Cork Company, Raybestos-Manhattan, Sperry-Rand, ITT Grinnell, RCA, and the Kerr Glass Company became prominent employers in the county. These companies manufactured products such as rubber, glass, brakes, and cork. A garment industry also persisted in the county through the twentieth century, including clothing, hats, and shoes.

Present-day Lancaster County's economy consists of three basic components—manufacturing, agriculture, and tourism. Two-thirds of the land area consists of farmland, with animal products representing approximately 90 percent of farm cash receipts. Much of the tourist industry in Lancaster County focuses on the Amish community in the area. The Amish, along with other Anabaptist groups, settled in the Lancaster area at the onset of European settlement of the region, as described above. Anabaptists originated in sixteenth-century Europe. These groups share a belief in voluntary adult baptism, nonviolence, and discipleship. The Amish and the Mennonites are two of the Anabaptist religions. Today, the Amish community in Lancaster County represents the oldest and largest Amish settlement in the United States, totaling nearly 30,000 people. The population has doubled over the past 20 years. Lancaster County is currently home to nearly 30 different Anabaptist groups, with more than 52,000 members. These groups reject individualism and are noted for their plain dress and aversion to technology (which they believe helps keep them separate from the modern world) to varying degrees, depending on sect and church (Lancaster Mennonite Historical Society 2009; Pennsylvania Dutch Convention & Visitors Bureau 2013). Tours of Lancaster County often focus on these Anabaptist communities and their lifestyle, which plays into notions of traditionalism and past simpler times.

2.4 Cartographic Review

Analysis of historical maps and aerial photographs of the APE was conducted to develop a detailed understanding of the development and land use history of the APE between 1842 and 2019. The historical development of the APE is discussed below relative to the year in which it was mapped.

The *Bridgens' Atlas of Lancaster County* (1864) shows dispersed settlement throughout Lancaster County with little to no development within most of the sites (Figures 3-5). There are structures labeled "Mrs. Messimer" in Site 1 and "J. Hummer" in Site 2 (see Figure 3). The atlas also depicts a graveyard in Site 3 (see Figure 4). There is a structure labeled "Dd. Greiner" mapped in Site 7 on this atlas and there is also a structure labeled "Jn. Greiner" adjacent to the Site (see Figure 5).

The Lancaster 1902 15-minute quadrangle by the United States Geological Survey (USGS 1902) depicts a structure in the approximate location of the one labeled as "J. Hummer" on the 1864 atlas in Site 2 (Figure 6). The structure associated with "Mrs. Messimer" on the 1864 atlas is now clearly depicted on the west side of Meadowview Rd. There are now two structures depicted in the southeastern portion of Site 3 and a church is depicted along Mastersonville Road outside of the site as well as a structure in the eastern portion of Site 7.

The Middletown 1908 15-minute quadrangle by the USGS depicts a structure within the boundaries of Site 5 along Elizabethtown Road (Figure 7). There are no structures depicted within Sites 4, 8, and 9.

The Lancaster and Middletown 1943 15-minute quadrangles show a similar level of development to the earlier ones, however; the structure previously depicted in Site 2 is not mapped (Figure 8). There is also a structure now depicted in the eastern extent of Site 2 along Buckwale Road. The structures within Site 3 are still depicted as is the church and graveyard adjacent to the site. The structure depicted in Site 7 on the 1902 USGS map is still showing on the 1943 map.

Topographic mapping from 1943 to 2019 shows little change to the area beyond a few additional structures visible within the study area.

Aerial imagery is available from the mid-twentieth century to the present day (NETR var.; USGS var.). The earliest imagery dates to 1951 and shows predominately agricultural fields with limited preserved wooded areas in the proposed APE and study area. Farm complexes and agricultural structures are common features on the landscape within the proposed APE. Aerial imagery from sites 2, 3, 4, 5, 6, 7, and 8 all indicate structures present in 1951. Sites 1, 4, 5, 6 and 8 show no additional major changes to the APE landscape from 1951 through the present day. However, aerial imagery from various years show either landscape alterations or limited structural development/removal at Sites 2, 3, 7, 9 and 10. For example, the 1969 aerial imagery at Site 9 shows the construction of the extant barn structure directly adjacent to T-406, while still later imagery from 1999 shows the construction of two extant homes within the APE bordering Little Chiques Creek to the southeast (USGS var.).

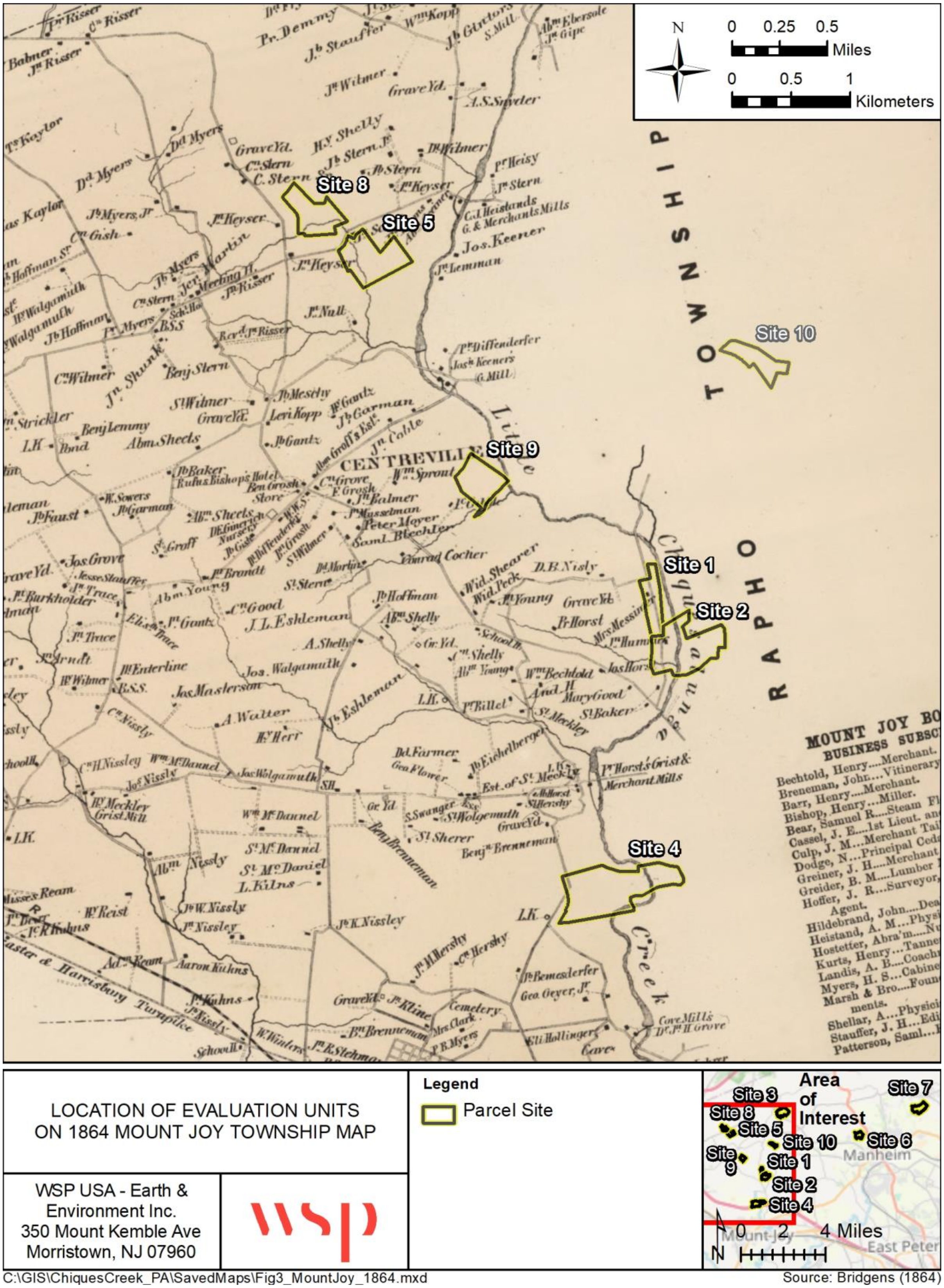


Figure 3: Location of Evaluation Units on 1864 Mount Joy Township Map

Figure 4: Location of Evaluation Units on 1864 Rapho Township Map

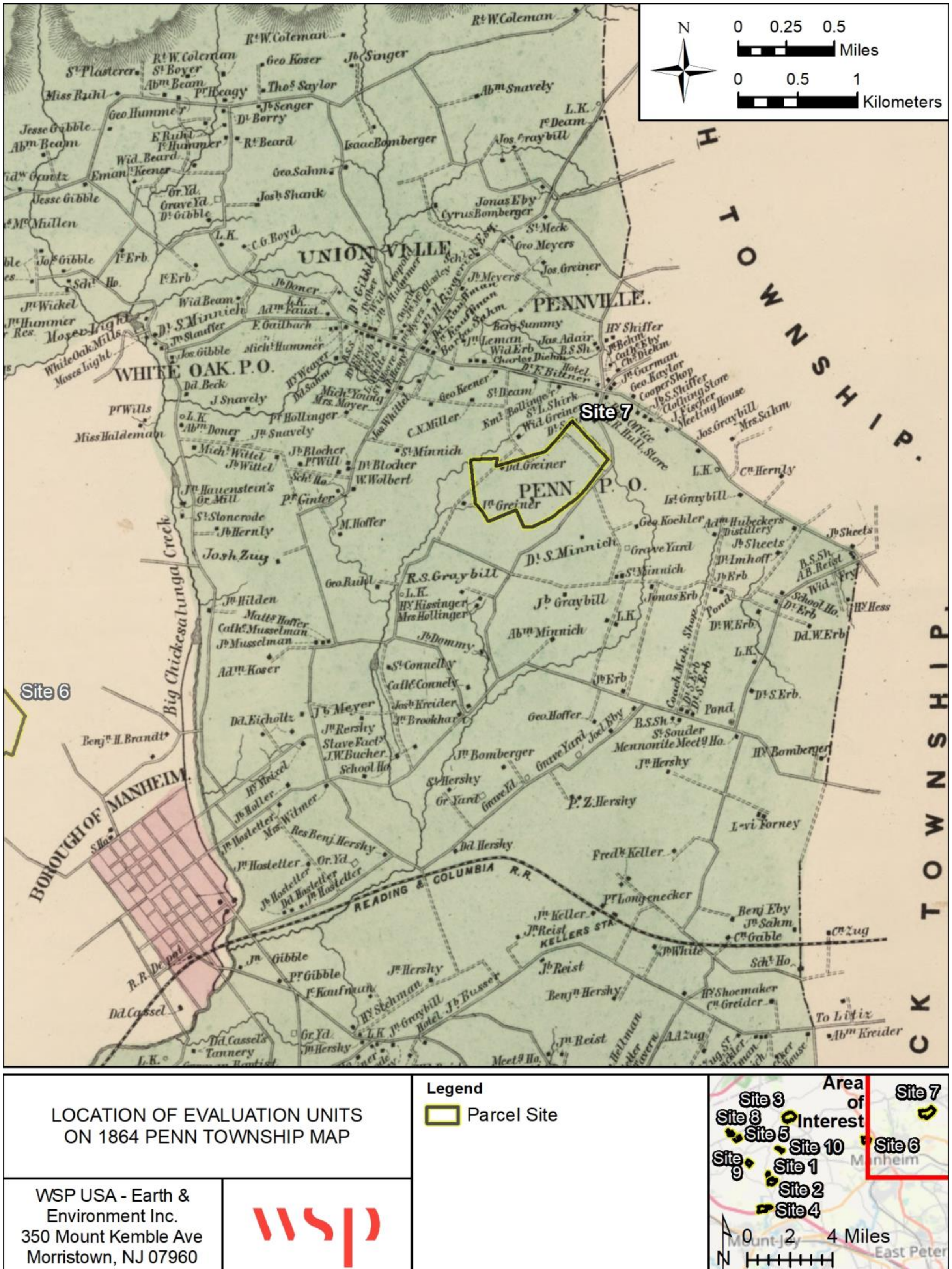


Figure 5: Location of Evaluation Units on 1864 Penn Township Map

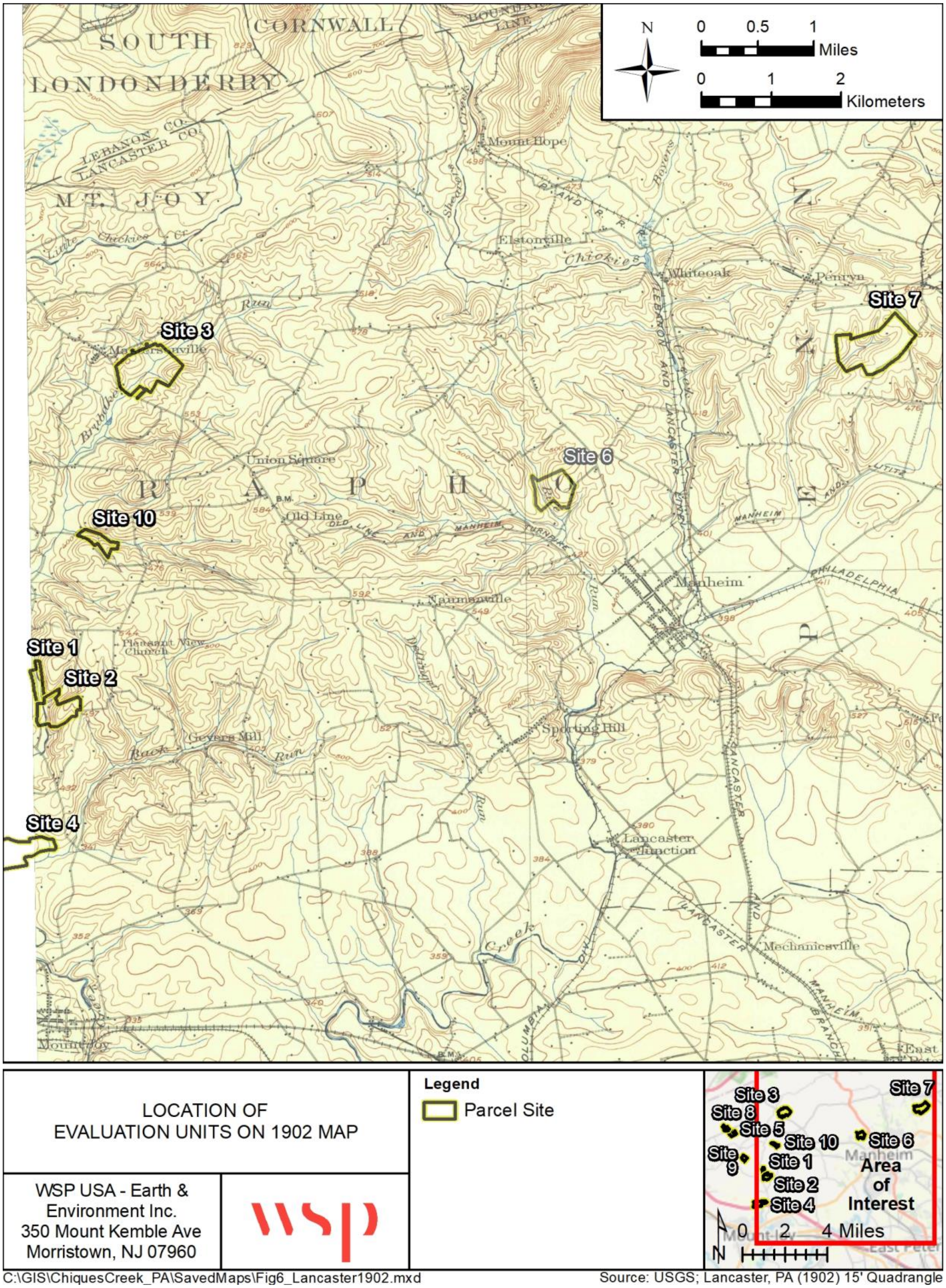
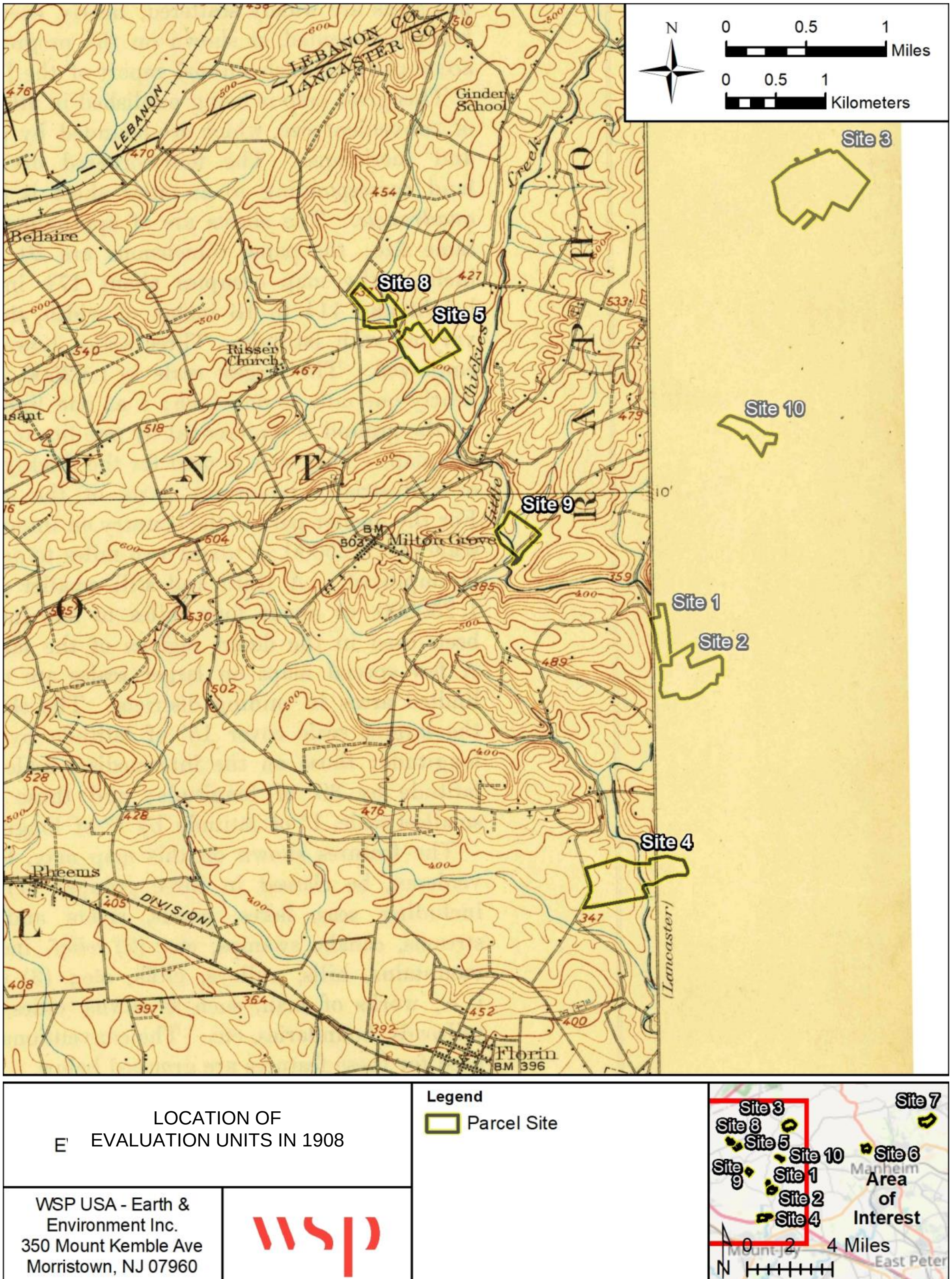


Figure 6: Location of Evaluation Units on 1902 Map



C:\GIS\ChiquesCreek_PA\SavedMaps\Fig7_Middletown1908.mxd

Source: USGS; Lancaster, PA (1902) 15' Quadrangle

Figure 7: Location of Evaluation Units on 1908 Map

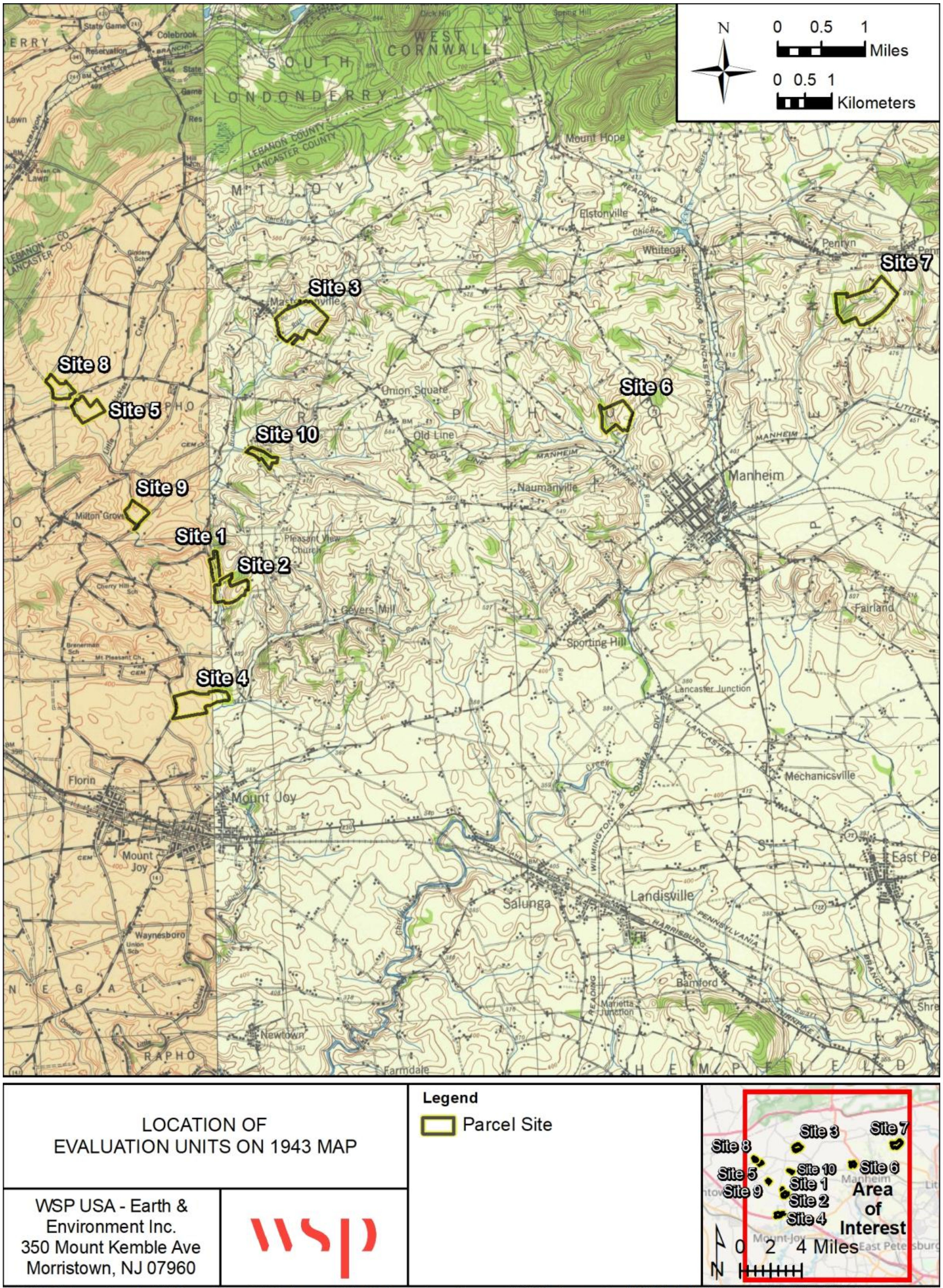


Figure 8: Location of Evaluation Units on 1943

2.5 Previously Documented Archaeological Sites

Research conducted using PA-SHARE revealed that 16 archaeological sites have been previously documented within a 1.6-kilometer (1-mile) radius of the APE (Table 2). Seven pre-contact sites, five historic, and four multi-component historic and pre-contact sites. There are no recorded archaeological sites within the APE.

TABLE 2

RECORDED ARCHAEOLOGICAL SITES WITHIN 1.6 KILOMETERS (1 MILE) OF THE APE

EVALUATION AREA	SITE NUMBER/ NAME	DISTANCE FROM PROJECT AREA	SITE TYPE/ TIME PERIOD	ARTIFACTS/ FEATURES	NRHP ELIGIBILITY	REPORTED BY
1/10	36LA1560 / S4C-vi-JRS-06	1,596 m (5,236 ft)	Open habitation/Pre-Contact	Quartz debitage/none	Not eligible	Susan Landis
1/10	36LA178 / S4C-vi-JRS-05	1,561 m (5,121 ft)	No data / Pre-Contact	Quartz debitage/none	Undetermined	Susan Landis
1	36LA1558 / S4C-vi-BML-01	1,470 m (4,822 ft)	Pre-Contact and Historic	Historic ceramics and metal. Pre-Contact quartz lithics	Not eligible	Susan Landis
1/10	36LA1559 / S4C-vi-JRS-04	1,461 m (4,793 ft)	Open habitation/Pre-Contact	Quartz debitage and chipped stone tools/no data	Not eligible	Susan Landis
1/2/10	36LA177 / S4C-vi-BML-02	1,416 m (4,645 ft)	Isolated find/Pre-Contact	Quartz debitage/no data	Undetermined	Susan Landis
1/2/9	36LA1517 / Meadowview Rd 1	360 m (1,181 ft)	Farmstead/historic	Architectural and kitchen/fence line and foundation	Not eligible	Susan Landis
5	36LA1557 / S4C-vi-ALW-02	505 m (1,656 ft)	Pre-Contact and historic	Quartz debitage and historic architectural/no data	Not eligible	Susan Landis
5/8	36LA176 / S4C-vi-AWL-01	445 m (1,460 ft)	Non-site collection/Pre-Contact	Quartz debitage/no data	Undetermined	Susan Landis
5/8	36LA/153 / S4C-vi-JRS-03	745 m (2,444 ft)	Non-site collection/historic	Ceramics/no data	Undetermined	Susan Landis
5/8	36LA/179 /	840 m (2,755 ft)	Non-site collection/historic	Ceramics/no data	Undetermined	Susan Landis
5/8	36LA/152 / S4C-iv-JRS-02	825 m (2,706 ft)	Non-site collection/Pre-Contact	Quartz debitage	Undetermined	Susan Landis

TABLE 2 (continued)

EVALUATION AREA	SITE NUMBER/ NAME	DISTANCE FROM PROJECT AREA	SITE TYPE/ TIME PERIOD	ARTIFACTS/ FEATURES	NRHP ELIGIBILITY	REPORTED BY
5/8	36LA1549 / S4C-vi-JRS-01	910 m (2,985 ft)	Open habitation/Pre-Contact	Quartz debitage	Undetermined	Susan Landis
5	36LA/156 / S3C-iii-KSJ-01	1,071 m (3,513 ft)	Non-site collection/Pre-Contact and historic	Argillite debitage and historic ceramic	Undetermined	Susan Landis
5/8/9	36LA0982 / Gantz, Gish, Derr Farmhouse	1,022 m (3,453 ft)	Unknown/historic	Ceramic, glass, metal, and bone/foundation	Not eligible	Not available
8	36LA1561 / S5A-iii-ALW-01	1,530 m (5,019 ft)	Undefined/Pre-Contact and historic	Quartz debitage, historic ceramic and metal/no data	Not eligible	Susan Landis
1	36LA175 / S4Bviii-KSJ-01	1,626 m (5,334.5 ft)	Unknown/historic	Whiteware	Undetermined	AECOM

2.6 Previously Documented Architectural Resources

Research conducted using PA-SHARE identified no previously conducted architectural surveys documented in the APE or the study area. Two previously identified architectural resources were recorded in the APE and an additional 47 resources were identified in the study area (Table 3). Five District Resources were identified in the study area; no District Resources were documented in the APE. Only the Risser's Mill Complex is recorded as an eligible District Resource and is located directly adjacent to the current proposed APE boundary (Site 4).

TABLE 3

RECORDED ARCHITECTURAL AND DISTRICT RESOURCES WITHIN 1.6 KILOMETERS (1 MILE) OF THE APE

RESOURCE NO.	RESOURCE NAME	DATE CONSTRUCTED	ELIGIBILITY STATUS	WITHIN APE (Y/N)
1980RE00704	Risser's Mill Covered Bridge	1849	Not Eligible	N
1984RE01007	Risser House	1811	Eligible	N
1991RE00901	Hossler School House	1916	Eligible	N
1993RE00022	Zug, Samuel, Farm	ca. 1815	Eligible	N
1995RE07171	Snyder's Mill	ca. 1800/1820	Undetermined	N
1995RE07180		ca. 1800/1835	Undetermined	N
1995RE32650	Miller, David L., House	ca. 1800/1835	Undetermined	N
1995RE32653	Schiringer, H., House	ca. 1773	Undetermined	N
1995RE32655		ca. 1836/1865	Undetermined	N
1995RE32660		-	Undetermined	N
1995RE32665	Milton Grove Mill	ca. 1813	Undetermined	N
1995RE32667		**-**	***Undetermined***	***Y***

1995RE32668		ca. 1816	Undetermined	N
1995RE49346	Saint Paul's Lutheran Church	ca. 1912	Undetermined	N
2004RE04035		1951	Not Eligible	N
2004RE04036	Little Chickies Bridge 1	1926	Not Eligible	N
2004RE04038		1907	Demolished	N
2004RE05452		ca. 1930	Not Eligible	N
2004RE05453		ca. 1920	Not Eligible	N
2004RE07017		ca. 1950	Not Eligible	N
2004RE10139		1947	Not Eligible	N
2004RE11828		ca. 1950	Demolished	N
2004RE11833	***Bridge***	***ca. 1920***	***Demolished***	***Y***
2004RE11834		1934	Not Eligible	N
2008RE00319	Herr's Mill	ca. 1800	Eligible	N
2008RE00822	Brandt Farm	1864	Eligible	N
2014RE00342	Manheim Central Junior High School	ca. 1923	Undetermined	N
2016RE01557	Henry Ruhl Farmstead	ca. 1859	Not Eligible	N
2018RE00149	Building associated with Samuel Zug Farm	ca. 1878	Undetermined	N
2018RE03301	Bruckhart, Randall G. and Julie A., Farmstead	ca. 1900	Undetermined	N
2019RE01083		ca 1766/1799	Undetermined	N
2019RE02235		ca. 1762	Undetermined	N
2019RE08004		ca. 1815/1840	Undetermined	N
2019RE09113		ca. 1910/1920	Undetermined	N
2019RE12654		ca. 1800	Undetermined	N
2019RE12655		ca. 1850	Undetermined	N
2019RE12657		ca. 1850/1870	Undetermined	N
2019RE16158	Kready's Store	ca. 1870	Undetermined	N
2019RE18244	Plasterer's, Molly, Tavern	ca. 1835/1870	Undetermined	N
2019RE19581		ca. 1880/1890	Undetermined	N
2019RE19582		ca. 1800/1824	Undetermined	N
2019RE19583	Prussian House	ca. 1875/1890	Undetermined	N
2019RE20458	Old Peter's Road	ca. 1718/1719	Undetermined	N
2019RE21808	Risser's Mill	ca. 1815/1816	Undetermined	N
2019RE22773		ca. 1800	Undetermined	N
2019RE25067		ca. 1818/1849	Undetermined	N
2019RE26067		ca. 1762/1799	Undetermined	N
2019RE26068	Keler Property	ca. 1762/1799	Undetermined	N
2023RE06874	Lincoln Cemetery	-	Undetermined	N
1990RE00571	Manheim Borough Historic District	1762-1949	Listed	N
1996RE00192	Mount Joy Historic District	-	Not Eligible	
2000RE00579	Florin Historic District	-	Not Eligible	
2005RE01095	Risser’s Mill Complex	-	Eligible	
2021RE02630	Philadelphia & Reading Railroad	ca. 1833-1960	Eligible	

PA-SHARE 2024
Notes: Resource No. = the unique identification number assigned to each document in PA-SHARE; N/A = not available.
Bold and Italicized = Resource within APE

2.7 Previously Conducted Cultural Resource Investigations

Research conducted via PA-SHARE identified 11 previously conducted cultural resource investigations in the vicinity of the APE (Table 4). No previously conducted cultural resource investigations are in the APE.

TABLE 4

PREVIOUS CULTURAL RESOURCE MANAGEMENT REPORTS IN THE VICINITY OF THE APE

EVALUATION UNIT	REPORT AUTHOR	REPORT TITLE	RESULTS	REPORT NO.
1/2/5/8/9/10	URS. 2015	Phase I Archaeological Survey, Atlantic Sunrise Pipeline Project, Lancaster, Lebanon, Schuylkill, Northumberland, Columbia, Luzerne,	Survey included 46,300 sample loci and 17,812 shovel tests. Survey identified 64 archaeological resources, 33 isolated findspots, and 31 archaeological sites. Addendum identified 81 archaeological resources including 43 isolated finds and 37 archaeological sites.	
1/2/5/8/9/10	URS, 2015	Phase I Archaeological Survey, Addendum 1, Atlantic Sunrise Pipeline Project, Lancaster, Lebanon, Schuylkill, Northumberland, Columbia, Luzerne, Wyoming, Susquehanna, Lycoming, and Clinton Counties	Addendum 1 also included a geomorphology investigation. Additional deep testing was recommended for a few locations.	2009-6113-063-B
1/2/9/10	Robert D. Wall, 1992	Phase I Archaeological Survey, Wenger Subdivision, Rapho Township, Lancaster County	Surface collection and auger testing within 18 acres. No archaeological material or features identified.	1992-RP-00017
1/2	Rebecca Knapp, 2013	Supplemental Phase I Archaeological Survey of Lancaster 4033-001, MPMS 74955 Meadowview Bridge #3 Replacement	Archaeological site 36LA1517 identified dating to the first half of the 20th century. Site determined not eligible.	2013-RP-00567
1/2/4/	Corey L. Hovanek, 2022	Geomorphological Assessment Report, SR 4033-007 Bridge over Little Chickies Creek, MPMS 20149, Mount Joy and Ralpho Townships, Lancaster County, PA	Survey determined there is little to no potential for Pre-Contact archaeological resources in the project APE.	2022-RP-00204
1/2/4	Archaeological and Historical Consultants, Inc., 2007	Phase I Archaeological Survey Report, Risser's Mill Bridge over a tributary to Little Chiques Creek, Lancaster County	No NRHP eligible archaeological resources identified.	2007-RP-00054

4/8	Michael A. Stanilla	Phase I Archaeological Report, SR 4008 Section 019, Bridge over Chickies Creek Replacement, Mount Joy and Rapho Townships, Lancaster County	No archaeological resources identified.	2008-RP-00127
4/8/9	W. Fred Kinsey and June Evans, 1989	A Phase I Archaeological Survey of the Milton Grove Quarry, Mount Joy Township, Lancaster County, PA	Survey determined most of the APE was disturbed. No archaeological resources identified.	1989-RP-08472
7	W. Fred Kinsey, 1995	Phase I Archaeological Survey of the Elm Subdivision, Penn Township, Lancaster County	No archaeological resources identified.	1995-RP-00132
7	Elizabeth L. Roman, 2017	Phase I Archaeological Survey, Elm 1 Cell Tower Project (New Location), Penn Township, Lancaster County	No archaeological resources identified.	2017-RP-00280
9	Stell Environmental Enterprises, Inc., 2012	Negative Survey Form, SR 4033 Sec 001, Bridge over Little Chiques Creek Replacement Project, Mount Joy and Ralpho Townships, Lancaster County	Modern historic materials were recovered. Determined not to constitute an archaeological site.	2012-RP-00059

3.0 Archaeological Resource Potential

The potential for the Evaluation Units to contain archaeological resources is informed by the Pre-Contact Probability Model on PA-SHARE, archival background research, the mapped soils in the sites, and the historical cartographic research.

3.1 Site 1

Site 1 is located along Meadow View Road and is split between Rapho and Mount Joy Townships (see Figure 2). The township line follows Little Chiques Creek which runs through the center of the site. The site is primarily agricultural and forested land. According to the topographic maps, the majority of the eastern side of the site appears to be on slope. The Pre-Contact Probability Model on PA-SHARE shows portions of the site near the creek as containing moderate to high sensitivity for *p*re-Contact archaeological resources. The soils mapped in the site range from moderately well drained to well drained (see Table 1). As such, portions of the site located on level and dry land have a moderate to high probability to contain archaeological resources. The cartographic and archival background research did not indicate the presence of a historic-period occupation in or in the immediate vicinity of the site. Therefore, the potentially undisturbed portions of the project area are considered to possess low historical archaeological sensitivity.

3.2 Site 2

Site 2 is located south of Site 1 between Meadow View Road and Buckwalter Road in Rapho and Mount Joy Townships. Little Chiques Creek runs through the western portion of the site (see Figure 2). The site is primarily agricultural and forested land. The Pre-Contact Probability Model on PA-SHARE shows portions of the site near the creek as containing moderate to high sensitivity for pre-Contact archaeological resources. The soils mapped in the site range from moderately well drained to well drained (see Table 1). As such, portions of the site located on level and dry land have a moderate to high probability to contain archaeological resources. The cartographic and archival background research identified a historic structure dating from at least 1864 within the western portion of the site and a structure dating to from the mid-twentieth century or earlier in the eastern extent (see Figures 3 and 8). Therefore, the potentially undisturbed, dry portions of the project area are considered to possess moderate to high historical archaeological sensitivity.

3.3 Site 3

Site 3 is located near the intersection of Mastersonville Road and N. Colebrook Road in Rapho Township (see Figure 2). Brubaker Run runs through the approximate center of the site. The site is primarily agricultural land. The Pre-Contact Probability Model on PA-SHARE shows only a couple of small portions of the site near Brunbaker Run as containing moderate to high sensitivity for Pre-Contact archaeological resources. The soils mapped in the site range from moderately well drained to well drained (see Table 1. As such, portions of the site located on level and dry land have a moderate to high probability to contain *p*re-Contact archaeological resources. The cartographic and archival background research identified a graveyard along the northern boundary of Site 3 as early as 1864 and historic structures in the southeastern portion of the site as early as 1902 (see Figures *4* and *6*). Therefore, the potentially undisturbed, dry portions of the project area are considered to possess moderate to high historical archaeological sensitivity.

3.4 Site 4

Site 4 is located at the intersection of Risser Mill Road and PA 283 in Mount Joy Township (see Figure 2). Little Chiques Creek meanders along the eastern edge of the property boundary. The site is primarily agricultural land. The Pre-Contact Probability Model on PA-SHARE shows portions of the site near Little Chiques Creek in the north as containing moderate to high sensitivity for *p*re-Contact archaeological resources. The soils mapped in the site are well drained (see Table 1). As such, portions of the site located on level and dry land have a moderate to high probability to contain *p*re-Contact archaeological resources. There is a farm complex visible on the 1951 aerial imagery in the Site 4 APE. Therefore, the potentially undisturbed, dry portions of the project area is considered to possess moderate to high historical archaeological sensitivity.

3.5 Site 5

Site 5 is located along Elizabethtown Road in Mount Joy Township and is primarily agricultural land (see Figure 2). Shells Run runs through the western portion of the site. The Pre-Contact Probability Model on PA-SHARE shows a few areas east of Shells Run as containing moderate to high sensitivity for Pre-Contact archaeological resources. Most of the soils mapped in the site range are well drained (see Table 1). As such, portions of the site located on level and dry land have a moderate to high probability to contain *p*re-Contact archaeological resources. The cartographic and archival background research identified an historic structure in the northern portion of the site along Elizabethtown Road as early as 1908 (see Figure *7*). Therefore, the potentially undisturbed, dry portions of the project area are considered to possess moderate to high historical archaeological sensitivity.

3.6 Site 6

Site 6 is located along West Hernley Road in Rapho Township and is primarily agricultural land (see Figure 2). Rife Run runs through the western portion of the site. The Pre-Contact Probability Model on PA-SHARE shows portions of the site as containing moderate sensitivity for *p*re-Contact archaeological resources. Most of the soils mapped in the site range are well drained (see Table 1). As such, portions of the site that are located on level and dry land have a moderate probability to contain *p*re-Contact archaeological resources. There is a farm complex visible on the 1951 aerial imagery in the Site 6 APE. Therefore, the potentially undisturbed, dry portions of the project area is considered to possess moderate to high historical archaeological sensitivity.

3.7 Site 7

Site 7 is located along Elm Road and Brooklawn Road in Penn Township (see Figure 2). The site is an agrotourism operation and is therefore primarily agricultural land. Doe Run runs through the western portion of the site. The Pre-Contact Probability Model on PA-SHARE shows small portions of the site as containing moderate sensitivity for *p*re-Contact archaeological resources. Most of the soils mapped in the site range are well drained (see Table 1). As such, portions of the site that are located on level and dry land have a moderate probability to contain *p*re-Contact archaeological resources. The cartographic and archival background research identified historic structures in the northern portion of the site dating as early as 1864 and in the eastern portion of the site dating as early as 1902 (see Figures *5* and *6*). Therefore, the potentially undisturbed, dry portions of the project area are considered to possess moderate to high historical archaeological sensitivity.

3.8 Site 8

Site 8 is located along Harvest Road and Trail Road North in Mount Joy Township (see Figure 2). The site is an agrotourism operation and is therefore primarily agricultural land. Site 8 is located along Shells Run and is bisected by a tributary to Shells Run. The Pre-Contact Probability Model on PA-SHARE shows portions of the site as containing moderate to high sensitivity for *p*re-Contact archaeological resources. Most of the soils mapped in the site range are well drained (see Table 1). As such, portions of the site that are located on level and dry land have a moderate probability to contain *p*re-Contact archaeological resources. There is a farm complex visible on the 1951 aerial imagery in the Site 4 APE. Therefore, the potentially undisturbed, dry portions of the project area is considered to possess moderate to high historical archaeological sensitivity.

3.9 Site 9

Site 9 is located along Echo Valley Road in Rapho Township (see Figure 2). The site is primarily maintained lawn. Site 9 is located along Little Chiques Creek and is bisected by a tributary to Little Chiques Creek. The Pre-Contact Probability Model on PA-SHARE shows most of the site as containing moderate to high sensitivity for Pre-Contact archaeological resources. Most of the soils mapped in the site range are well drained (see Table 1). As such, portions of the site that are located on level and dry land have a moderate probability to contain *p*re-Contact archaeological resources. The cartographic and archival background research did not indicate the presence of a historic-period occupation in or in the immediate vicinity of the site. Therefore, the potentially undisturbed portions of the project area are considered to possess low historical archaeological sensitivity.

3.10 Site10

Site 10 is located along Valley Road in Rapho Township (see Figure 2). The site is primarily forested land. Site 10 is located along a tributary to Brubaker Run. The Pre-Contact Probability Model on PA-SHARE shows portions of the site as containing moderate sensitivity for *p*re-Contact archaeological resources. Most of the soils mapped in the site range are well drained (see Table 1). As such, portions of the site that are located on level and dry land have a moderate probability to contain *p*re-Contact archaeological resources. The cartographic and archival background research did not indicate the presence of a historic-period occupation in or in the immediate vicinity of the site. Therefore, the potentially undisturbed portions of the project area are considered to possess low historical archaeological sensitivity.

3.0 Conclusions and Recommendations

WSP competed a Phase IA archaeological desktop review for the for the Chiques Creek Watershed Project Programmatic Environmental Assessment project. The purpose of the Project is to identify and implement a programmatic approach to reducing the amount of nutrient-laden legacy sediment loads from the Chiques Creek Watershed entering the Chesapeake Bay.

The purpose of the Phase IA archaeological and architectural survey was to determine the extent to which the Project may affect cultural resources. The survey included a literature search and archaeological sensitivity assessments for the sites and the associated study area. The Chiques Creek Watershed has approximately 36 previously identified archaeological sites with evidence of Pre-Contact habitation. None of the pre-Contact archaeological sites are located within the APE; however, eleven of the Pre-Contact archaeological sites are located within the study area. The study area included 16 archaeological resources. Since all ten sites are near water sources and have well drained soils, the survey determined that those portions of the ten sites that are dry and level have moderate to high potential to contain pre-Contact archaeological resources.

Two previously identified architectural resources were recorded in the APE and an additional 47 resources were identified in the study area. Five District Resources were identified in the study area, but no District Resources were documented in the APE. Only the Risser's Mill Complex is recorded as an eligible District Resource located directly adjacent to the current proposed APE boundary.

The archival background research and cartographic review identified historic-period resources in Evaluation Units 2, 3, 5, 6, 7, and 8. The portions of these sites that are dry, and level have moderate to high potential to contain historic-period archaeological resources.

It is recommended that additional archaeological investigation, such as a Phase IB archaeological survey, is warranted if there are to be any ground-disturbing activities to the areas classified as moderately and highly sensitive for archaeological resources.

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